

Dec. 11, 1945.

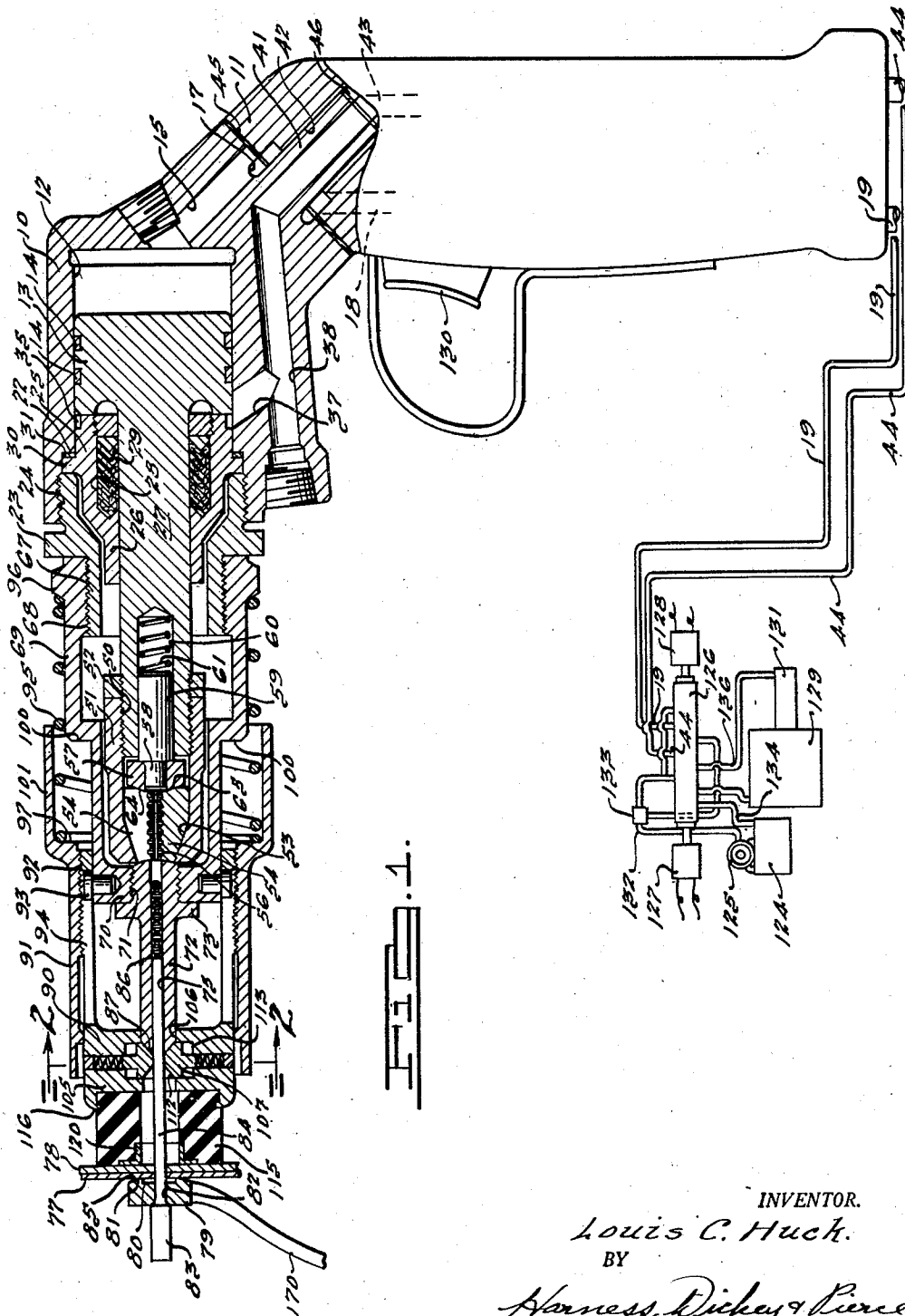
L. C. HUCK

2,390,537

METAL PLATE DIMPLING MACHINE

Original Filed Aug. 12, 1940

2 Sheets-Sheet 1



Dec. 11, 1945.

