

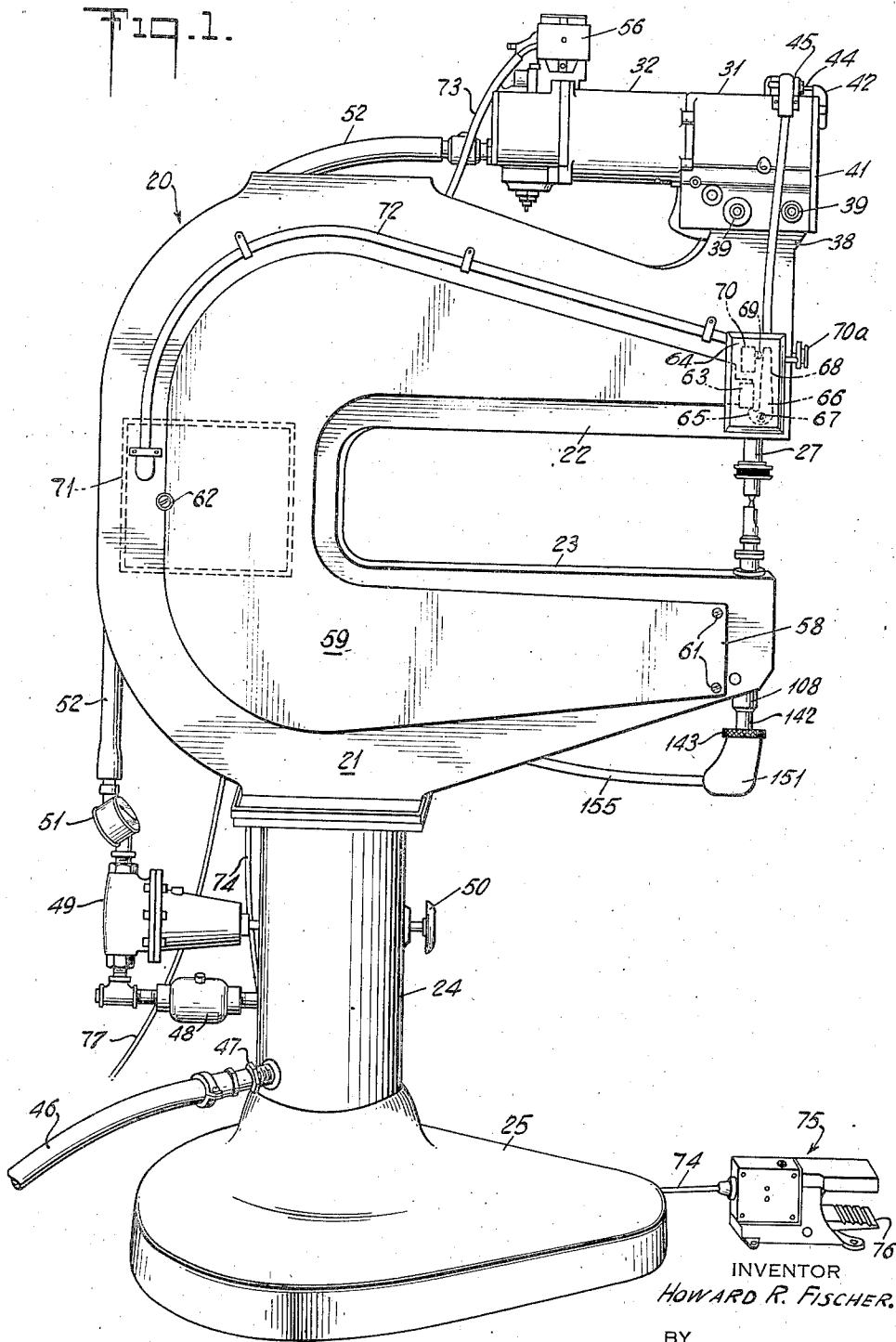
Jan. 4, 1949.

H. R. FISCHER
DIMPLING MACHINE

2,457,992

Filed Jan. 15, 1945

6 Sheets-Sheet 1



INVENTOR
HOWARD R. FISCHER.
BY
Raymond S. Muller
ATTORNEY

2,457,992

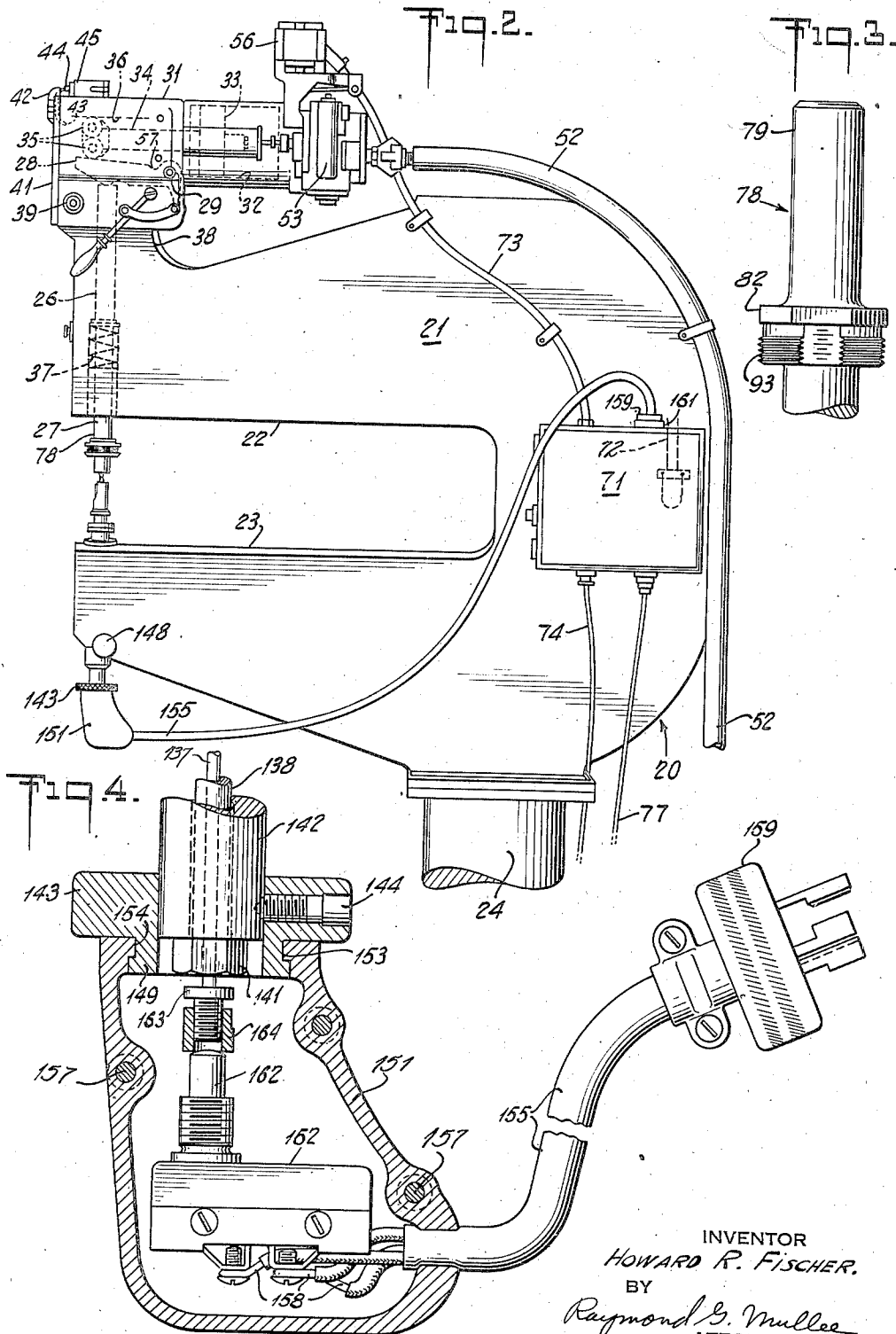
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6 Sheets-Sheet 2



