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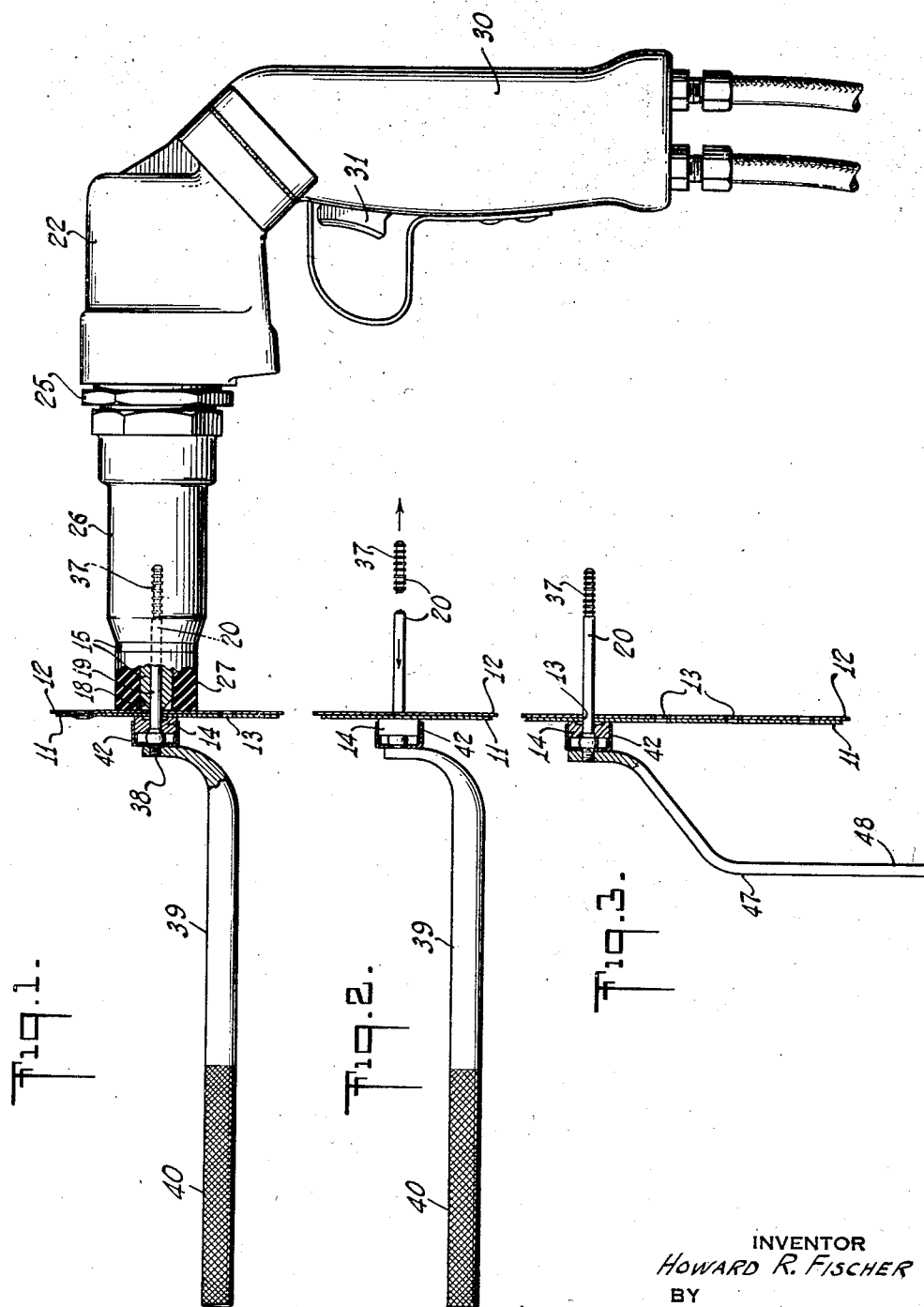
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DIMPLING APPARATUS

