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Hafner

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[54] **ADJUSTABLE DIE AND PUNCH FOR SHEET MATERIAL FASTENING MACHINES**

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[22] Filed: **Aug. 26, 1976**

Related U.S. Patent Documents

Reissue of:

[64] Patent No.: **3,862,485**
Issued: **Jan. 28, 1975**
Appl. No.: **384,494**
Filed: **Aug. 1, 1973**

U.S. Applications:

[63] Continuation-in-part of Ser. No. 275,946, Jul. 28, 1972, abandoned.

[51] **Int. Cl.**[3] **B23P 19/00**

[52] **U.S. Cl.** **29/432.2;** 29/21.1; 29/509; 29/521; 29/798

[58] **Field of Search** 29/21.1, 283.5, 432, 29/432.1, 432.2, 509, 521, 798; 72/325, 326, 331

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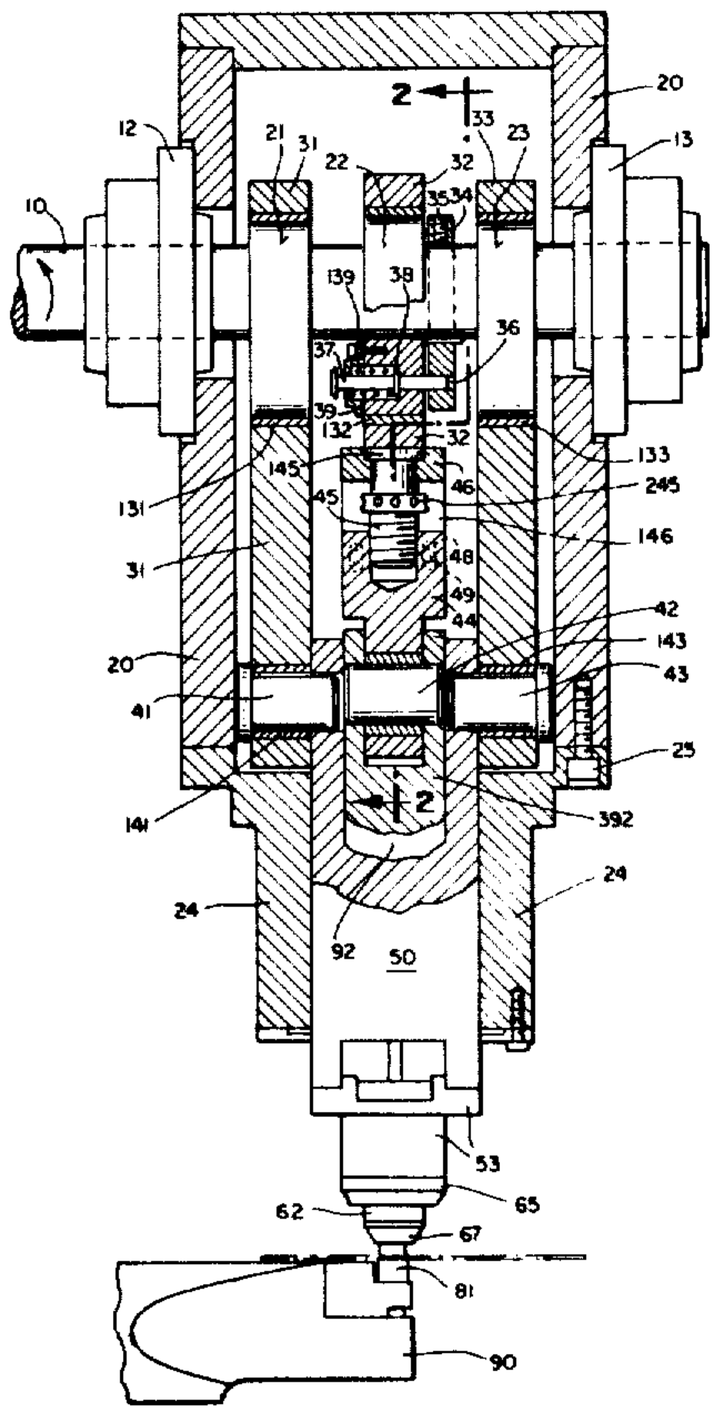
Primary Examiner—E. Michael Combs

[57] **ABSTRACT**

To fasten together two or more overlying sheets of metal or other material having plasticity or deformable properties by partially piercing and deforming sections of the sheets, a fixed pierce-and-forming punch is used in cooperation with a double-acting press having two separately actuatable rams. For displacing sections of the overlying sheets, one of the rams carries a hollow cylindrical pierce-and-forming die the die cavity of which is vertically aligned with, and cooperates with, a fixed pierce-and-forming punch supported in the base. The other of the rams carries a flattening punch which is slidably movable within the central bore of the hollow cylindrical die. The pierce-and-forming die is supported by means which includes fine adjustment means so that the position of the die may be adjusted for different thicknesses of sheets to be fastened, and also for wear on the die and/or punch. The flattening punch is supported by phase adjustment means which permits the angular relationship between the flattening punch and the die to be adjusted for different thicknesses of sheets to be fastened. The latter adjustment is made such that the downwardly-moving flattening punch engages the upper displaced section or sections just after the lower displaced section is uncovered by the upwardly-moving cylindrical die, thereby to spread the lower displaced section while the upper section or sections are still constrained.