INVENTOR
HOWARD R. FISCHER.
BY
Raymond G. Muller
ATTORNEY

K-118-172

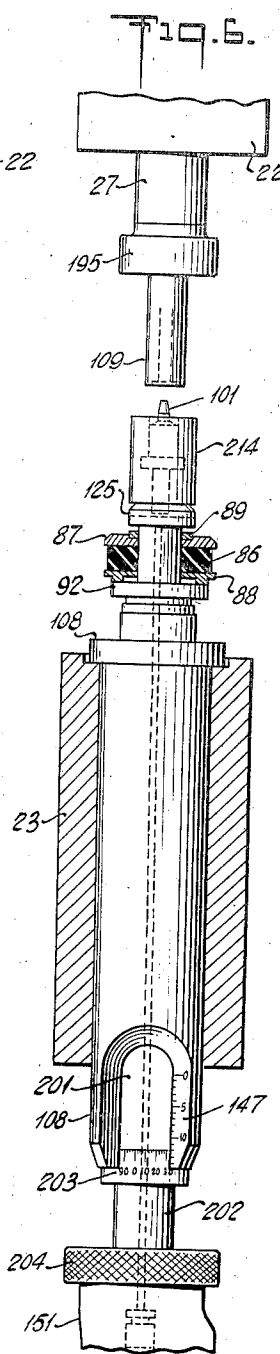
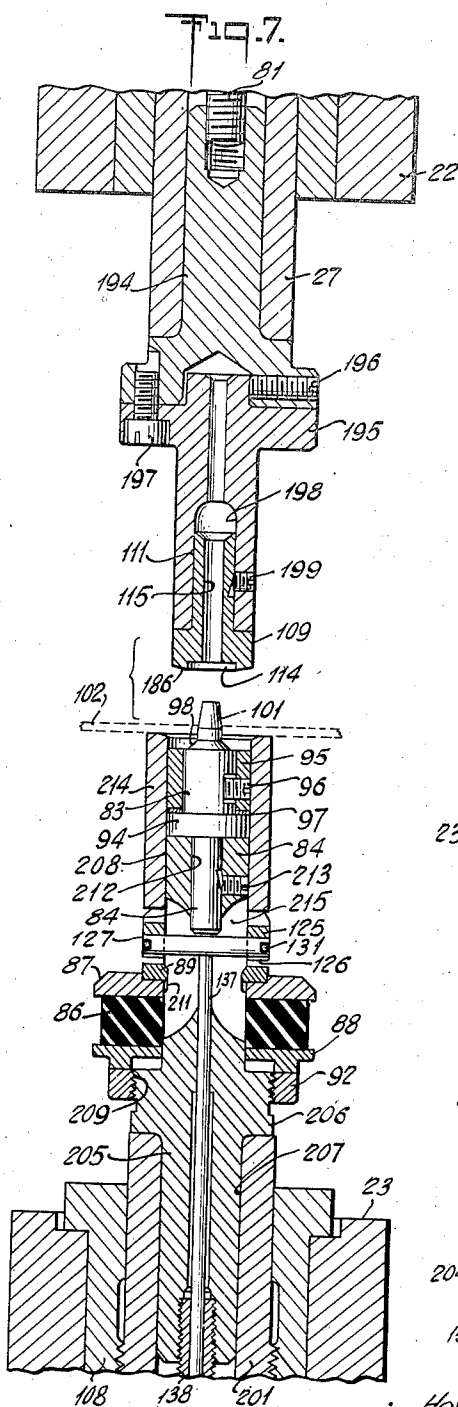
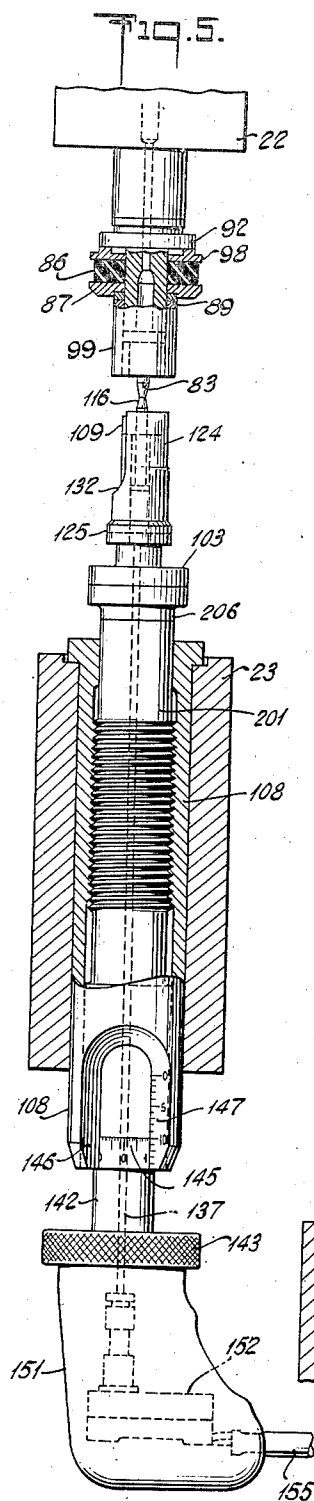
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6 Sheets-Sheet 3



INVENTOR
HOWARD R. FISCHER

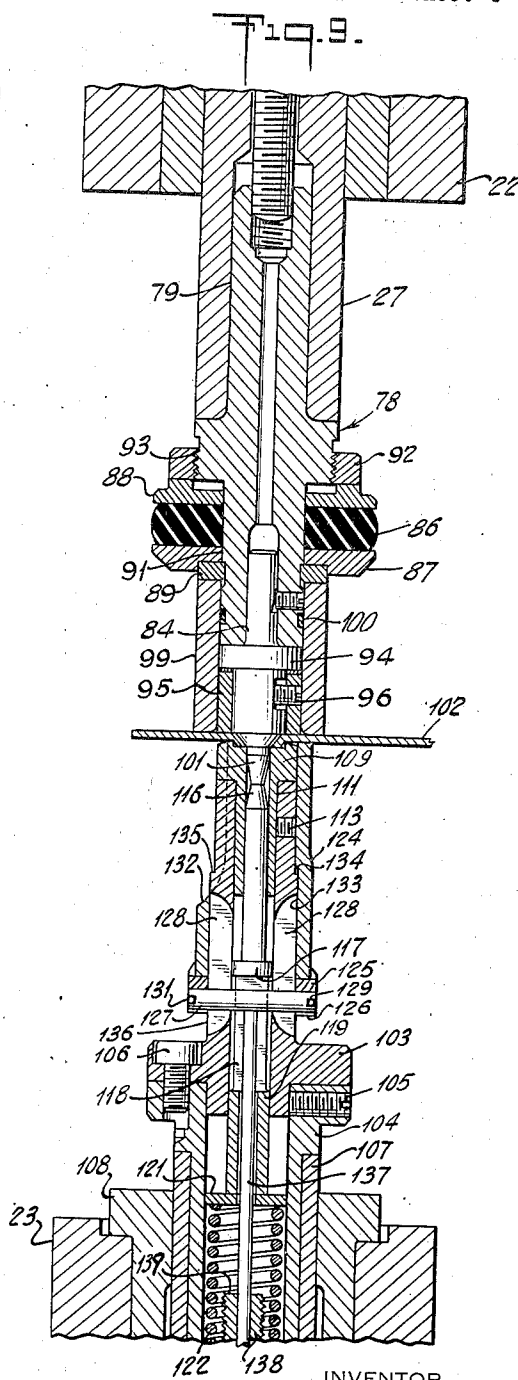
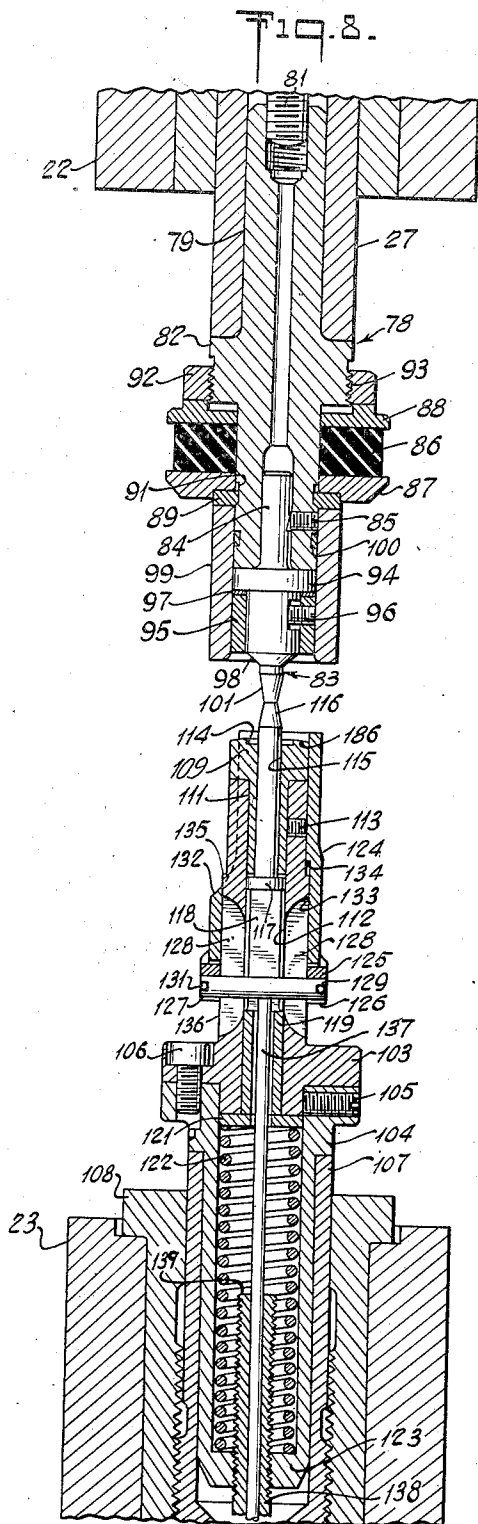
BY
Raymond G. Muller
ATTORNEY

K-116-177

H. R. FISCHER
DIMPLING MACHINE

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6 Sheets-Sheet 4



INVENTOR
HOWARD R. FISCHER.