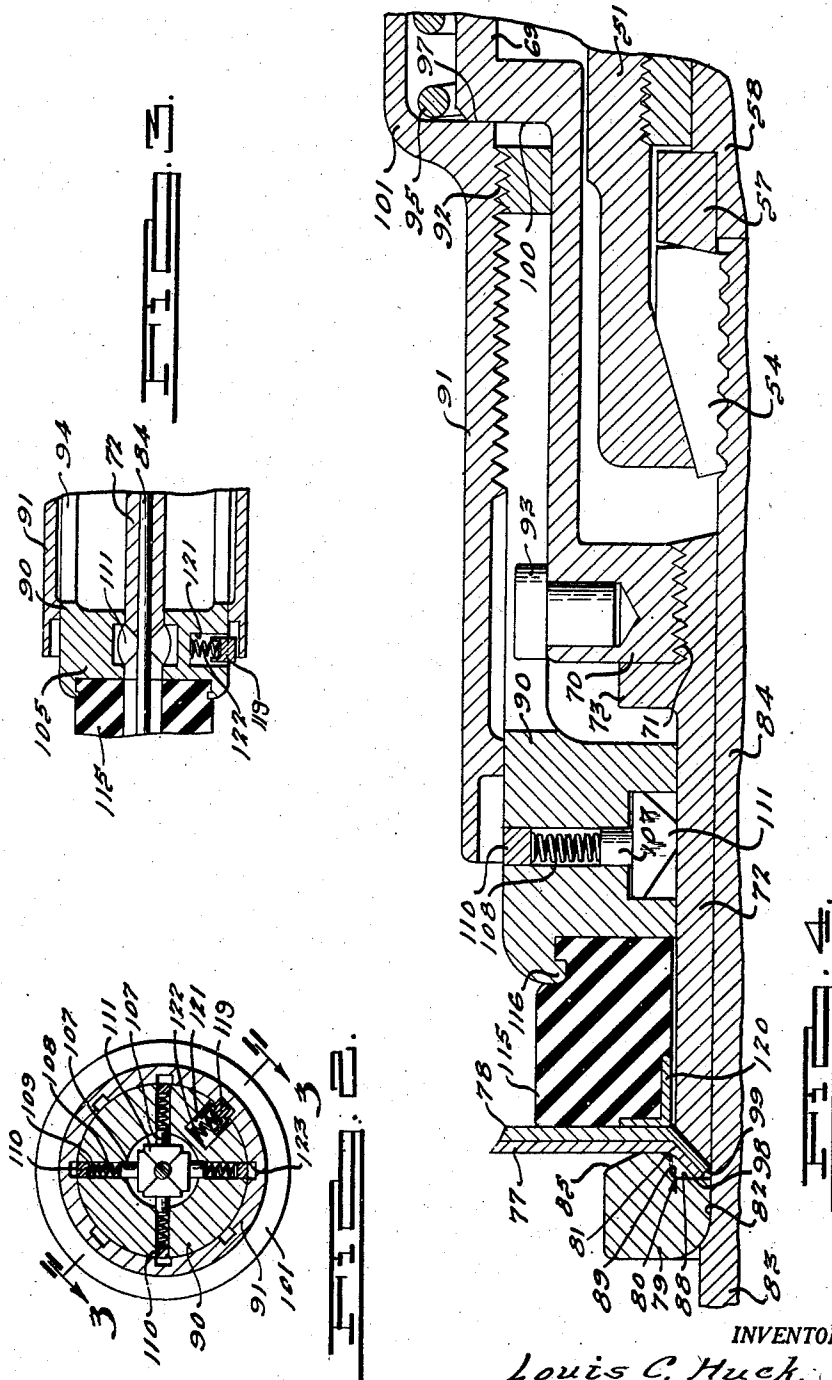
L. C. HUCK

2,390,537

METAL PLATE DIMPLING MACHINE

Original Filed Aug. 12, 1940

2 Sheets-Sheet 2



INVENTOR.

Louis C. Huck.

BY

Harness, Dickey & Pince.

UNITED STATES PATENT OFFICE

2,390,537

METAL PLATE DIMPLING MACHINE

Louis C. Huck, Grosse Pointe Shores, Mich., assignor, by mesne assignments, to Huxon Holding Corporation, Detroit, Mich., a corporation of Michigan

Original application August 12, 1940, Serial No. 352,204. Divided and this application May 19, 1943, Serial No. 487,582

8 Claims. (Cl. 153—21)

The invention relates generally to riveting and it has particular relation to dimple riveting and the formation of dimples in metal sheets to be riveted together; more particularly, the invention constitutes a division of the co-pending application for patent, Serial No. 352,204, filed August 12, 1940.

In certain respects, also, the present invention is related to that embodied in my Patent 2,292,446 wherein a simplified form of dimpling apparatus is shown along with a disclosure of methods of dimple riveting. As discussed in that application for patent, especially in conjunction with aircraft, it is extremely desirable in the riveting of the metal skin or cover, to employ rivets having heads flush with the surface of the cover in order to eliminate projections on surfaces exposed to air flow. It is a general practice in such cases where the metal cover is too thin to allow counter-sinking, to dimple the metal around each rivet hole so as to provide a recess for the rivet head. Dimpling of the metal is particularly advantageous, in that it increases the shear strength of the riveted joint, since the contacting dimpled portions of the overlapping metal sheets provide a means, in addition to rivet, for carrying the shear load.

An object of the invention is to provide an efficient, small, and easily maneuverable dimpling apparatus, which is operated by fluid pressure.

Another object of the invention is to provide dimpling apparatus such as mentioned heretofore, which includes means for centering and guiding a mandrel into the end of a dimpling tool forming part of the apparatus.

Another object of the invention is to provide a mandrel centering and guiding device such as last mentioned which automatically is retracted to an out of the way position during the dimpling operation so that it will not interfere with movement of the tool into engagement with the sheet metal.

Another object of the invention is to provide improved means for modifying the tendency of the sheets to bend during the dimpling operation so that bending will be avoided or controlled in a desirable manner.

Another object of the invention is to provide an improved dimpling apparatus having means for counteracting this tendency of the sheets to bend during the bending operation, wherein the action of this counteracting means may be varied by adjustments provided for this purpose.

Another object of the invention is to provide an improved dimpling apparatus for dimpling

assembled metal sheets which includes mandrel or pin gripping jaws and a means for automatically retracting or releasing the jaws at the end of the dimpling operation, so that the mandrel or pin may be easily released and again inserted.

Another object of the invention is to provide an improved method of dimpling metal sheets which will require minimum forces while still allowing a suitable dimple to be formed without breaking or cracking of the dimpled metal.

Another object of the invention is to provide an improved mechanism for dimpling metal sheets which will enable forming the dimple with minimum forces and which will automatically govern the formation of the dimple by controlling the amount of force applied.