Filed Oct. 13, 1942

2 Sheets-Sheet 1



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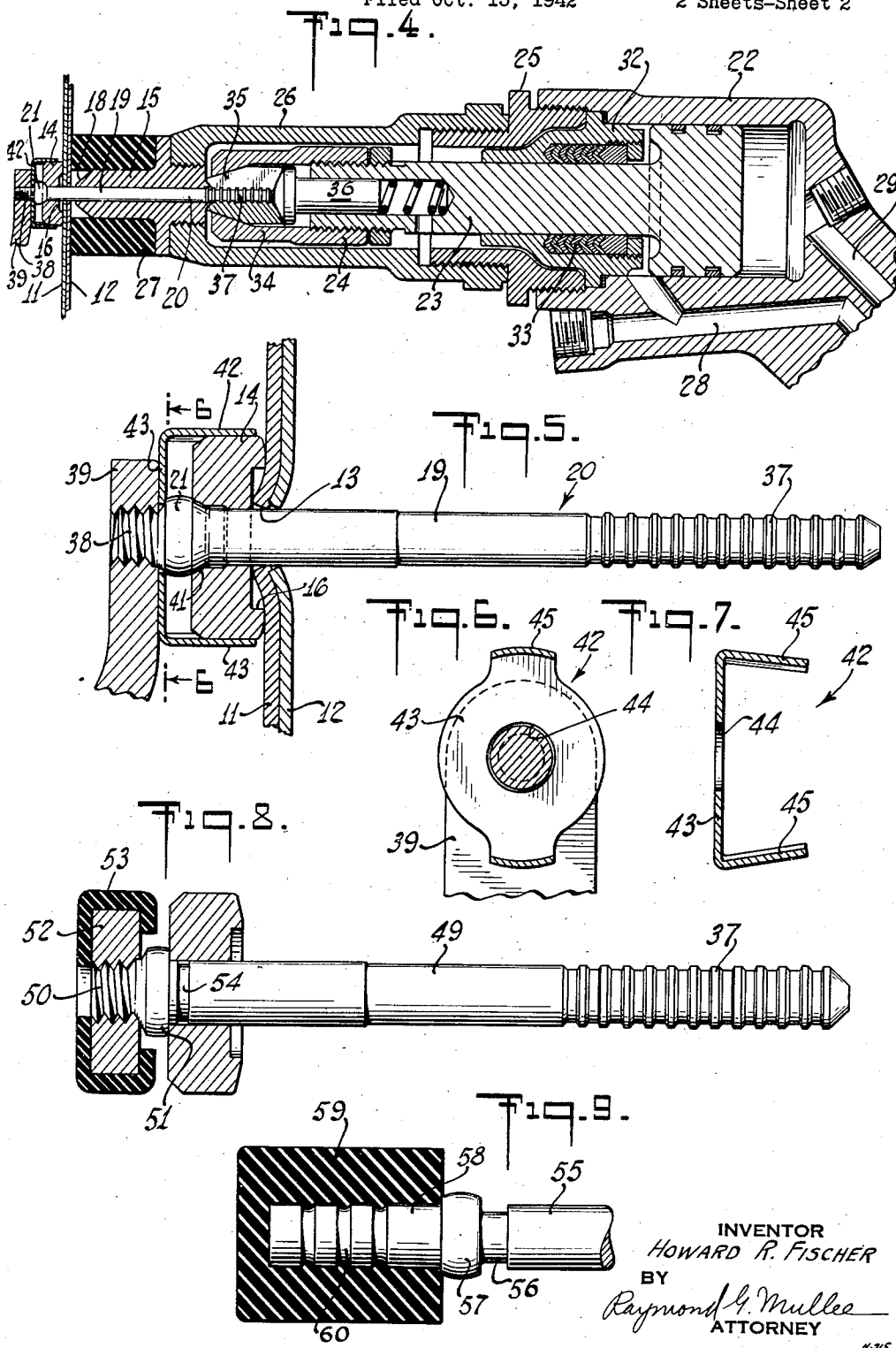
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DIMPLING APPARATUS

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4 Claims. (Cl. 153—21)

This invention relates to apparatus for forming dimples around rivet holes in thin metal sheets to adapt them for the reception of flush type rivets. It has particular reference to a draw pin which extends through the hole and forms part of the means for applying force between two opposed dies.

Flush rivets are used extensively in aircraft construction on the exposed surfaces of the metal skin which forms a cover for the fuselage, wing sections and other structural elements. The metal sheets, usually made of aluminum alloy, are mounted in place and the overlapping portions thereof are provided with registering perforations formed by drilling or punching. The sheets are dimpled around the holes to provide recesses for receiving the heads of the rivets. The resulting structure has the advantages of increased strength of the rivet joint and decreased wind resistance.