BY
Raymond G. Muller
ATTORNEY

K-416-177

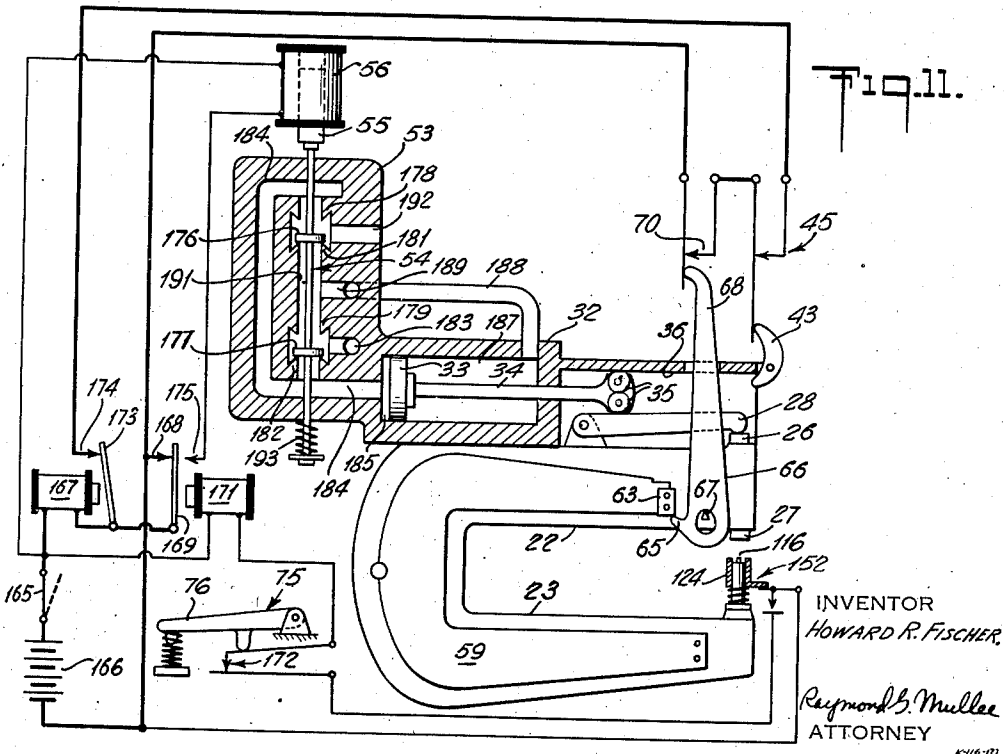
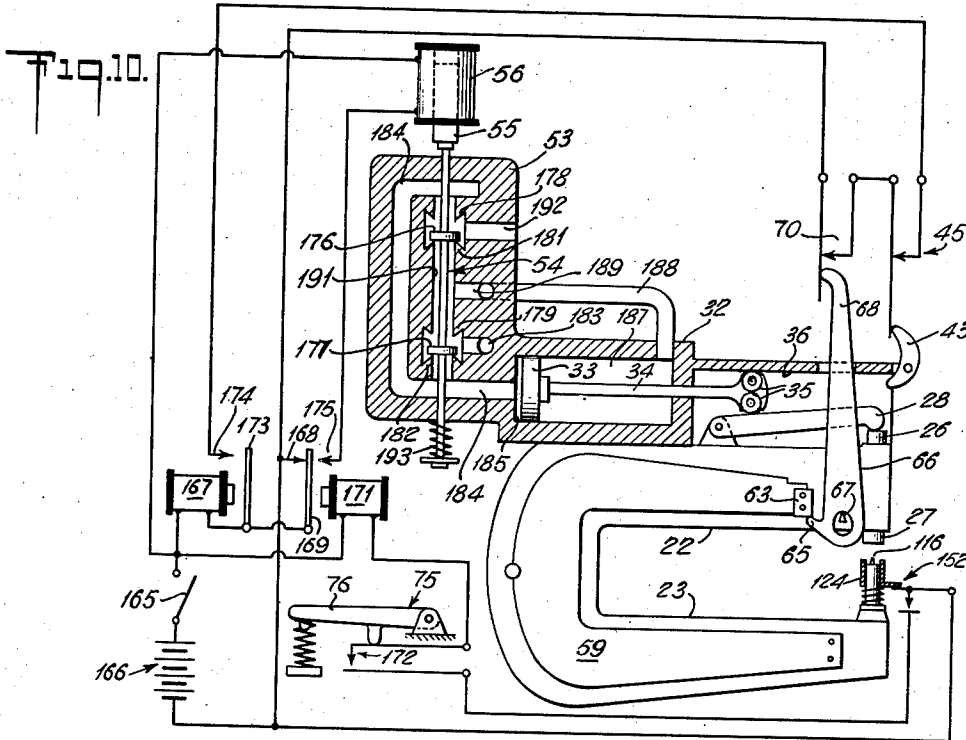
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H. R. FISCHER
DIMPLING MACHINE

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6 Sheets-Sheet 5



INVENTOR
HOWARD R. FISCHER.

Raymond B. Muller
ATTORNEY

K-416-17.

Jan. 4, 1949.

H. R. FISCHER
DIMPLING MACHINE

2,457,992

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6 Sheets-Sheet 6

Fig. 12.

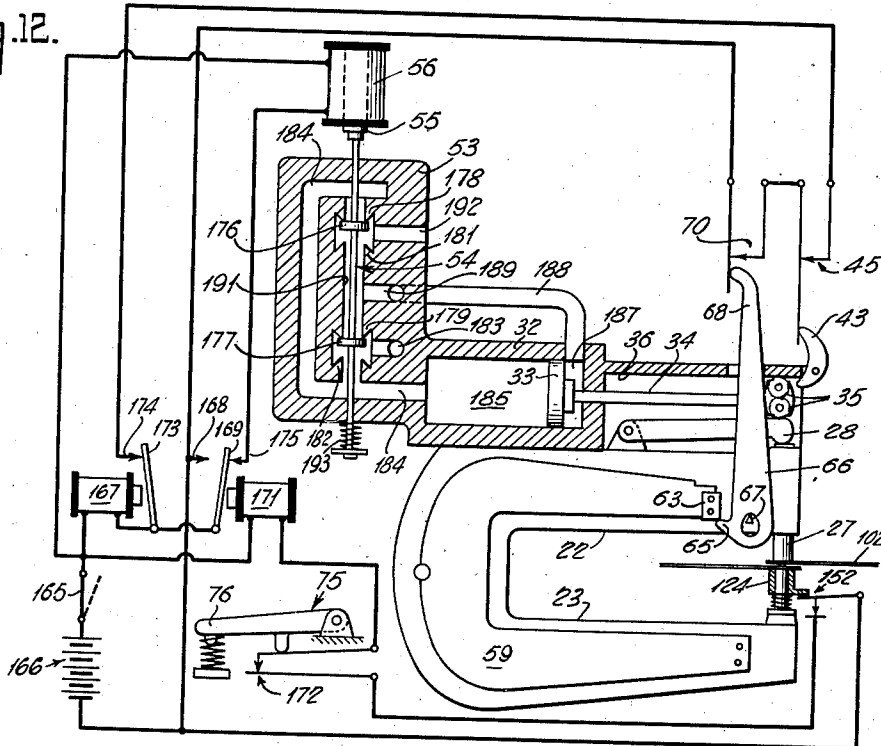
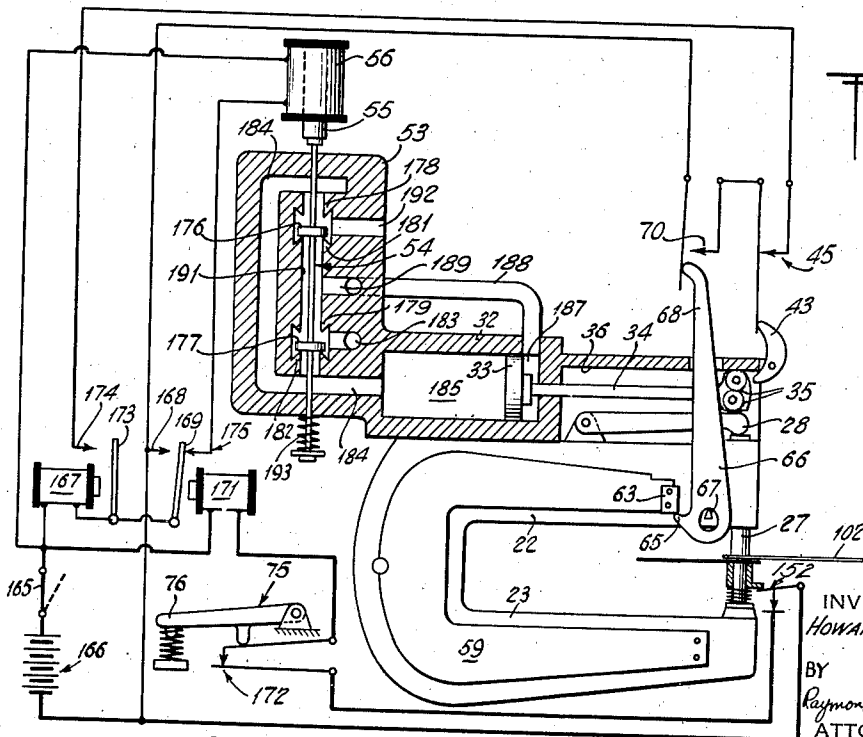


Fig. 13.



INVENTOR
HOWARD R. FISCHER.
BY
Raymond B. Muller
ATTORNEY

K-104-177

UNITED STATES PATENT OFFICE

2,457,992

DIMPLING MACHINE

Howard R. Fischer, Detroit, Mich., assignor to
Chicago Pneumatic Tool Company, New York,
N. Y., a corporation of New Jersey

Application January 15, 1945, Serial No. 572,839

20 Claims. (Cl. 153—21)

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This invention relates to automatic dimpling machines with particular reference to apparatus or attachments adapted to be applied to conventional riveting machines for quickly converting them into machines for dimpling work sheets from the topside and alternatively from the underside thereof.

The main object of the invention is to provide automatic means for dimpling metal work sheets from above or below the latter by mounting upon a riveting or dimpling machine a special type of dimpling tool and equipment which is partly reversed in position for topside dimpling from the position of said tool and equipment when arranged for underside dimpling.

Another object is to provide a riveting or dimpling machine with dimpling equipment which also includes a movable member and associated micro-switch operated thereby for stopping operation of the machine at the end of the dimpling stroke in order to produce uniform dimpling.

A further object is to have dimpling equipment which is accurately adjustable for uniformly dimpling work sheets of various gauges in predetermined manner.

It is also an object of the invention to have such equipment adapted to cooperate with a starting switch circuit which is arranged to cause only one cycle of operation for each time it is closed without regard to the length of time said circuit remains closed. According to a feature of this invention the starting circuit includes two switches arranged in series, one being depressed by the foot of the operator and the other being closed by the weight of the sheet metal when properly positioned on the dimpling die.