Another object of the invention is to provide an improved mechanism for dimpling metal sheets wherein the dimpling operation will automatically be governed by stop means limiting the relative movement of the dimpling members.

Other objects of the invention will become apparent from the following description, from the drawings forming a part of the specification, 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 longitudinal view, mainly in longitudinal section, of apparatus for forming dimples in assembled metal sheets, as constructed according to one form of the invention;

Fig. 2 is a cross-sectional view taken substantially along the line 2—2 of Fig. 1;

Fig. 3 is a sectional view taken substantially along the line 3—3 of Fig. 2; and

Fig. 4 is a fragmentary view on the order of Fig. 1, illustrating the relation of parts approximately at the end of the dimpling operation.

Referring to Fig. 1, the dimpling mechanism or gun as shown comprises a cylinder 10 having a handle 11 secured thereto by suitable means not shown, so that the gun may be manually held and manipulated. The cylinder 10 has an inner cylindrical wall 12 slidably receiving a piston 13 having suitable sealing rings 14 for preventing a leakage of fluid between the wall and piston. At its right hand end, the cylinder is closed by an integral wall portion, excepting for a fluid passage 15, and this passage leads to an annular passage 17 at the junction of the handle and cylinder and in turn the annular passage 17 communicates with a passage 18 extending through the handle for connection with a fluid conducting line 19.

At its left end the cylinder 10 is enlarged thereby forming a shoulder 22 and within the enlargement a bushing 23 is threaded as indicated at 24. An annular end member 25 has a cylindrical portion 26 slidably receiving a piston rod 27 projecting from the piston 13 and a recess 28 having packing rings 29 engaging the rod and this member is held in place at the left of the cylinder by a collar 30 thereon disposed between the end of the bushing 23 and the shoulder 22. A gasket 31 is located between the shoulder and collar 22 to prevent leakage of fluid at this point.

The extreme right end of the member 25 has an annular relief 35 which communicates with a fluid passage 37 extending laterally through the wall of cylinder 10 and communicating with a passage 38 leading to the handle 11. The passage 38 also extends through a projection 41 on the cylinder 10 disposed in a similar opening 42 in the handle and from this point the passage is connected with a passage 43 leading to an outlet 44. Sealing gaskets 45 and 46 disposed at the junction of the casing and handle portions prevent leakage of fluid.

The piston rod 27, at its left end, terminates in a threaded portion 50 and on this threaded portion a jaw holder 51 is threaded and is retained in place by means of a lock nut 52. The left end of the jaw holder is provided with a plurality of circumferentially arranged sockets 53, which converge toward the left end of the jaw holder and which respectively receive similarly shaped jaws 54. The sockets and surfaces of the jaws may represent conical forms, or, in other words, the surface of each socket and the outer surface of each jaw may form a section of a conical surface, with the surfaces having substantially full surface contact when the jaws are in clamping positions. Grooves 56 in the inner faces of the jaws are adapted to engage a grooved mandrel to be mentioned presently, and when the end of the mandrel is between the jaws, movement of the jaw holder to the right will cause the jaws to grip the mandrel.

The jaws are urged towards the left end of the jaw holder by means of a jaw follower 57 mounted on a reduced end portion 58 of a plunger 59 that is slidably mounted in a bore 60 in the left end of the piston rod. A spring 61 in such bore urges the plunger 59 and jaw follower 57 to the left and hence the jaws to the left end of the jaw holder. It may be observed that the right ends of the jaws have angled or tapered faces 64 and that the left end of the follower 57 is similarly tapered as indicated at 65, and this relation of surfaces is provided in order to effect expansion of the jaws when forced to the right relatively to the jaw holder.

The bushing 23 has an outer cylindrical portion 67 threaded as indicated at 68 and upon which a barrel 69 is threaded, and the latter at its left end has an inwardly extending end wall 70 terminating in a threaded aperture 71 adjacent the end of the jaw holder 51. A metal dimpling tool 72 is threaded into the threaded aperture 71 until a head 73 thereon engages the wall 70 of the barrel and the inner end of the tool is shaped to fit the left end of the jaws so as to provide an abutment which serves to force the jaws rearwardly when the jaw holder and piston move to the left. In other words, just before the piston reaches its left limited position, the jaws strike the end of the tool 72 and are moved to the right relative to the jaw holder 51 and also ra-

dially outwardly into releasing position due to the relation of the surfaces 64 and 65 on the jaws and follower 57. Hence, the jaws move outwardly in their sockets to releasing positions and this movement is such that the mandrel mentioned previously may be freely removed axially from the jaws. It may be observed here that the tool 72 has an axial bore 75 leading to the jaws so that the mandrel may be inserted axially through the tool and into position between the jaws.

For dimpling sheets of metal indicated at 77 and 78 disposed in overlapping relation, a die 79 is employed which has a recess 80 into which the metal is forced during the dimpling operation and a rounded edge 81 adapted to engage the sheet metal around the dimpling area for supporting the metal. This die is centrally apertured as indicated at 82 and the mandrel previously mentioned and indicated at 84 extends through this opening. The mandrel may have a press fit in the opening 82 so that it will not be easily removable and has a head portion 83 for preventing pulling of the mandrel through the die during the dimpling operation. It may be noted that the die outwardly of the recess 80 has its face next to the sheet metal 77 relieved as indicated at 85 and the purpose of this is to provide a space for the sheet metal to be axially pressed to the left around the dimpling area in counteracting or modifying bending caused by the dimpling operation. The mandrel 84 has a grooved or ribbed end 86 adapted to fit between the grooved jaws 54 in order to positively lock the jaws and mandrel together during the dimpling operation. For forcing the sheet metal into the die recess 80, the tool 72 has a frusto conical end 87, which, when moved against the sheet, dimples the sheets into the die recess 80.