According to one method of dimpling, which is considered to be the most effective for certain types of work, a draw pin is inserted from one side of the sheets through the rivet hole and the projecting end on the other side is grasped with a power tool which applies pressure to opposed dimpling dies through the application of tensile force to the draw pin. As soon as the dimple is formed, the draw pin is retracted and moved to the next hole. The cycle of operation must necessarily be repeated in rapid succession because of the thousands of holes required to be dimpled in a single airplane. In the development of this method, it was found that the draw pins frequently broke under the repeated strains and that the release of the forces on the pin at the instant of breakage caused the free end to be projected like a bullet. This not only endangered the operator but also resulted in loss of time, and excessive cost of replacement of dimpling apparatus.

Among the objects of the invention are the prevention of accidents, the provision of means for moving the pin from one rivet hole to another with greater facility, and to minimize waste of time and materials in reconstructing parts of the dimpling apparatus following breakage of the pin.

A feature of the invention resides in an extension on the draw pin which is adapted to be connected to a holder. Another feature resides in a clip which prevents the die from becoming accidentally separated from the broken end of the pin, but which permits the die to be readily transferred to a new pin.

Other objects and features of the invention

will appear more clearly from the description which follows.

In the accompanying drawings:

Fig. 1 is a side elevation partly in section showing a draw pin arranged in operative relation to a holder and to a power tool;

Fig. 2 is an elevational view showing the relation between the holder and the pin when the latter breaks;

Fig. 3 is a side elevation partly in section of a draw pin positioned to be attached to a power tool and supported by a holder of modified form;

Fig. 4 is a longitudinal section through a part of the power tool shown in Fig. 1, on a larger scale;

Fig. 5 is an elevational view of the draw pin on a much larger scale, showing in section the pin, one of the dies, and fragmentary parts of the holder and sheet metal;

Fig. 6 is a cross section, as indicated by the arrows 6 in Fig. 5;

Fig. 7 is a longitudinal section of the clip showing the shape it assumes when detached from the die;

Fig. 8 is a view partly in elevation and partly in longitudinal section of a modified pin and holder assembly; and

Fig. 9 is a fragmentary view of another modified pin and holder assembly.

The dimpling apparatus of the present invention is designed to operate on the overlapping portions of two thin metal sheets 11 and 12 after they have been provided with registering perforations 13 formed by drilling or punching. The two sheets are dimpled simultaneously by the application of opposing pressures to a pair of dies 14 and 15. As shown in Fig. 4, die 14 has a recess 16 to receive the flanged metal while the die 15 has a frusto-conical portion 18 complementing the recessed die. The two dies are arranged in surrounding relation to the shank 19 of a draw pin or mandrel 20 which extends through the opening 13 in the metal sheets and which has a head 21 against which the recessed die 14 is seated.

A power tool may be provided for pulling pin 20 and the recessed die while applying the reactive force against the die 15. One embodiment of a tool for this purpose is described herein and not claimed, per se. It comprises a cylinder 22, a piston 23 reciprocable therein, a chuck 24 at the front end of the piston for grasping the rear end of the draw pin 20, a pair of casing sections 25 and 26 connecting the cylinder 22 with the die 15, and a rubber abutment member 27 adapted to press forwardly against the metal

sheets during the dimpling operation. The piston is reciprocated by pressure fluid, preferably oil, supplied through front and rear cylinder passages 28 and 29 respectively, which extend through a handle 30 and which are controlled by a manipulative trigger 31. A bearing 32 is supported near the front end of the cylinder and held in place by the casing section 25. The bearing supports a packing 33 in which the piston 23 reciprocates.

Chuck 24 comprises an internally tapered sleeve 34, a plurality of radially moveable jaws 35, and a spring-pressed plunger 36 urging the jaws forward into camming engagement with the sleeve. The inner surfaces of the jaws have arcuate grooves arranged to grip the circumferentially grooved portion 37 near the rear end of the draw pin 20. The sleeve 34 has a screw-threaded connection with piston 23.