Other objects and advantages of the invention are set forth more fully in the following specification so as to become obvious when the latter is considered in conjunction with the accompanying drawings, in which:

Fig. 1 is a side elevation of a machine having a yoke of the type commonly employed for riveting, but equipped with the automatic dimpling attachment embodying the invention when arranged for topside dimpling of metal work sheets;

Fig. 2 is another elevational view of the same machine as seen from the opposite side, the base portion being omitted;

Fig. 3 is a fragmentary elevation of the uppermost part or tool holder of the topside dimpling equipment;

Fig. 4 is a section of the lowest portion of the dimpling equipment including a switch casing with

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a micro-switch and associated parts in operative position;

Fig. 5 is an elevation partly in section of the topside dimpling equipment alone showing only fragments of the jaws of the dimpling or riveting machine;

Fig. 6 is a similar elevation partly in section of the dimpling equipment arranged for underside dimpling, the lower portion of the micro-switch and its casing being broken off;

Fig. 7 is a fragmentary section of the portions of the underside dimpling equipment of Fig. 6 which are generally exposed between the jaws of the machine;

Fig. 8 is also a fragmentary section of the portions of the topside dimpling equipment of Fig. 5 generally exposed between the jaws of the machine and disposed in initial operative position;

Fig. 9 is a similar section of the same equipment in operated position with a work sheet in place in fully dimpled condition;

Fig. 10 is a circuit diagram of the machine and the dimpling equipment when considered as an electrical system, the latter being shown in initial idle or open circuit condition;

Fig. 11 illustrates the same circuit diagram with the main switch closed and the foot switch depressed;

Fig. 12 is another view of the circuit diagram when the machine is carrying out a dimpling operation; and

Fig. 13 is a final condition of said circuit diagram when the dimpling operation is completed and the circuit has been automatically opened.

Figs. 1 and 2 are drawn to a much smaller scale than Figs. 5 and 6, while Figs. 3, 4, 7, 8 and 9 are drawn to twice the size of Figs. 5 and 6.

In dimpling machines and apparatus it is desirable to have the latter capable of being arranged for dimpling metal work sheets from the upper side thereof and also for dimpling said sheets from the underside, certain conditions in the industry requiring this type of dimpling and at other times the other type of dimpling in order to save time and effect various economies and conveniences. Especially is it desirable to be in a position to adjust the dimpling equipment accurately so that whether topside or underside dimpling is performed it is uniformly and perfectly carried out to allow subsequent satisfactory riveting of said sheets.

It is therefore proposed to equip a dimpling or riveting machine of the general type disclosed in the copending application of Howard R. Fischer and James A. Roberts, Serial No. 514,068, filed

December 13, 1943, for a "Compression riveter," with special attachment means which fulfill the foregoing objects in making the machine adapted either for topside dimpling or for underside dimpling by using the major portion of the same equipment in both cases, with the machine equally effective in either case to produce repeated dimpling to exactly the same degree or extent.

In industries dealing with sheet metal, as for example that occupied with the production of airplanes, dimpling and riveting the metal sheets or skin form a large part of the work to be accomplished and in order to set flush type rivets to best advantage in said sheets which are usually of aluminum and aluminum alloys, the sheets are first drilled and dimpled to facilitate proper setting of the rivets, the work being necessarily carefully done to avoid damaging the metal. It is therefore most desirable that the dimpling be uniformly and carefully done for any given size of rivet so that perfect setting of the rivets will be facilitated to produce strong and safe joints which will be useful in airplane construction and capable of withstanding considerable stresses without danger of failure. It is also very desirable to have the dimpling uniform and regular in order that the rivet heads shall all be uniformly flush to avoid surface friction between the airplane and the atmosphere during flight; not to mention that it is desirable to dimple the work automatically and repeatedly to save time and increase production.

Referring again to the drawings, a dimpling or riveting machine generally indicated at 20 consists mainly of a more or less massive yoke 21 terminating at the front of the machine in opposed jaws 22, 23 and supported rigidly on a column 24 fixed upon a wide base 25. As the yoke is rather deep in order to accommodate work pieces of large size, the jaws have considerable length and during operation are under appreciable strain, and hence the yoke as a whole is made of material having great strength, toughness and elasticity, such as boiler plate steel in order to permit the development of great dimpling pressures with consequent measurable spreading apart of the jaws 22, 23 but without straining the yoke beyond its elastic limit or endurance limit. In the upper jaw is mounted a plunger 26 (Fig. 2) to the lower end of which is attached a set or tool holder 27, while above the plunger is an operating cam lever 28 pivoted at 29 in the superstructure or frame 31 above the yoke, which lever in lowered position is adapted to exert pressure on the upper end of said plunger to depress the latter. The superstructure is continued rearwardly in the form of a cylinder 32 in which piston 33 is reciprocable and provided with a piston rod 34 with traction rollers 35 at the outer end of the latter, the upper roller engaging against upper track 36 as a reaction basis on the one hand and on the other hand upon the upper straight surface of cam lever 28, it being obvious that when the piston, rod and rollers thereof are withdrawn rearwardly, the plunger 26 is relieved of the pressure of the lever and allowed to rise to initial position under the influence of a restoring spring 37, as will be further explained.

As may be noted in Fig. 2, rollers 35 are designed to roll upon each other and thereby tend to relieve the piston rod upon which they are mounted of a large part of the reaction which is transmitted from cam lever 28 and upwardly through the rollers to the track and yoke. As

the specific details of these parts are more or less conventional and form no actual parts of the invention as such, it may suffice to state that the piston rod, piston and mounting of the rollers may follow known principles or the corresponding features in the mentioned copending application. On the other hand the superstructure or frame 31 as well as cylinder 32 rigidly secured thereto are fixed upon the upper yoke extension 38 by screws or bolts 39 while a front plate 41 is attached to the front of the yoke extension and of frame 31 by screws or the like (not shown) to form a closure for the frame and further support therefor. Incidentally the front plate also includes the casing 42 pivotally supporting stop switch lever 43 which is disposed in the path of the front end of piston rod 34 and rocked by the latter to operate a button 44 of stop switch 45 to stop the piston in case said piston and piston rod should overrun their proper stroke in the forward direction when executing a power stroke. This operation will be referred to in connection with the circuit diagrams of Figs. 10 to 13.

The pressure fluid, which is preferably compressed air, is conducted by hose 46 to fixture 47 (Fig. 1) on the machine from an appropriate outside source of pressure fluid. From the fixture the pressure fluid passes through the air line oiler 48 and a pressure regulator 49 controlled by a manual regulating screw 50, past pressure gauge 51 and thence up through hose line 52 to the valve housing 53 (Fig. 2). Within the latter the control valve generally indicated diagrammatically at 54 in Figs. 10 to 13 is movable to control the supply of the pressure fluid to the cylinder 32 by the armature or core 55 of solenoid device 56 surmounting the superstructure, certain detail being omitted as superfluous here, but the operation in general will be set forth in connection with the circuit diagrams already referred to which include the essentials of the system as a whole involved in the machine.

From the foregoing it is evident that when the control valve is operated to allow the cylinder to exhaust rearwardly of the piston the spring 37 (Fig. 2) will raise plunger 26 and thereby raise cam lever 28 to a higher inclined initial position while pressure fluid is allowed to operate in front of the piston so that the latter with its rod and rollers will be returned to rearward initial position in which the rollers are disposed directly above the depression or clearance 57 in the cam lever. When the piston rod and rollers 35 occupy the rearward position, spring 37 is effective to raise plunger 26 and by the latter the cam lever to the raised inclined position (not shown) ready for a new power stroke.

It has already been mentioned that during operation when considerable dimpling pressures are produced, the yoke jaws 22 and 23 are measurably spread apart by the reaction of such pressures and this effect is therefore used to good advantage by attaching the lower forward end 58 of a U-shaped deflector plate 59 (Fig. 1) to the lower jaw 23 by screws 61 or the like and loosely retaining the intermediate portion in proximate association with the yoke 21 by a screw 62, the latter merely serving as a support or guard to prevent the plate from being accidentally bent outward away from the yoke. The upper forward end 63 projects into a switch box 64 and within the latter overhangs the lower short end 65 of a deflection switch lever 66 preferably pivoted on a knife-edge fulcrum 67 supported on

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the upper jaw 22. The upper long arm 68 of the deflection switch lever is spaced a predetermined small distance from the trigger, depressible button, or plunger 69 of a deflection plate micro-switch 70 within the switch box. The switch 70 is mounted on jaw 22 for limited movement forward and rearward in response to the turning of an adjusting knob 70a (Fig. 1). By this means the operator may regulate the distance between arm 68 and button 69 and thereby predetermine the extent of swinging movement of lever 66 required for the actuation of the micro-switch 70. For a more complete description of the mounting for switch 70, reference is made to the copending application, aforesaid. The electrical conductors between the switch and the relay box 71 on the rear of yoke 21 (Fig. 2) extend through cable 72 (Fig. 1), while from said relay box a further cable 73 extends up to solenoid 56. A cable 74 also extends down from the relay box to a foot switch 75 having a pedal 76 which when depressed by the foot of the operator closes the operating circuit associated therewith, a further cable 77 bringing electric current to the machine from an outside source.

The topside dimpling equipment will first be considered and then the operation thereof after which the underside dimpling equipment will be dealt with in due order. In the set holder 27 (Figs. 8 and 9) is mounted a punch holder 78 with shank 79 thereof secured in the set holder by a screw 81 extending up into and preferably secured to the plunger 26 in more or less conventional manner (not shown), the hexagonal flange 82 (Fig. 3) serving the double purpose of forming a stop against the lower end of set holder 27 and a means adapted for engagement by a wrench when screwing the punch holder in place or removing the same. The punch holder 78 rigidly follows the movements of the set holder and carries a skirted dimpling punch 83 with the shank portion 84 thereof secured in the lower end of punch holder 78 by a set screw 85.