It is to be observed that the die recess 80 has a flat bottom 88 and a cylindrical side wall 89 and that the edge of the sheet metal is flattened against the bottom 88 during the dimpling operation while the metal between the shoulders 81 and the flattened edge is unsupported. This flattened edge is indicated at 98 and during its formation the metal is upset along the mandrel as indicated at 99. Flattening of the metal edge prevents splitting or cracking and thereby allows the dimple to be formed without danger of splitting. At the same time, by leaving the metal unsupported between the edge 98 and shoulder 81, it is easier to form the dimple and, therefore, a smaller force may be used and this is of considerable importance since smaller pressures may be used that will not endanger breaking of the mandrel 84. It may be observed that the dimple portions tend to extrude or shift towards the die along wall 89 of the latter a slight amount due principally to the fact that the diameter of the wall 89 is less than the diameter of the tool 72 plus the doubled thickness of the sheets 77 and 78.

During dimpling of sheets such as mentioned, bending of the latter around the dimpling area tends to occur, and if not counteracted or modified the sheets finally will become bowed or arcuate and this may be undesirable. To offset or modify this tendency of the sheets to bend, means are provided which will be described presently for exerting a force against the sheets during the dimpling operation and this force tends to bend the sheets over the rounded edge 81 of the die and towards the relief 85 in the die face. It may be desirable when the dimpling operation is effected to have the sheets remain flat, but

again it may be desirable to variably control the amount of bending of the sheets over the edge of the die so that finally the sheets will have a desired contour. It would be even feasible to so vary the force applied to the sheets to bend them that the sheets as finally dimpled would have a bent contour opposite to that which would have been obtained through the dimpling operation alone. Therefore, it should be understood that the contour of the sheets may be varied simply by varying the pressure applied to the sheets to bend them.

It may be mentioned now that the frusto-conical end of the tool 72 presents a problem of mandrel insertion into the bore 75, because the opening for inserting the mandrel is approximately the same size as the mandrel and there is nothing on the tool end to guide the mandrel into the opening. Where dimples must be formed rapidly, some delay might be incurred in repeatedly inserting a mandrel into the end of the tool without guiding means and the construction to be described solves this problem.

Again directing attention to Fig. 1, it will be observed that inner and outer sleeves 90 and 91 are mounted on the barrel 69 and these sleeves are threadedly connected at 92, so that the sleeves may be moved axially in a relative sense by turning one with respect to the other. The sleeve 90 is maintained on the barrel by circumferentially separated pins 93 on the barrel which are slidably arranged in slots 94 in the wall of the inner sleeve with the slots having closed ends so that the sleeves 90 cannot normally be removed. The two assembled sleeves are normally urged to the left end of the construction by a coil spring 95 encircling the barrel and engaging a collar 96 at the right end of the latter and a shoulder 97 on the outer sleeve 91. Attention is directed to the fact that the barrel has a shoulder 100 which is in a position to engage the shoulder 97 on the sleeve 91 when sufficient relative movement of the barrel and sleeve occurs in an axial direction. A flange or rim 101 on the sleeve 91 normally will prevent anyone from accidentally having a finger caught between the two shoulders during operation of the mechanism and also will prevent external objects of other character from becoming disposed in the space between the two shoulders.

The left end of the sleeve 90 has a relatively thick end wall 105 which is apertured at its center as indicated at 106 for allowing passage of the tool 72 through the wall. Now for providing a means for facilitating the insertion of the end of the mandrel into the frusto conical end of the tool 72, radially disposed guide members are provided in the end wall 105 and these members have pin portions 107 slidably mounted in radial openings 108 in such wall. Springs 109 in the openings 108 urge the members inwardly and the outer ends of the springs are retained in the openings by plugs 110 suitable secured in the outer end of the latter. The inner ends of the pins 106 carry centering or guiding portions 111, respectively, and these centering portions, when brought together as shown in Figs. 1, 2 and 3, jointly form a frusto conical cavity at the right side which fits the frusto conical end of the tool 72, and at the left side, a frusto conical cavity 112 for guiding the pin 84 into the bore of tool 72. It is to be observed that the portions 111 are disposed in an annular channel shape recess 113 and that they are guided radially by the walls of the recess. It may be noted also that the cen-

tering devices are formed at their center to provide an opening which will allow the end of the mandrel to be pushed therethrough.

With the sleeve 90 moved to its extreme left position as governed by the slots 94 and pins 93, it will be apparent that the spring pressed guiding devices will be urged to the positions shown in Fig. 1, so that they will form a centering and guiding cavity which renders it easy to insert the end of the mandrel. On the other hand, it will be apparent that the sleeve 90 can be moved to the right easily and against the action of the spring 95 and the plunger springs 109 and that during this operation the guiding devices will be moved outwardly by the tool 72, thereby allowing the latter to pass through the end wall 105 of the sleeve.