In use, the draw pin is inserted through a pre-formed opening 13 in sheets 11 and 12 until the recessed die 14 abuts against sheet 11. The power tool is held in position to receive the grip portion 37 of the draw pin 20. The trigger 31 is pressed, thereby operating remote control mechanism (not shown) to initiate flow of hydraulic pressure fluid through passage 28 to pull piston 23 rearwardly. The chuck 24 pulls the draw pin 20 which in turn draws the recessed die 14 into tight engagement with sheet 11. The reaction of the pulling force moves the cylinder 22, casing sections 25 and 26, and the frusto-conical die 15 forwardly, thereby dimpling or flanging the metal sheets into the shape shown in Fig. 5. A part of the reaction is also transmitted to the rubber block 27 which supports the sheet metal at the circumference of the dimpled portion.

The draw pin or mandrel is made of hardened steel and has a tensile strength which is generally not much greater than the maximum applied stress, due to the annular recesses in the portion 37 and to the fact that the outer diameter is limited by the size of the drilled hole, for example one-eighth inch. The strain of repeated operations eventually results in fatigue failure of the steel whereupon the pin breaks. Just before the pin snaps, very heavy strains are present in various parts of the machine. Likewise severe strains are set up in the pin which are manifested by a considerable stretch or elongation before the elastic limit is reached and a fracture of the pin occurs. All these strains represent potential energy which is instantly released upon breakage of the pin and which tends to project the broken end like an arrow from a bow.

The present invention provides means for protecting the operator by preventing the broken end of the pin from being projected. Accordingly, the draw pin is provided with an extension forwardly of the head 21 to receive a holder. In the preferred form of the invention, shown best in Figs. 1 and 5, the extension 38 is screw-threaded from the head 21 to the front extremity of the pin 20. The threaded extension forms a detachable connection with a tapped opening in the flanged end of a holder 39. The main part of the holder extends perpendicular to the sheet metal and terminates in a knurled portion 40 providing a handle grip for the operator.

The recessed die 14 is detachable from the draw pin 20 and may be transferred from one pin to another as the pins break. According to one feature of this invention, the die loosely surrounds shank 19 and seats against a shoulder

41 on the pin head 21, said shoulder and the complementary surface on the die having a non-locking taper. This permits the die to be removed from the pin by hand. Prior to this invention, it was the practice to make a press fit between the die and the pin. Whenever a pin broke, it was necessary to take the parts to an arbor press to remove the broken pin from the die. To obviate the need for a press fit with its resulting inconveniences, a quick detachable connection is herein provided. It comprises a clip 42 having a disc portion 43 provided with a central perforation 44 whereby the disc may surround the draw pin and may be clamped between the pin head 21 and the holder 39. Extending rearwardly from the disc portion is a pair of integral spring jaws 45 adapted to receive the die 14 therebetween. As shown in Fig. 7, the clip when unattached is of such shape that the jaws taper rearwardly toward each other. To attach them to the die 14 they must be sprung into parallel relation thereby providing sufficient tension to hold the die against movement away from the tapered shoulder 41. This provides a friction lock for the die which prevents accidental separation but permits removal of the die relative to the pin at the will of the operator.

Summarizing the operation; two operators are located respectively on opposite sides of the metal sheets 11 and 12, one grasping the holder 39 and the other the grip handle 30 of the power tool. The holder 39 forms a unitary structure with the draw pin 20, recess die 14, and clip 42, and by manipulating the holder the pin may be inserted through the drilled holes 13 at the start of the dimpling operation. The power tool is advanced until the chuck jaws 35 pass over the grip portion 37 of the draw pin, and the trigger 31 is then pressed. This starts the power stroke of the tool, pulling the draw pin 20 and recessed die 14 rearward, while applying an equal and opposite pressure to the frusto-conical die 15 and rubber block 27. The opposing pressures on dies 14 and 15 dimple or squeeze the metal sheets 11, 12 into the shape shown in Fig. 5. The trigger 31 is then released to cause the hydraulic pressure fluid to reverse the piston stroke whereupon the chuck 24 releases its grip on pin 20. The operators then move their respective appliances to the succeeding drilled hole. The operations are repeated in rapid succession and it is only a matter of time before the draw pin breaks. The point at which breakage most frequently occurs is at the foremost groove on grip portion 37 as shown in Fig. 2. Immediately following the rupture, the front end of the pin tends to be projected under the influence of stored energy, as in the case of prior devices. The escape of the pin is prevented however by the attached holder 39, which is much heavier than the pin and which absorbs the shock tending to propel the latter. The broken pin is unscrewed from the holder and removed from the die 14 and clip 42 by hand. Another pin is then substituted thereby permitting the die, clip, and holder to be used repeatedly.