Exteriorly on the punch holder are mounted a pressure pad or cushion 86 of rubber or other resilient plastic material confined between a pressure pad washer 87 and a pressure pad plate 88. The washer is retained in place by a split retaining ring 89 slidably seated in the lower end of a wide annular groove 91 on the set holder, while an adjusting nut 92 for the pressure pad is screwed down upon the thread 93 against plate 88 for adjusting the pressure pad to the desired degree of compression for producing proper resistance during operation. The punch has an intermediate flange 94 engaging against the lower end of the punch holder to properly locate and back the punch and beneath which is fixed the dimpling punch sleeve 95 held on the punch by set screw 96 and spaced from flange 94 by one or more punch sleeve shims 97, the sleeve 95 being one of a series of sleeves of different length individually adapted to cooperate with the frusto-conical portion 98 of the punch to dimple sheets of various gauges. Exteriorly of the sleeve 95 is a slidably mounted skin support sleeve 99 extending upwardly about punch flange 94 and the lower end of punch holder 78 against retaining ring 89 and downwardly a small distance to approximately the lower end of the frusto-conical portion 98 on the punch. Sleeve 99 is retained in assembled relation with the parts just enumerated by a sleeve retaining ring 100 in a second groove on the punch holder. Thus if the pilot pin 101 of the punch enters a hole in

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the metal work sheet 102 to engage the dimpling portion 98 with said work sheet, the lower end of skin support sleeve 99 will also make contact with the work sheet and be forced upward by the latter during the dimpling operation to compress pad 86 while lifting ring 89 toward the upper portion of groove 91. It will be understood that the punch 83 may be applied either to a single sheet 102 or to a pair of overlapping sheets having registering rivet holes to receive the pilot pin 101.

Complementing the dimpling punch and its assembly supported by the upper jaw 22 is a lower die holder or dimpling dolly 103 supported in the lower jaw 23 with its associated parts which are now to be described. The dolly 103 is secured in the dolly sleeve 104 by screws 105 and 106, the sleeve 104 being rigidly secured in the adjustable dolly spindle or screw 107 which is screwed into internally threaded bushing 108 fixed in the lower yoke jaw. The dolly 103 is surmounted by dimpling die 109 which has a downwardly extending hollow shank 111 occupying the upper end of a bore 112 in said dolly and secured in place by a set screw 113. The upper face of the dimpling die has a recess 114 to provide clearance for the metal displaced downwardly by the conical dimpling portion 98 of punch 83 above (Fig. 9). Within bore 115 in die 109 is a slidably mounted pilot pin 116 normally projecting with its upper end above die 109 and terminating at the lower end in a head or retaining shoulder 117 which prevents accidental removal or loss of the pin from the die and rests on the upper ends of the prongs 118 (one shown) of a bifurcated pilot pin sleeve 119. The latter in turn rests on a pilot pin sleeve washer 121 resiliently maintained in extreme raised position by the upper end of pilot pin return spring 122, the lower end of the latter being confined by the bottom 123 of the dolly sleeve 104.

Surrounding the dimpling die 109 in slidable relation therewith is a dimpling sleeve 124 normally projecting with its upper edge a slight distance above the general upper level of the dimpling die and at its lower end terminating immediately above the short sleeve or ring 125 through the open bottom slots 126 (Fig. 9) of which a crossbar 127 extends, the latter also extending transversely through side slots 128 in the dimpling dolly as well as between the prongs 118 already mentioned. The ring 125 has a peripheral groove (not shown) registering with the end slots 129 in the crossbar and the latter is retained in assembled association with the ring by a retaining wire 131 or the like. The mentioned dimpling sleeve 124 has a cut away portion 132 exposing part of the side of the dimpling die and of the upper portion of the dimpling dolly to provide ready access to said die during operation, and interiorly has a counterbore 133 terminating at an intermediate shoulder 134 adapted to engage against shoulder 135 to form a stop upon the wide portion 136 on said dimpling dolly to limit downward movement of the dimpling sleeve to normal operation thereof. The crossbar 127 rests upon the upper end of a long push rod 137 which is guided in the tubular punch die bolt 138 (Fig. 8) screwed by its upper threaded end 139 into the bottom 123 of dolly sleeve 104 to hold the latter in place in the dolly spindle 107. The lower end of the bolt has a hexagonal head 141 rigid therewith (Fig. 4) engaging against the lower end of a reduced extension 142 of the dolly spindle 107, which facilitates turning the bolt, the

latter being thus held rigid between the spindle extension and the dolly sleeve 104.

The dolly spindle extension 142 has a die adjusting screw knob 143 fixed thereto by set screw 144 by which to rotatably adjust the die adjusting screw, the same extension 142 having a transverse scale 145 (Fig. 5) exposed in a cut-out portion 146 below jaw 23 in bushing 108 which is provided with a corresponding scale 147 to indicate the amount of adjustment effected by turning the knob to raise or lower the dolly spindle and thereby raise or lower the dimpling die 109 to accurately adjusted position. The dolly spindle is fixed in attained adjusted position and prevented from rotating by manual set screw 148 (Fig. 2). Upon knob 143 is a lower annular extension 149 (Fig. 4) upon which is rotatably mounted a hollow switch housing 151 of special form for accommodating a microswitch 152. The upper end of the switch housing which surrounds the mentioned annular extension has an inwardly directed flange or rib 153 fitting rotatably in a corresponding groove 154 in the annular extension and serving to retain the housing in effective association with said extension while allowing the dolly spindle or screw and the extension of the latter to be rotated for adjusting the dimpling die without also rotating the switch housing. In other words the housing is supported in virtual floating or suspended condition on the spindle extension, and as a cable 155 extends from the lower portion thereof to relay box 71 on the yoke, the housing is prevented from rotating with the spindle. The switch housing is made of two halves secured together by screws 157 and clamp the lower end of the cable between them with the conductors 158 entering the housing from the cable and being connected to the micro-switch, the other end of the cable terminating in the switch cable plug or connector 159 detachably plugged into the relay box receptacle 161 (Fig. 2). The connections in detail as well as the relays associated with the relay box will presently be explained when considering the circuits of the diagram figures.

The micro-switch 152 has an upwardly projecting depressible button or plunger 162 disposed directly beneath push rod 137 (Figs. 4 and 5) for actuation by the latter, the lower end of the rod extending a limited distance into an adjusting screw 163 mounted thereon and provided with an internally threaded adjusting ferrule or nut 164 screwed upon said adjusting screw and directly engaging the oval top of switch plunger 162. The adjusting nut 164 is adjusted by rotation to a position in which the plunger 162 supports the weight of the push rod, crossbar 127, ring 125 and dimpling sleeve 124, with the latter projecting above the dimpling die 109 in proper initial position ready for operation. It is thus evident that depression of the dimpling sleeve will be transmitted to the push rod and will cause the latter to depress the switch plunger and operate the switch.

Referring to the circuit diagrams in Figs. 10 to 13, the main line switch 165 is first closed as shown in Fig. 11 which effects closure of the circuit of current source 166 and relay 167 through back contact 168 and armature 169 of a second relay 171, setting up the apparatus for regular operation. In other words closure of the main switch first energizes relay 167 to cause the armature 173 thereof to make contact 174 and thereby close the circuit including pressure limiting or deflection plate switch 70 and end-of-

stroke or stop switch 45 which are connected in series and both normally closed. As long as they remain closed, relay 167 is locked in energized condition independently of armature 169 on relay 171. The winding of relay 171 is connected to the source of electro-motive force 166 through a starting switch circuit including main line switch 165, contacts 172 on foot switch 75, and work supporting switch 152.

Operation may be initiated by the operator in depressing pedal 76 of foot switch 75 and thereby partly closing the starting switch circuit by bringing contacts 172 together. When the work sheet 102 is placed in position between the pilot pins 101 and 116 (Figs. 8 and 9) with the preformed rivet holes registering with the pilot pins, the sheet rests on the dimpling sleeve 124 about pilot pin 116 (Figs. 8 and 9) and as the sleeve tends to yield downwardly, the weight of the sheet depresses the sleeve a limited distance and this downward movement is immediately transmitted to ring 125 and crossbar 127 and by the latter to push rod 137 and as a result the latter depresses plunger 162 of micro-switch 152. Upon closure of the circuit through the starting switches and relay 171, the armature 169 of the latter breaks contact 168 (without any effect at this time) and makes contact 175 which establishes a circuit extending from main switch 165, through solenoid 56, front contact 175 and armature 169 of relay 171, armature 173 and front contact 174 of relay 167, end-of-stroke switch 45, pressure limiting or deflection plate switch 70 and voltage source 166. When the solenoid 56 is energized it draws the core 55 upward and raises the control valve 54 to the position shown in Fig. 12.

In the raised position of the control valve 54, both valve heads 176, 177 thereof engage the upper valve seats 178, 179 in casing 53 but are separated from the lower valve seats 181, 182 respectively. Pressure fluid from the outside source flows into passage 183, and passing lower valve seat 182 reaches passage 184 communicating directly with the rear piston chamber 185 and thus propels piston 33 and its rod 34 forwardly. At the same time the front piston chamber 187 is open to exhaust through conduit 188, passage 189, central valve passage 191, past valve seat 181 and out through exhaust passage 192. As the piston advances, rollers 35 roll forward along rail 36 and on cam lever 28, depressing the latter as diagrammatically shown in Figs. 12 and 13. Cam lever 28 in turn depresses plunger 29 and tool holder 27 (Fig. 9) with punch holder 78 as well as punch 33 depending therefrom. At the same time pilot portion 101 of punch 33 pushes pilot pin 116 down into dimpling die 109 and causes upper pilot 101 to descend a short distance through the work sheet until the outer sleeve 93 makes direct contact with the work sheet. As pilot pin 116 rests with its head 117 on the upper ends 118 of the bifurcated pin sleeve 119 and as the latter rests on washer 121 which is resiliently supported by spring 122, the washer will yield and allow the pilot pin to be depressed to a low withdrawn position within the dimpling die, ready to rise again to original projecting position by the urging of the spring 122 as soon as the upper pilot 101 is raised at a later stage.

It is to be noted that crossbar 127 extends transversely through the space separating the upper ends 118 of bifurcated pin sleeve 119 and rests directly on the upper end of push rod 137 so as to be moved by contacting sleeve 124 to depress

rod 137 independently of pin sleeve 119 and pilot pin 116 which are also independently movable.