For applying pressure to the sheets in order to modify the bending tendency, a rubber bushing 115 is mounted on the end face of the wall 105 and this bushing may be retained in place by an overhanging flange 116 although it may be desirable to bond the bushing to the end face of the wall. This rubber sleeve is adapted to engage the sheet 78 and resiliently to apply pressure thereto during the dimpling operation. Attention is directed to the fact that an angular ring 120 confines the inner corner edge of the bushing at its outer end and this washer is provided mainly to prevent the rubber from being deformed inwardly into a position where it would be caught by the tool moving into the die during the dimpling operation. In other words, it confines the corner at this point and governs the bow of rubber and at the same time a radial leg of the washer provides a metal face contact with the sheet immediately adjacent the dimpling area and this may be found desirable in order to insure flatness of the sheet immediately adjacent the edge of the dimpling area.

It has been stated that the shoulder 100 on the barrel 69 is adapted to engage the shoulder 97 on the sleeve 91, and that this engagement will occur after a predetermined relative axial movement of the sleeve and barrel. In other words, the distances between the two shoulders governs the movement required before engagement. For varying the distance between the two shoulders, it is only necessary to turn the sleeves 90 and 91 relatively which will adjust the position of the shoulder 97 on sleeve 91 with respect to the ends of slots 94 and pins 93, holding the sleeve 90 in its outermost position. While it is desirable to have the sleeves 90 and 91 relatively turnable in order to make this adjustment, it is also expedient that turning not accidentally occur and in order to normally prevent turning of sleeve 91 on the sleeve 90, a plunger 119 is provided as shown by Figs. 2 and 3. This plunger is disposed in a recess 121 in the end wall 105 of sleeve 90 and is pressed outwardly by means of a spring 122. The outer end of the plunger is adapted to selectively fit circumferentially spaced notches 123 arranged on the inner periphery of the end of sleeve 91 and the outer end of the sleeve overhangs the plunger 119 so that normally release of the plunger will not occur. When it is desired to relatively turn the sleeves, the plunger may be pushed inwardly by any suitable instrument and then the sleeve 91 may be turned on the sleeve 90 until the sleeves are in the positions desired, and then the plunger may be allowed to enter an adjacent notch 123. It will be apparent, of course, that the pins 93

on the barrel 69 prevent turning of the sleeve 90 relatively to the barrel.

Fluid under pressure may be conducted through the lines 19 and 44 to either side of the piston 13 and ordinarily high fluid pressure will be required at the left side of the piston since movement of the piston to the right is the working movement while a lower fluid pressure may be used to return the parts to their original positions, it being understood that fluid will exhaust at one side of the piston while being allowed to flow into the cylinder at the opposite side of the piston.

Assuming that the dimpling operation is now to be performed, the die 79 with attached pin is associated with the sheets 77 and 78 and the mandrel is passed through a previously drilled opening in the sheets around which the dimpling is to occur. The dimpling mechanism is moved over the projecting mandrel to the position shown in Fig. 1 and it will now be readily apparent that when the mechanism is moved over the projecting end of the mandrel, the guiding devices 111 will facilitate movement of the mandrel into the end of the tool 72.

When the parts are positioned as shown in Fig. 1, and the rubber bushing is against the sheet 78, the operator applies further pushing effort to the mechanism and toward the sheet 78 and this will cause the barrel 69 and tool 72 carried thereby to move to the left relative to the sleeves 90 and 91, and, as a result, the tool 72 will spread the guiding devices 111 and move through the end wall 105 and through the rubber bushing. During this action, the spring 95 is compressed and the shoulders 97 and 100 relatively approach each other. Final movement of the plunger 72 manually in this respect, causes the grooved end of the mandrel to move into the space between the jaws 54 until it engages the end of the reduced portion 58 of the plunger 59. This serves notice to the operator that the parts are in operative position and in particular that the end of the mandrel is located properly between the jaws.

When the parts are in this relation, the fluid under pressure is caused to enter the cylinder at the left side of the piston 13 and to exhaust from the right side of the piston and as a result the piston 13 will move to the right relative to the cylinder. The first part of this movement will cause the jaw holder 51 to move relative to the jaws 54 and clamping of the jaws about the end of the mandrel will occur. Further movement of the jaw holder and piston then will carry the jaws and mandrel therewith but if the sheets 77 and 78 are in relatively fixed position, the piston and parts carried thereby instead of moving, will remain stationary so to speak, while the barrel will move to the left. In any event, after the piston has moved sufficiently to cause the jaws to be clamped about the end of the mandrel, relative axial movement of the barrel and tool 72 with respect to the mandrel will occur and this will cause the frusto conical end of the tool to move through the bushing and to press the sheets 77 and 78 into the die recess 80 thus performing the dimpling operation. During the dimpling operation, the shoulders 100 and 97 on the barrel 69 and sleeve 91, respectively will engage each other and then the sleeves 90 and 91 will be directly and positively moved by the barrel and will forcefully press the rubber bushing to apply the pressure against the sheet 78. Thus, this pressure becomes positive and direct except for

the resiliency of the rubber during the dimpling operation, although the pressure may become positive and direct earlier or only during part of the dimpling operation, depending upon the location of the shoulders 97 and 100 relatively. From this it can be seen that the shoulders 97 and 100 can be adjusted axially in a relative sense so that the barrel will pick up the sleeves 90 and 91 at a desired time to cause direct and positive pressure through the rubber bushing and against the sheets 77 and 78. While preliminary movement of the barrel relative to sleeve 91 will compress the spring 95, ordinarily this pressure would not be of such character as to bend the sheets as the spring ordinarily is used to return the sleeves 90 and 91 to their lefthand position when the parts return to inoperative positions as seen in Fig. 1. By placing the shoulders 97 and 100 closer together, positive and direct pressure to the rubber bushing can be secured earlier and it follows that the pressure applied by the rubber will become greater and greater as the tool and die move together. The amount of pressure thus can be determined by adjustment of the shoulders 97 and 100 relatively, and as stated before, modification of the bending of the sheets during the dimpling operation can be varied and the contour of the sheet can actually be governed as may be found most desirable.