From the above description it is apparent that the holder 39 not only protects the operator against possible injury but also functions to facilitate insertion of the draw pin into the metal sheets. Moreover, the holder cooperates with the clip 42 to prevent the die 14 from becoming lost when the pin 20 breaks.

Fig. 3 shows a modified form of holder 47

formed by bending a flat strip of metal. The modified holder has a grip portion 48 extending parallel to the metal sheets instead of perpendicular thereto as in the case of the holder 39. This enables the holder and attached parts to be manipulated in close quarters.

Fig. 8 discloses a modified pin, die, and holder assembly. The pin 49 has a threaded portion 50 extending forwardly from a head 51. Extension 59 cooperates with a modified holder consisting of a metal knob 52 internally threaded to receive the extension 50 and being of approximately the same length as the extension. A rubber sleeve 53 is vulcanized around the knob to permit it to be grasped directly by the hand. The knob 52 has the advantage of fitting into close quarters but the disadvantage that its mass is not very large in relation to the weight of the pin. In order to reduce the size of the broken end portion, the pin is provided with a neck 54 just rearwardly of the head 51. The neck is recessed to such an extent that the tensile strength is slightly weaker at the neck than at the pull grooves 57. When a rupture occurs, the larger part of the pin remains in the grip of the power tool while only a small portion at the front end tends to be projected and can easily be held by the operator.

Fig. 9 shows a further modification in which the draw pin 55 has a neck 56, head 57 and extension 58 adapted to perform the same functions as the corresponding elements in Fig. 8. The extension instead of being screw-threaded is generally cylindrical and is secured to a rubber knob 59 by vulcanization. If desired a series of annular grooves 60 may be provided to strengthen the grip of the rubber knob.

What is claimed is:

1. Dimpling apparatus comprising a draw pin having a shank extending through a hole in a metal sheet and being inserted from the front side to the rear side of the metal, a grip portion on the pin near its rear end, a shoulder on the pin near its front end, a recessed die seated against said shoulder and engageable with the front face of the sheet around the hole, a complementary frusto-conical die engageable with the rear face of the sheet around the hole, power means for pulling the pin at said grip portion and for transmitting the reaction of the pulling force to the frusto-conical die, a screw-threaded portion at the front extremity of the pin, and a threaded handle secured to said screw-threaded portion, said handle providing manual means for

inserting the draw pin through the hole and also for restraining the pin in the event of breakage.

2. Dimpling apparatus comprising a draw pin having a shank extending through an opening in laminated metal sheets and being inserted from the front side to the rear side of the metal, a grip portion on the pin near the rear end, a shoulder on the pin near the front end, a removable die mounted on the shank and seated against said shoulder and having a recessed part engageable with the front face of the sheets around the opening, a complementary frusto-conical die engageable with the rear face of the sheets around the opening, power means for pulling the pin at said grip portion and for transmitting the reaction of the pulling force to the frusto-conical die, an integral extension at the front extremity of the pin, a handle secured to said extension, said handle providing manual means for inserting the draw pin through the holes and also for restraining the pin in the event of breakage, and releasable means for securing the recessed die against rearward movement away from the shoulder.

3. Dimpling apparatus for sheet metal comprising a pair of complementary dies engageable with opposite sides of the metal, a draw pin adapted to extend through said dies and through an opening in said metal, power means for pulling said pin and applying the reactive force to one of said dies, a head on said pin for applying the pulling force to the other of said dies, an extension on said pin beyond said head, and a holder having a grip portion extending parallel to the pin and having a flanged portion provided with a tapped opening, said pin extension being screw-threaded to form a detachable connection with said tapped opening.

4. Dimpling apparatus comprising a draw pin having a shank, a shoulder at the forward end of the shank, a die having a shoulder complementing the shoulder on the pin, said shoulders having a non-locking taper to permit separation of the die from the pin, said pin having a head and a threaded extension in advance of the shoulder, a holder with a tapped portion receiving said threaded extension, and a clip for preventing accidental separation of the die from the pin, said clip having a perforated disc portion surrounding the pin and clamped between the holder and the pin head, said clip having resilient fingers projecting from the disc portion and frictionally engaging the die.

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