While punch 83 continues to descend, the frusto-conical portion 98 begins to dimple the work sheet by projecting the metal beneath said portion into recess 114 of die 109 and simultaneously causing sleeve 99 to remain in contact with the work sheet under increasing pressure because said work sheet supported by the dimpling die obstructs further movement of the sleeve while the punch holder and punch continue moving, compressing pressure pad 86 above washer 89 against plate 88, and causing washer or ring 89 above sleeve 99 to shift to the upper end of groove 91 on punch holder 78. The resilient pad serves to prevent shocks as well as mutilation of the work sheet. The dimpling continues until the upper inner sleeve 95 on the punch comes into contact with the flat portion of said work sheet around the dimpled portion which is supported by the upper face 186 about the recess on the dimpling die.

When sleeve 95 strikes the flat supported portion of the work sheet as just stated, the resistance to further descent of the punch immediately increases to a very high counter-pressure because the sleeve is backed by the punch flange 94 and obviously cannot yield. The increase of the resistance to further dimpling or movement is then in fact so great as to stop the dimpling and instead impose an expanding strain on the yoke jaws which separates them sufficiently to raise fulcrum 67 on jaw 22 and thereby tend to raise deflection switch lever 66. However the deflection plate 59 is not under any strain and therefore is not expanded with the yoke during the dimpling operation and its forward end 63 tends to prevent the short lower end 65 of the lever from rising; and thus the latter instead swings counter-clockwise about its fulcrum, correspondingly swinging upper arm 68 of the lever against operating button 69 of micro-switch 70 (Fig. 1) and thereby opening the circuit of said switch as diagrammatically shown in Fig. 13. This immediately cuts off the current to valve solenoid 56 thereby allowing valve spring 193 to draw valve 54 downward to engage the heads thereof with the lower valve seats 181, 182 and thereby reverse operation of the piston 33.

The opening of switch 70 also opens the circuit of relay 167 and allows armature 173 thereof to leave front contact 174 and assume normal open position and thus open the same circuit at a second point. Relay 167 cannot be re-energized as long as relay 171 continues to be supplied with current through the circuit of foot switch 75 and work supporting switch 152, and thereby continues to hold the armature 169 away from back contact 168. The circuit of said switches must first be broken and then re-closed in order to re-energize relay 167 and start a new cycle of operation.

The control valve 54 having returned to its initial lower position as diagrammatically indicated in Fig. 13 and in which the piston as a result is about to return to initial rearward position, the operation is reversed as already noted, and the pressure fluid flows from supply passage 183 past valve seat 179 and up through valve passage 191, through passage 189 and conduit 188 into front piston chamber 187, driving the piston rearwardly through the return stroke. The piston in turn drives the spent fluid in rear piston chamber 185 out through passage 184, down past

upper valve seat 178 and finally out through exhaust passage 192.

By the rearward or return movement of the piston and piston rod, the cam lever 28 is free to swing up from the operated position of Figs. 2, 12 and 13 to initial idle position (diagrammatically indicated in Figs. 10 and 11) and the plunger 26 with set holder 27 and associated punch holder and dimpling punch will rise to the initial position of Fig. 8, freeing the work sheet for removal by the operator. The pilot pin 116 is also raised to initial position by spring 122 urging washer 121 upward until it is stopped against the bottom of die holder or dolly 103, the washer raising pin sleeve 119 and with it the pilot pin. As soon as the work sheet is removed from the machine or from the position in which the dimpled portion is dissociated from the dimpling die, contact sleeve 124 is free to rise with ring 125, push rod 137 and switch plunger 162, which thus opens the work supporting micro-switch 152. For this purpose the latter is preferably provided with interior resilient means (not shown) having sufficient strength to raise plunger 162 when relieved of the weight of the dimpled sheets. As soon as the starting switch circuit is broken, either by relieving the switch 152 of the weight of the workpiece or by release of the foot switch 75, relay 171 is de-energized, restoring armature 169 into engagement with back contact 168 and permitting a new cycle of operations to commence, whenever the starting switch circuit is again closed.

If desired the operator may disable the deflection switch 70 by turning the adjusting knob 70a (Fig. 1) to create an excessively wide gap between deflection switch lever arm 68 and the associated trigger or switch button 69. In that condition of the apparatus, the piston rod 34 is permitted to continue to advance until the forward end strikes the lever 43 to open the end-of-stroke switch 45. This has the same effect on the solenoid circuit as does the opening of deflection switch 70. In the use of the end-of-stroke switch, the operator predetermines the maximum distance of approach or penetration of dimpling punch 83 with respect to recessed dimpling die 109. This distance can be varied, to suit the requirements of different workpieces, by turning the knob 143 (Figs. 1, 2, 5 and 6) to regulate the height of the dolly spindle 107.

Proceeding now to consider the underside dimpling, it will be noted that certain of the operating parts and tools supported by the yoke jaws or inverted or modified as shown in Figs. 6 and 7, about to be described, in contrast with the corresponding parts of Figs. 1, 2, 3, 5, 8 and 9, and are even reduced in number. However the set holder 27 in upper jaw 22, and bushing 108, crossbar 127, switch push rod 137 and micro-switch 152 etc., associated with lower jaw 23 are unchanged, while the circuits, relays and switches also remain in principle as already described in connection with Figs. 1, 4 and 8 to 13. Thus the set holder 27 is held in place by screw 46 previously described and into the set holder is fitted die holder shank 194 to which is fixed die holder 195 secured by screws 196, 197. The first screw is a set screw holding the die holder in place from the side and the second is a headed screw disposed at a right angle to the first and also retaining the die holder in assembled relation with the shank and preventing the holder from turning. The dimpling die 109 in inverted position has shank 111 thereof secured in bore 198

of the die holder by set screw 109 while the working face 106 and recess 114 face downwards.

In the lower jaw 23 the hollow punch adjusting screw or sleeve 201 replaces the dolly spindle or die adjusting sleeve 107 of the former structure and is screwed adjustably into bushing 108, the lower end with the extension 202 (Fig. 6), scale 203 and adjusting knob 204 in all respects resembling the corresponding parts in Figs. 4 and 5. The shank 205 of a punch holder 206 extends down into bore 207 of adjusting sleeve 201 and is secured in place by the tubular screw 138 through which the switch push rod 137 extends, this screw terminating in the head 141 at the bottom (Fig. 4) although not shown in Figs. 6 and 7. The periphery of the punch holder may have two or more flat portions (not shown) fitting a wrench by which to hold it against rotation when the screw 138 is screwed into the lower end of the holder.

The pressure pad 86 of rubber or other resilient plastic is mounted upon the upwardly projecting cylindrical portion 208 of the punch holder 206, supported by pressure pad plate 88 and surmounted by washer 87 which is confined from above by split retaining ring 89 while beneath plate 88 the adjusting nut 92 is screwed up on thread 209 on the punch holder to proper adjustment of the pressure pad, which resiliently urges ring 89 to the upper end of a wide groove 211 in which it is slidable. Upon the upper end of the punch holder 206 is mounted the dimpling punch 83 with flange 94 thereof resting on the punch holder and shank 84 secured in bore 212 by a set screw 213 and the pilot portion 101 with associated frusto-conical dimpling portion 98 projecting upwards toward the dimpling die. A slidably mounted contact or skin supporting sleeve 214 slidably surrounds cylindrical portion 208 on the punch holder and flange 94 of the punch and rests on the short sleeve or ring 125 which in turn is supported on crossbar 127 which extends transversely through slot 215 in the punch holder and into bottom slots 126 in the ring and rests intermediately on the upper end of push rod 137. Above punch flange 94 the inner sleeve 95 is secured to the punch body by set screw 96 and accurately spaced from the flange by sleeve shim 97, the punch, sleeve and shim each being one of a series of different sizes selected and grouped together for each size of dimple to be applied to the work sheet.

The crossbar 127 in normal idle position is located a sufficient distance above retaining ring 89 to allow contact sleeve 214 to depress the crossbar and thereby operate the push rod 137 in order to actuate micro-switch 152 without said crossbar being stopped short by said ring 89 when a work sheet is placed in position on said sleeve 124 with a rivet hole registering with pilot portion 101 of the punch. The resulting closure of switch 152 starts a cycle of operation which electrically is exactly as previously described with reference to the circuits shown in Figs. 10 to 13 but mechanically differs by certain details as follows.

Inasmuch as the dimpling is now to be accomplished upwardly in the same direction in which punch pilot 101 projects, it is unnecessary to depress or otherwise dispose of this pilot during operation, and hence, when the plunger and thus also set holder 27 descend due to the forward travel of the piston, the die holder and dimpling die 109 will approach the punch 83 below and the work sheet 102 resting on contact

sleeve 214 and depressing the latter. As the die descends, pilot 101 on the punch enters bore 115 and the frusto-conical portion 98 of the punch dimples the metal by forcing it up into the recess as a result of the working face 106 of the die forcing the work sheet down upon inner sleeve 95, meanwhile depressing the outer contact sleeve to the same general level as sleeve 95. This operation is believed to be clearly understood from Figs. 6 and 7 when considered in the light of the description and showing of Figs. 8 and 9. The outer sleeve 214 having already been sufficiently depressed by the weight of the work sheet to depress rod 137 and thereby operate switch 152 for initiating the dimpling operation, the descent of the dimpling die on a work sheet depresses sleeve 214 still further to the inner sleeve level as just mentioned, thereby causing sleeve or ring 125 associated with the crossbar to bear down upon retaining ring 89 and washer 87 to compress pad 86 and also shift ring 89 downward in its groove 211 on the punch holder. The pressure thus exerted on the work sheet around the portion being dimpled serves primarily to prevent distortion and definitely to keep the sheet flat during dimpling, and also when the pressure is great enough to spring the yoke jaws apart and operate the deflection plate switch and reverse operation for releasing the dimpled work sheet and thereafter repeating the cycle at will.