Fig. 4 shows the parts on a larger scale approximately at the end of the dimpling operation. Deformation of the rubber naturally will occur owing to its incompressible character and accordingly it will expand as shown.

In effecting the aforesaid dimpling operation, a fluid pressure system may be employed as diagrammatically illustrated in Fig. 1 and which generally may correspond to the system embodied in my Patents Nos. 2,088,859 and 2,132,112. This system includes a fluid tank or reservoir 124, a motor driven pump 125, a control valve 126, solenoids 127 and 128 for moving the valves in opposite directions, respectively, and a pressure booster 129 including a small barrel 131. The supply line leading from the pump is indicated at 132 and an adjustable relief by-pass valve 133 in this line is also connected to a return line 134 leading to the tank. The valve allows the liquid to by-pass to the tank when necessary and may be so adjusted that the necessary dimpling pressures in any case will be available before by-passing occurs. Fluid is delivered to the booster when the valve 126 is in one position and from the booster barrel 131, the fluid flows through a line 136 leading to the valve 126. With the valve 126 in one axial position, fluid is supplied to line 19 directly from the pump in order to return the piston 13 to its inoperative position, whereas, when the valve is reversed, the line 44 is placed in communication with the barrel 131. Higher pressure is available therefore for the working stroke but when this pressure reaches a definite amount, the valve 133 will allow by-passing from which it follows a definite but adjustably limited pressure may be employed for governing the character of the dimpling action.

A trigger 130 on the handle 11 may control switches not shown for either energizing one or the other of the solenoids 127 and 128 depending upon whether the trigger is moved in one direction or the other.

From the foregoing it will be understood that when the trigger is operated to effect the dimpling operation, the tool 72 will press the sheets into the die recess until the edge of sheet 77 strikes

the bottom 88 of the die and then continued movement of the tool will deepen the dimple since the metal is unsupported between the bottom 88 and shoulder 81 of the die, but the resistance to dimpling increases with the dimpling, and as flattening of the edge occurs and at a predetermined pressure, the valve 133 will operate to by-pass the liquid to the tank. It should be appreciated that a high pressure is not required to dimple the metal and to get the correct dimple angle since the die is unsupported to the side of the dimple, while at the same time it should be appreciated that cracking is prevented by the flattening and upsetting of the edge of the sheet metal.

Under certain circumstances, liquid under pressure may be supplied to the line 44 and air under pressure to the line 19 in accordance with the supply system disclosed in my Patent No. 2,053,718, relating to riveting mechanism. In this case, the trigger 130 will operate a valve on the handle for connecting and disconnecting the passage 18 and line 19 to exhaust or atmosphere and operation of the trigger in this way as disclosed in such patent will cause the required movements of the piston.

Upon completion of the dimpling operation, release of the trigger 130 causes the line 44 to become open to return or exhaust while the line 19 is open to fluid pressure. Then the piston 13 returns to its lefthand position and finally the jaws 54 strike the right end of the tool 72 and expand so that the mandrel is released. Then the mechanism can be bodily moved away from the metal sheets following which the parts may be associated with another opening in order to effect another dimpling operation.

A fluid supplying system such as shown in the patent to Peterson, et al., No. 2,163,627 also may be employed in which case the lines 15 and 16 of such patent will correspond with the lines 44 and 19 respectively, herein. Also, the switch 49, 51 in the patent will correspond to the trigger 130 in the present application so that operation of the trigger 130 will control the system in the manner that the switch in the patent controls the supplying of fluid under pressure in the lines 15 and 16. In using a system of this character, operation of the switch will cause fluid under pressure to be supplied to line 44 until resistance is encountered such as when the end of the tool 72 first engages the plate 78 and then a higher fluid pressure may automatically be supplied to perform the dimpling operation. In this system, when the pressure on the piston reaches a predetermined amount in the dimpling operation, automatic reversal of fluid flow may occur so that the piston will be reversed automatically.

In all the systems, it is desired that the control be simple and handy for the operator, such as by employing a trigger on the handle of the gun and that the lines 19 and 44 be flexible in character so that the fluid supplying or developing source can be located remotely to the dimpling mechanism from which it follows that the operator may be at some distance from the source of fluid pressure while still maintaining complete control through a simple form of controlling means on the mechanism. It might be added that where the trigger on the handle operates electrical controlling means, wires will lead from the handle to the electrically controlled valves or means at the source of pressure development.

As stated heretofore, the plates 77 and 78 may comprise laminations of an airplane cover and in

this event they may be constructed of an aluminum alloy. It will be understood pursuant to this that the die 79, tool 72, pin 84, anvil 170, and other parts will be formed of suitably hard metal to perform the functions necessary in the use of the mechanism.