14 Claims, 6 Drawing Figures



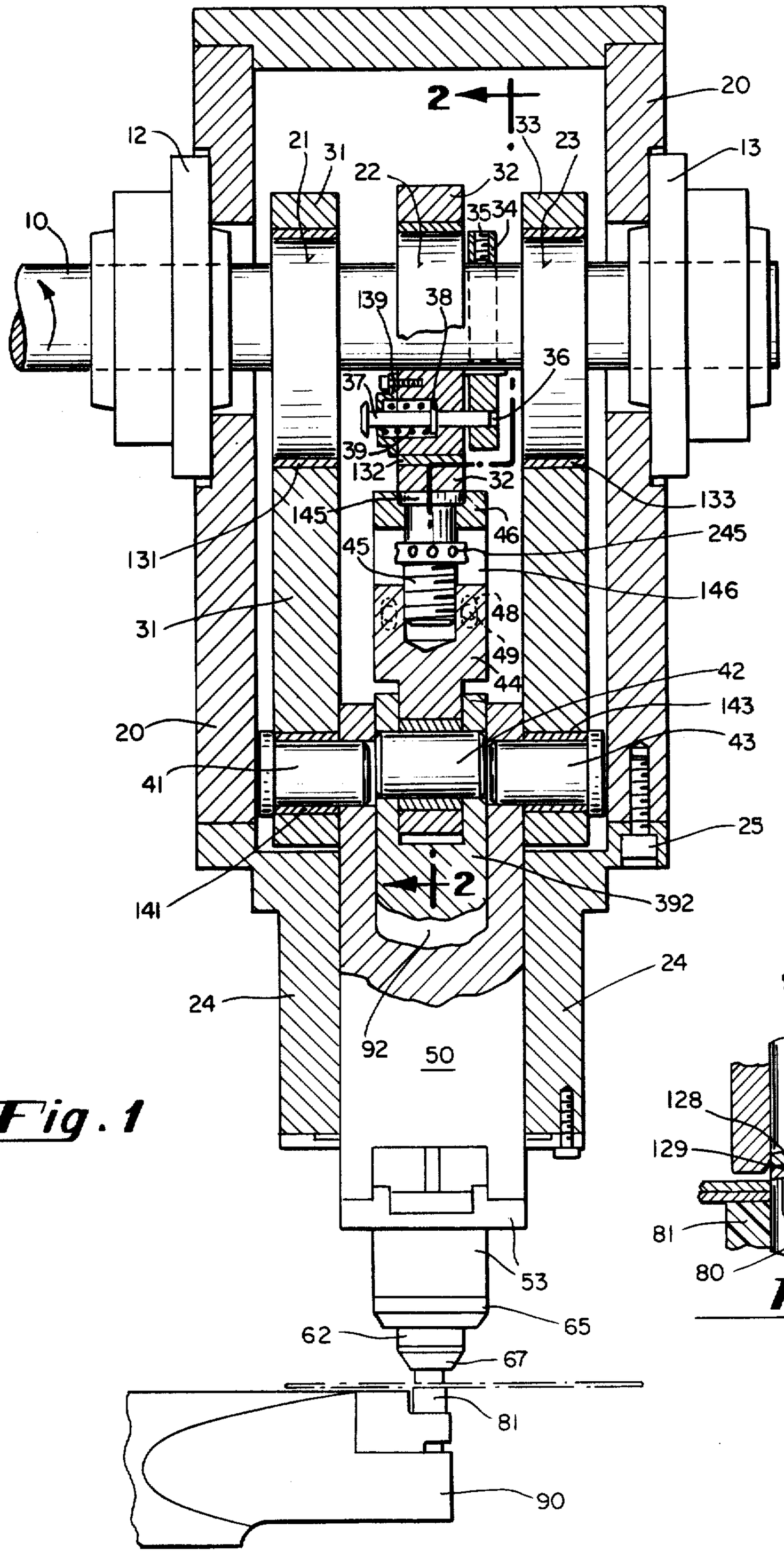

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Fig. 1

92
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Fig. 