In both the topside and the underside dimpling, the pressure pad causes the pressure applied around the portion of the work sheet being dimpled to rise gradually from below that sufficing to keep said portion flat up to the high expanding pressure springing the yoke and effecting operation of the deflection switch plate. This feature eliminates shocks and tends to avoid marring, distorting or otherwise damaging the work sheets during the later stages of the operation.

Disclosures related to that of the present invention appear in copending applications of Howard R. Fischer and James A. Roberts, Serial No. 514,068, filed December 13, 1943, and Serial No. 636,406, filed July 26, 1946.

What is claimed is:

1. In a press having a pair of jaws spaced apart and individually supporting mutually opposite tools for forming work sheets, operable means for bringing one of the tools toward the other tool upon a work sheet to form the latter and for separating the tools from each other, and movable control means adapted in one position to initiate operation of the operable means and in another position adapted to cause reversal thereof to separate said tools, the combination of an electrical actuating means connected to the control means and capable of moving the latter from the one position to the other, an electric switch means for controlling the circuit of the electrical actuating means to allow current from a current source to flow through and actuate said electrical actuating means and thereby move said operable means, a switch operating member movably associated with said other tool and projecting a sufficient limited distance toward the respectively opposite one tool to be moved by a work sheet when placed in proper forming position in relation to said other tool, a foot switch associated with the mentioned circuit for initially closing it at will, means communicating the movement of the switch operating member to said electrical switch means to effect closure of the latter, and automatic means arranged to be

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actuated in response to a predetermined pressure between the tools for causing said control means to reverse operation of said operable means for separating said tools and releasing the work sheet upon completion of the forming of the latter.

2. A press according to claim 1, in which the last mentioned automatic means includes a reversing switch associated with the circuit and capable upon being actuated of causing the control means to effect reversal of the operation of the operable means to terminate the forming operation, and operable means responsive to a predetermined pressure between the tools for automatically actuating the reversing switch upon completion of the forming of the work sheet.

3. In a press having a pair of jaws spaced apart and provided with support means for individually supporting mutually opposite tools for forming work sheets, operable means for bringing one of the tools toward the other tool upon a work sheet to form the latter and for separating the tools from each other, and movable control means adapted in one position to initiate operation of the operable means and in another position adapted to cause reversal thereof to separate said tools, the combination of an electrical actuating means connected to the control means and capable of moving the latter from the one position to the other, an electric switch means for controlling the circuit of the electrical actuating means to allow current from a current source to flow through and actuate said electrical actuating means and thereby move said operable means, switch operating means for said switch means including an exposed movable member mounted exteriorly adjacent to and relatively movable with respect to said other tool and capable of being moved by a work sheet when placed in proper forming position relatively thereto, an interior switch actuating member mounted within the support means for and in axial alignment with one of said tools for movement in unison with said exposed movable member to directly actuate and close said electric switch means and thereby cause operation of said operable means, and an intermediate member extending from an exterior portion to an interior portion of the support means for the one tool in effective position to transmit the movement of said exposed movable member to the interior switch actuating member to actuate said electric switch means by movement of said exposed movable member, and further electric switch means also associated with said circuit and operable at will for initially closing the latter.

4. In a press having a pair of jaws spaced apart and provided with support means for individually supporting a pair of mutually opposite tools for dimpling work sheets, one of the tools being a hollow dimpling die and the other a frusto-conical dimpling tool terminating in a pilot portion adapted to project into the die in operated position, operable means for bringing one of the tools toward the other to dimple the work sheet between them, the combination of movable control means for initiating operation of the operable means in one position and in another position effective to cause reversal of said operable means, a movable contact member mounted adjacent to the exterior of one tool and the support means thereof and capable of being moved by a work sheet when placed in position to register a rivet hole therein with said pilot portion, an interior actuating member movable within the

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last mentioned support means, and an intermediate movable member extending from an exterior portion to an interior portion of said last support means in effective position to communicate the movement of the movable contact member to the interior actuating member in order to move the latter in unison with said movable contact member, and means actuated by said interior actuating member effective to cause operation of said control means with consequent operation of the tools to dimple said work sheet.

5. In a press having a pair of jaws spaced apart, one jaw having a substantially stationary support means thereon supporting a dimpling tool, a second support means mounted on the other jaw and movable with respect to the latter toward and from the first mentioned support means, a second dimpling tool mounted on said second support means, the combination of a resilient cushion member forming a pressure pad mounted on one of the support means, a pilot portion projecting upon one tool toward the other, the said dimpling tool with the pilot portion having a flange, a tool sleeve removably secured to said tool in axial alignment with the flange, a shim mounted on the tool between the tool sleeve and the flange and removable with the tool sleeve to be replaced by another shim whereby to alter the tool to dimple different gauges of metal, a movable contact member disposed exteriorly adjacent to the tool about the flange and the tool sleeve and normally occupying a position wherein a portion projects beyond said tool to be movable by a work sheet when placed in position to register a rivet hole therein with said pilot portion, means for operating said movable support means and associated tool, the resilient cushion member being associated with the support means of the tool provided with the pilot portion and serving to cushion the movement of the contact member when the latter makes contact with the work sheet during the dimpling operation while said work sheet rests against the tool opposite said pilot portion, and means for automatically stopping the dimpling movement of said movable support means and associated tool when the work sheet is dimpled.

6. In a press having a pair of jaws spaced apart, one jaw having a substantially stationary support means thereon supporting a dimpling tool, a second support means mounted on the other jaw and movable with respect to the latter toward and from the first mentioned support means, and a second dimpling tool mounted on said second support means, the combination of a resilient cushion member forming a pressure pad mounted on one of the support means, a pilot portion projecting upon one tool toward the other, a rigid stop member removably mounted on the latter tool to form a stop for said tool against the work sheet, a shim retained on the tool by the stop member and removable with the stop member to be replaced by another shim whereby to alter the tool to dimple different gauges of metal, a movable contact member disposed exteriorly adjacent to the tool on the latter and normally occupying a position wherein a portion projects beyond said tool to be movable by a work sheet when placed in position to register a rivet hole therein with said pilot portion, means for operating said movable support means and associated tool, the resilient cushion member being associated with the support means of the tool provided with the pilot portion and serving to cushion the movement of the contact member when

the latter makes contact with the work sheet during the dimpling operation while said work sheet rests against the tool opposite said pilot portion, and means for automatically stopping the dimpling operation when said rigid stop member engages against said work sheet.

7. In a press having a pair of jaws spaced apart, one jaw having a substantially stationary support means thereon supporting a dimpling tool, a second support means mounted on the other jaw and movable with respect to the latter toward and from the first mentioned support means, and a second dimpling tool mounted on said second support means, the combination of a pilot portion rigidly mounted upon one tool and adapted during dimpling to project into the other tool, an exterior sleeve slidably mounted upon the support means of the tool having the pilot portion, a cushion member mounted on the last mentioned support means in effective position to urge the sleeve to project a limited distance beyond the tool on said support means, a stop portion rigidly associated with said last mentioned tool adapted to engage against the work sheet at the end of the dimpling step, means to initiate operation and cause movement of the movable support means and its associated dimpling tool to dimple the work sheet, and strain-responsive means between the jaws effective to terminate operation when a predetermined high dimpling pressure of the tools is attained upon said work sheet.

8. In a press having a pair of jaws spaced apart, one jaw having a substantially stationary support means thereon supporting a dimpling tool, a second support means mounted on the other jaw and movable with respect to the latter toward and from the first mentioned support means, and a second dimpling tool mounted on said second support means, the combination of operable means for initiating operation and causing movement of the movable support means and associated dimpling tool toward the other tool to dimple a work sheet, a pilot portion rigid with one tool and adapted to project into the other tool during dimpling, an exterior sleeve slidably mounted on the support means of the tool having the pilot portion, a cushion member mounted on the last mentioned support means in effective position to urge the sleeve to project a limited distance beyond the tool on said support means, a stop portion rigidly associated with the last mentioned tool adapted to engage against the work sheet at the end of the dimpling operation, operable control means associated with one jaw for initiating the dimpling operation, a movable push rod slidably associated with said one jaw in effective position to operate said operable control means, means movably carried upon the latter jaw intermediate said push rod and said sleeve to be effective to transmit initial movement of said sleeve to said push rod, the resilient cushion member mounted on the mentioned support means on said one jaw being disposed in the path of movement of the intermediate means and compressed by the latter when the sleeve is forced down upon the intermediate means by the other or opposite dimpling tool.

9. In a press having a pair of jaws spaced apart, one jaw having a substantially stationary support means thereon supporting a dimpling tool, a second support means mounted on the other jaw and movable with respect to the latter toward and from the first mentioned support means, and a second dimpling tool mounted on said second support means, the combination of a pilot por-

tion rigidly mounted upon one tool and adapted during dimpling to project into the other tool, an exterior sleeve slidably mounted upon the support means of the tool having the pilot portion, a cushion member mounted on the last mentioned support means in effective position to urge the sleeve to project a limited distance beyond the tool on said support means, a stop portion rigidly associated with said last mentioned tool adapted to engage against the work sheet at the end of the dimpling step, a stationary deflection member having one portion attached to one of said jaws, a stop switch for terminating operation when actuated, and a further portion upon said deflection member effective to actuate said stop switch upon attainment of a predetermined high dimpling pressure exerted by the tools on the work sheet.