It will be apparent that all of the operations in so far as the use of force is involved occur at only one side of the sheets and that no backing element requiring forceful manual holding at the opposite side of the sheet is required. In other words, it is only necessary for the operator to insert the mandrel at one side of the sheet and move the die 79 thereon into position and then it is a simple matter to hold them in that position while the mechanism is moved over the mandrel at the other side of the sheet. It may be added here that after the dimpling operation, the opening through the sheets may be enlarged slightly by a drill for example, to provide a more fully cylindrical and smooth hole, as disclosed in my Patent 2,292,446.

If the dimpling point is substantially removed from the edges of the sheet, a handle may be employed for allowing the operator to insert the mandrel at a point substantially removed from the edge. A handle 170 is shown on the die for this purpose, although it is to be understood that the handle may be releasable so that it could be connected to the die only when needed. In any event, the handle allows the operator to place the mandrel and die in position even though the opening in the plate is substantially removed from the operator and relatively inaccessible and thus access to different points interiorly of an airplane cover, for example, may easily be had. Since it is only necessary to insert the mandrel through the opening in the plate, and lightly hold the mandrel in place while the mechanism is pushed over the end of the latter, it can be easily seen that an operator will have no difficulty in performing the work necessary at the die side of the structure. Since after the dimpling operation the mandrel is definitely released from the mechanism, all the operator needs to do is to pull the mandrel away from the sheets of metal.

Dimpling can be rapidly performed in this manner even at points inaccessible and all dimpling operations can be performed while the sheets are in place on airplane wings or fuselages or other installations where sheets may be dimpled for subsequent riveting. Aside from this, the mechanism can be adjusted so that bending of the sheets that ordinarily would occur as a result of dimpling can be neutralized or counteracted so that finally undesirable deformations or bends can be avoided in the sheets. By having the mechanism connected to a remote source of fluid under pressure, the operator can quickly move from point to point for effecting one dimpling operation after another and since the gun is compact and light, this procedure is not fatiguing. Moreover, since the entire operation can be controlled by means of a trigger on the handle, all that the operator needs to do is to move the gun from one place to another and push it over the mandrel or mandrels successively and repeatedly move the trigger for effecting the dimpling operations. Two operators, one handling the mandrel and die device and moving it from point to point, and the other operating the dimpling mechanism and moving it from point to point, thus can rapidly effect one dimpling operation after another while the sheets

are in place on the structure. Rapidity of dimpling of airplane structures is thus increased and the dimpling operations are performed accurately and uniformly.

Although 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 appended claims.

What is claimed is:

1. An apparatus for forming a dimple around an opening in metal sheets comprising a tubular casing, pin gripping means axially movable in the casing, a tool projecting from one end of the casing and terminating in a frusto-conically shaped end adapted to press the sheets at one side, said tool having a central bore and being aligned with the pin gripping means so that a pin may be pushed through the tool and engaged by the pin gripping means, a die member to be disposed at the other side of the sheets and having a pin adapted to project through said opening in the latter and through said bore for engagement with said gripping means, means for relatively moving the gripping means and tool axially of the casing so as to bring the tool and die into sheet dimpling positions and for returning the gripping means and tool to inoperative positions, an axially movable member on the casing and extending along the tool, means on the end of the member adapted to contact the sheet metal around the dimpling area in order to modify bending of the sheets during the dimpling operation, retractable guide means on the member and disposed adjacent the frusto-conical end of the tool when the latter is in inoperative position so as to guide the pin into the bore, means normally urging the member outwardly along the tool axis and a stop for limiting such axially outward movement of the member so that the guide means may be disposed in operative position when the tool is moved to its inoperative position, said means on the end of the member for contacting the sheet metal comprising a resilient rubber bushing, and an annular washer of relatively hard material providing an end face portion on the outer end of the bushing.

2. An apparatus for forming a dimple around an opening in metal sheets comprising a tubular casing, pin gripping means axially movable in the casing, a tool projecting from one end of the casing and terminating in a frusto-conically shaped end adapted to press the sheets at one side, said tool having a central bore and being aligned with the pin gripping means so that a pin may be pushed through the tool and engaged by the pin gripping means, a die member to be disposed at the other side of the sheets and having a pin adapted to project through said opening in the latter and through said bore for engagement with said gripping means, means for relatively moving the gripping means and tool axially of the casing so as to bring the tool and die into sheet dimpling positions and for returning the gripping means and tool to inoperative positions, an axially movable member on the casing and extending along the tool, means on the end of the member adapted to contact the sheet metal around the dimpling area in order to modify bending of the sheets during the dimpling operation, retractable guide means on the member and disposed adjacent the frusto-conical end of the tool when the latter is in inoperative position so as to guide the pin into the bore, means normally urging the member out-

wardly along the tool axis and a stop for limiting such axially outward movement of the member so that the guide means may be disposed in operative position when the tool is moved to its inoperative position, said means on the end of the member for contacting the sheet metal comprising a resilient rubber bushing and an annular relatively hard washer of angular cross section fitting the inner peripheral edge of the outer end of the bushing and providing a relatively rigid end face portion for contacting the sheet metal immediately adjacent the dimpling area.

3. An apparatus for forming a dimple around an opening in metal sheets comprising a tubular casing, pin gripping means axially movable in the casing, a tool projecting from one end of the casing and terminating in a frusto-conically shaped end adapted to press the sheets at one side, said tool having a central bore and being aligned with the pin gripping means so that a pin may be pushed through the tool and engaged by the pin gripping means, a die member to be disposed at the other side of the sheets and having a pin adapted to project through said opening in the latter and through said bore for engagement with said gripping means, means for relatively moving the gripping means and tool axially of the casing so as to bring the tool and die into sheet dimpling positions and for returning the gripping means and tool to inoperative positions, an axially movable tubular member on the casing and through which the tool extends, and a resilient rubber bushing fastened on the outer end of the axially movable member and including an annular washer of relatively hard material on the end of the bushing and forming a part thereof.