10. In a press having a pair of jaws spaced apart, one jaw having a substantially stationary support means thereon supporting a dimpling tool, a second support means mounted on the other jaw and movable with respect to the latter toward and from the first mentioned support means, and a second dimpling tool mounted on said second support means, the combination of operable means for initiating operation and causing movement of the movable support means and associated dimpling tool toward the other tool to dimple a work sheet, a pilot portion rigid with one tool and adapted to project into the other tool during dimpling, an exterior sleeve slidably mounted on one support means and projecting a limited distance beyond the tool thereof in a position to be moved by a work sheet placed in proper dimpling relation with said tool, control means mounted on the latter support means adapted when actuated to cause operation of said operable means, a push rod movably mounted within said latter support means with one end adjacent to a portion of said control means in effective position to operate the latter, a bar having a portion disposed adjacent to the other end of said push rod, an annular member movably mounted on said latter support means adjacent to one end of the exterior sleeve and to said bar capable of transmitting movement of the exterior sleeve in one direction to said bar and push rod, means rigidly associated with the last mentioned tool for limiting the dimpling of the work sheet, and means upon said press for stopping the operation of said operable means when the work sheet has been dimpled.

11. In a press having a pair of opposite jaws spaced apart with one jaw provided with a stationary dimpling tool including a die and the other jaw with a movably mounted dimpling tool terminating in a pilot portion adapted to extend into said die in mutually engaged condition of said tools, and operable means for moving said movably mounted tool toward the other tool and for separating the same therefrom, the combination of control means for initiating operation of said operable means, a depressible pilot pin slidably associated with said die, means resiliently maintaining said pilot pin normally projecting from the die toward said pilot portion in a position allowing the latter to depress said pilot pin into said die, a movable contact member disposed exteriorly of said die, a push rod slidably associated with a portion supported by the first mentioned jaw with one portion of the push rod effective to actuate the control means upon movement of said rod, an intermediate member interposed between another portion of said push rod and said contact member to communicate the

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movement of the latter to the push rod and thereby actuate said control means, and means for automatically terminating the dimpling operation and separating said movably mounted tool from the other tool when the work sheet has been dimpled in order to release the latter and allow the pilot pin to resume its initial projecting position on the die.

12. In a press having a pair of opposite jaws spaced apart with one jaw provided with a stationary dimpling tool including a die and the other jaw with a movably mounted dimpling tool terminating in a pilot portion adapted to extend into said die in mutually engaged condition of said tools, and operable means for moving said movably mounted tool toward the other tool and for separating the same therefrom, the combination of control means for initiating operation of said operable means, a depressible pilot pin slidably associated with said die, means resiliently maintaining said pilot pin normally projecting from the die toward said pilot portion in a position allowing the latter to depress said pilot pin into said die, a movable contact member disposed exteriorly of said die, a push rod slidably associated with a portion supported by the first mentioned jaw with one portion of the push rod effective to actuate the control means upon movement of said rod, an intermediate member interposed between another portion of said push rod and said contact member to communicate the movement of the latter to the push rod and thereby actuate said control means, an annular member movably supported on the second or other jaw, a resilient cushion member also supported on the latter in effective position to resiliently resist movement of said annular member and normally urge the latter to project a limited distance toward the die in order to cushion the engagement of said annular member with the work sheet, when the latter rests on said die during dimpling, a stop rigidly associated with the dimpling tool to stop the latter against said work sheet, and means for automatically terminating the dimpling operation and separating said movably mounted tool from the other tool when the last mentioned stop exerts a predetermined high pressure on the work sheet.

13. A dimpling machine comprising a punch element, a recessed die element arranged coaxially therewith to receive sheet metal therebetween, a pilot pin coaxially mounted on one of said elements and adapted to enter a preformed hole in the sheet metal for centering the work forming elements relative to the preformed hole, a starting trigger positioned to be actuated automatically upon relative movement of the pilot pin into the hole, power operated means including a piston and cylinder for applying a squeezing pressure between the punch and die elements to form a dimple around said hole, valve control means automatically operable upon actuation of said starting trigger for supplying pressure fluid to said power operated means thereby forming the dimple as aforesaid, a stopping trigger arranged to be actuated in response to the development of a predetermined pressure between the die and punch elements, and valve control means automatically operable in response to the actuation of said stopping trigger for discontinuing the supply of pressure fluid to said power operated means, thereby relieving the pressure between the punch and die elements.

14. A dimpling machine comprising a pair of spaced jaws, a dimpling punch in one jaw, a die

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supporting member adjustably affixed to the other jaw by means of a threaded connection, a dimpling die in the die supporting member, means operable by fluid pressure for bringing the punch toward the die, and fluid control valve means adapted when in one position to initiate operation of the operable means and in another position to cause the reversal thereof to allow movement of the punch away from the die, the combination of a solenoid associated with said valve and capable of moving the latter from one position to another, an electric switch means for controlling the circuit of the solenoid, a switch operating sleeve surrounding the die supporting member and movable with reference thereto, said sleeve extending beyond the die in a direction to protrude beyond the forming face of the die, a supporting element for the switch operating sleeve surrounding the die supporting member, a transmission member associated with the sleeve supporting element and extending through the center thereof, a transmission rod coaxial with the sleeve to support the transmission member, the sleeve supporting element, and the sleeve, and a plunger for the solenoid controlling switch adapted, while the switch is open, to support the assembly comprising the transmission rod, the transmission member, the sleeve supporting element and the switch operating sleeve.

15. A dimpling machine comprising a pair of spaced jaws, a dimpling punch in one jaw, die supporting means adjustably affixed to the other jaw by means of a threaded connection, a dimpling die in the die supporting means, means operable by fluid pressure for bringing the punch toward the die, and fluid control valve means adapted when in one position to initiate operation of the operable means and in another position to cause the reversal thereof to allow movement of the punch away from the die, the combination of a solenoid associated with said valve and capable of moving the latter from one position to another, an electric switch means for controlling the circuit of the solenoid, a depressible pilot pin projecting through the die and slidably associated therewith, a pilot pin supporting member having a longitudinal slot therein, means within the die supporting means to resiliently support the pilot pin supporting member and hence the pilot pin, a switch operating sleeve surrounding the die supporting means and movable with reference thereto, said sleeve extending beyond the die in a direction to protrude beyond the forming face of the die, a supporting element for the switch operating sleeve surrounding the die supporting means, a transmission member associated with the sleeve supporting member and extending through the center thereof and through the slot of the pilot pin supporting member, a transmission rod connected to the transmission member, and a plunger for the solenoid controlling switch, the arrangement of the switch operating sleeve, the switch supporting element, the transmission member, and the transmission rod being such that they are moved as a unit to close the solenoid controlling switch when a work sheet is disposed in proper work forming position relative thereto, and the arrangement of the pilot pin, the supporting member therefor and the resilient support for said support being such that they move independently of the switch operating assembly.

16. In a dimpling machine of the class described, a solenoid to actuate a valve, a switch in the electrical circuit to the solenoid, a die holder

arranged in a jaw, a die having a longitudinal central aperture, a support therefor mounted on the die holder and having a longitudinal bore and radially disposed slots connected to the bore, a depressible pilot pin extending through the die aperture and the die support bore, a pilot pin supporting member having a longitudinal slot adapted to register with the die support slots, resilient means in the die holder to support the pilot pin supporting member, a switch operating sleeve surrounding the die, a sleeve supporting member, a cross-bar mounted in the sleeve supporting member and extending through the slot in the pilot pin supporting member and the slots in the die supporting member, and a transmission rod connected to the cross pin, the sleeve, the supporting member therefor, the cross pin, and the transmission rod being arranged to move as a unit to transmit motion imparted to the sleeve by the weight of a work sheet disposed thereon to close the switch to the solenoid, and the pilot pin, its supporting means, and the resilient supporting means being arranged to move as a unit independently of the switch operating mechanism.

17. In a press of the class wherein spaced jaws carry a stationary punch and a movable die actuated by fluid pressure controlled by an electrically operated valve and wherein the switch controlling the electric circuit is operated by the weight of a work piece disposed on the stationary punch, in combination, a dolly supported in a jaw, a punch rigidly mounted on the dolly, a sleeve movably associated with the dolly, support means for said sleeve surrounding the dolly, an intermediate transmission member extending from an exterior to an interior portion of said support means, transmission means connected to the intermediate member, the foregoing sleeve, supporting means, intermediate transmission member, and the transmission means being associated to move as a unit when a work sheet is disposed for operation upon the sleeve thereby to actuate the valve switch, a plunger for the switch arranged adjacent the transmission means and adapted to support said unit in initial position, resilient means in the switch adapted to support the plunger and unit in initial position and to return the plunger and unit to initial position upon the removal of the work sheet therefrom, and resilient cushion means mounted on the dolly in the path of the intermediate transmission member to offer resistance to the latter and hence to the sleeve when the latter is forced down upon the intermediate means by the movable die thereby to create a reactive force to maintain the work sheet in planar position when under operative pressure.

18. A combination, according to claim 17, wherein the resilient cushion means comprises an annular member of resilient material, a supporting washer therefor, a retaining plate, a retaining ring associated with the dolly, and an adjusting ring threadably mounted on the dolly, the retaining ring and the adjusting ring being arranged oppositely with respect to the ring to vary the resistance of the cushion.

19. In a machine of the class described, a hold-down device comprising a punch holder, resilient compression means mounted on the punch holder, means to retain the compression means in operative position, means to preload the compression means to a predetermined degree of compression, and a hold-down member movably associated with the punch holder and disposed adjacent the compression retaining means, said hold-down member being adapted to yieldably maintain a work sheet in planar position during a pressing operation.

20. In a machine of the class described, a combination comprising a punch holder, a punch, resilient compression means mounted on the punch holder, means to retain the compression means in operative position including a ring adapted for limited longitudinal movement in a slot on the punch holder, means to preload the compression means to a predetermined degree of compression, a sleeve movably mounted on the punch holder and spaced from the punch, support means for the sleeve arranged between the sleeve and the compression means, and switch operating means connected to the sleeve support, said sleeve being movable by the weight of a work sheet when the latter is placed in proper forming position to transmit motion through the sleeve support to the switch operating means thereby to actuate a switch and being further adapted thereafter to maintain the work sheet in planar position by the transmission of reactive force from the resilient compression means through the sleeve support means during the pressing operation.

HOWARD R. FISCHER.

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