4. An apparatus for forming a dimple around an opening in metal sheets comprising a tubular casing, pin gripping means axially movable in the casing, a tool projecting from one end of the casing and terminating in a frusto-conically shaped end adapted to press the sheets at one side, said tool having a central bore and being aligned with the pin gripping means so that a pin may be pushed through the tool and engaged by the pin gripping means, a die member to be disposed at the other side of the sheets and having a pin adapted to project through said opening in the latter and through said bore for engagement with said gripping means, means for relatively moving the gripping means and tool axially of the casing so as to bring the tool and die into sheet dimpling positions and for returning the gripping means and tool to inoperative positions, an axially movable tubular member on the casing and through which the tool extends, and a resilient rubber bushing fastened on the outer end of the axially movable member and including an annular washer of relatively hard material on the end of the bushing and forming a part thereof, said washer being angular in cross section and having an annular flange extending radially outwardly and an axial or cylindrical flange extending within the opening in the bushing.

5. An apparatus for forming a dimple around an opening in metal sheets comprising a tubular casing, pin gripping means axially movable in the casing, a tool projecting from one end of the casing and terminating in a frusto-conically shaped end adapted to press the sheets at one side, said tool having a central bore and being aligned with the pin gripping means so that a pin may be pushed through the tool and engaged by the pin gripping means, a die member to be disposed at the other side of the sheets and hav-

ing a pin adapted to project through said opening in the latter and through said bore for engagement with said gripping means, means for relatively moving the gripping means and tool axially of the casing so as to bring the tool and die into sheet dimpling positions and for returning the gripping means and tool to inoperative positions, an axially movable tubular member on the casing and through which the tool extends, retractible guide means on the member and disposed adjacent the frusto-conical end of the tool when the latter is in inoperative position so as to guide the pin into the bore, resilient means on the outer end of the tubular member for engaging the sheet metal around the area to be dimpled, and means for moving the tubular member during the dimpling movement of the tool so as to compress the rubber against the sheet metal.

6. An apparatus for forming a dimple around an opening in metal sheets comprising a tubular casing, pin gripping means axially movable in the casing, a tool projecting from one end of the casing and terminating in a frusto-conically shaped end adapted to press the sheets at one side, said tool having a central bore and being aligned with the pin gripping means so that a pin may be pushed through the tool and engaged by the pin gripping means, a die member to be disposed at the other side of the sheets and having a pin adapted to project through said opening in the latter and through said bore for engagement with said gripping means, means for relatively moving the gripping means and tool axially of the casing so as to bring the tool and die into sheet dimpling positions and for returning the gripping means and tool to inoperative positions, an axially movable tubular member on the casing and through which the tool extends, retractible guide means on the member and disposed adjacent the frusto-conical end of the tool when the latter is in inoperative position so as to guide the pin into the bore, means on the end of the tubular member for engaging the sheet metal around the area to be dimpled so as to modify bending of the metal around the area to be dimpled, and means on the casing for effecting axial movement of the member including the guide means thereon during the dimpling of the metal so as to apply pressure to the sheet metal around the area being dimpled.

7. An apparatus for forming a dimple around an opening in metal sheets comprising a tubular casing, pin gripping means axially movable in the casing, a tool projecting from one end of the casing and terminating in a frusto-conically shaped end adapted to press the sheets at one

side, said tool having a central bore and being aligned with the pin gripping means so that a pin may be pushed through the tool and engaged by the pin gripping means, a die member to be disposed at the other side of the sheets and having a pin adapted to project through said opening in the latter and through said bore for engagement with said gripping means, means for relatively moving the gripping means and tool axially of the casing so as to bring the tool and die into sheet dimpling positions and for returning the gripping means and tool to inoperative positions, an axially movable tubular member on the casing and through which the tool extends, retractible guide means on the member and disposed adjacent the frusto-conical end of the tool when the latter is in inoperative position so as to guide the pin into the bore, means on the end of the tubular member for engaging the sheet metal around the area to be dimpled so as to modify bending of the metal around the area to be dimpled, and means on the casing for effecting axial movement of the member including the guide means thereon during the dimpling of the metal so as to apply pressure to the sheet metal around the area being dimpled, said means for effecting axial movement of the member being adjustable so as to enable varying the pressure applied to the sheet.

8. An apparatus for forming a dimple around an opening in metal sheets comprising a tubular casing, pin gripping means axially movable in the casing, a tool projecting from one end of the casing and terminating in a frusto-conically shaped end adapted to press the sheets at one side, said tool having a central bore and being aligned with the pin gripping means so that a pin may be pushed through the tool and engaged by the pin gripping means, a die member to be disposed at the other side of the sheets and having a pin adapted to project through said opening in the latter and through said bore for engagement with said gripping means, means for relatively moving the gripping means and tool axially of the casing so as to bring the tool and die into sheet dimpling positions and for returning the gripping means and tool to inoperative positions, an axially movable tubular member on the casing and having an end wall through which the tool extends, retractible guide means in said end wall for guiding the pin into the bore, and a resilient element fastened directly to the outer end face of said end wall for engaging the sheet metal around the area to be dimpled so as to modify bending of the metal around the area to be dimpled.

LOUIS C. HUCK.