5

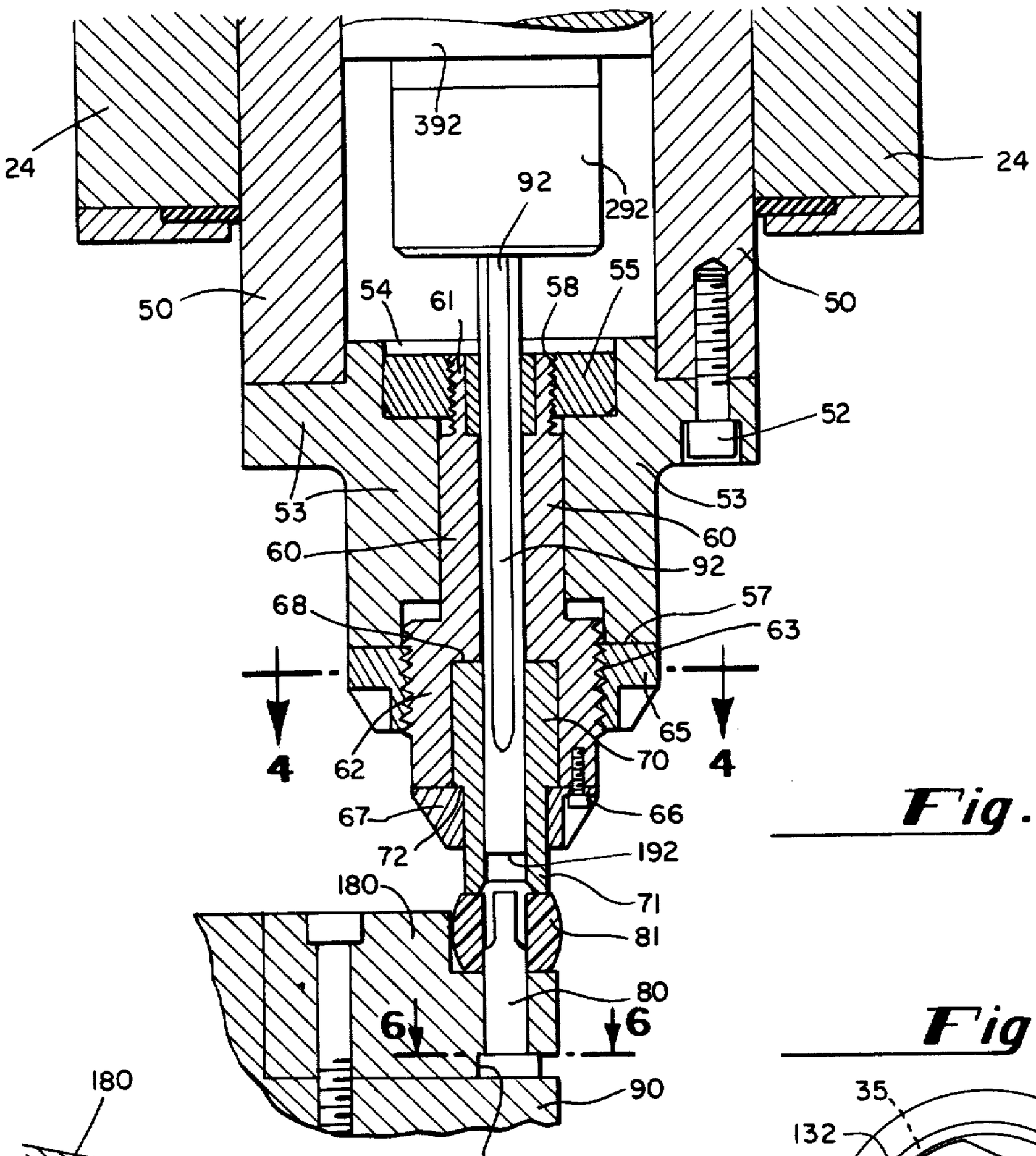


Fig. 3

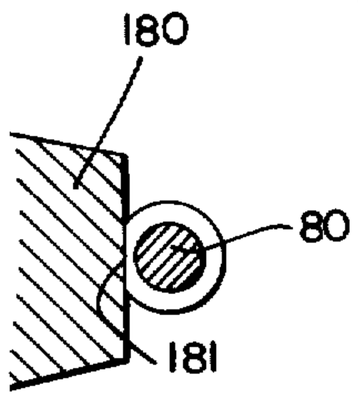


Fig. 6

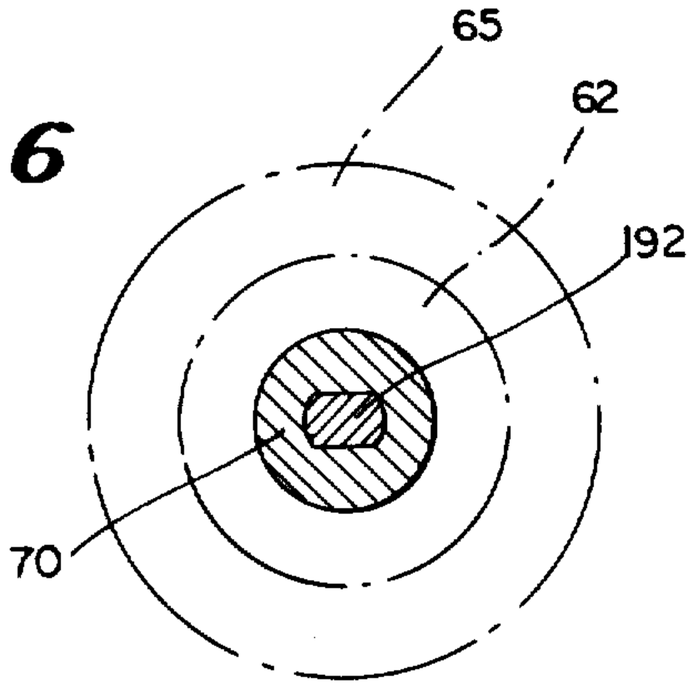
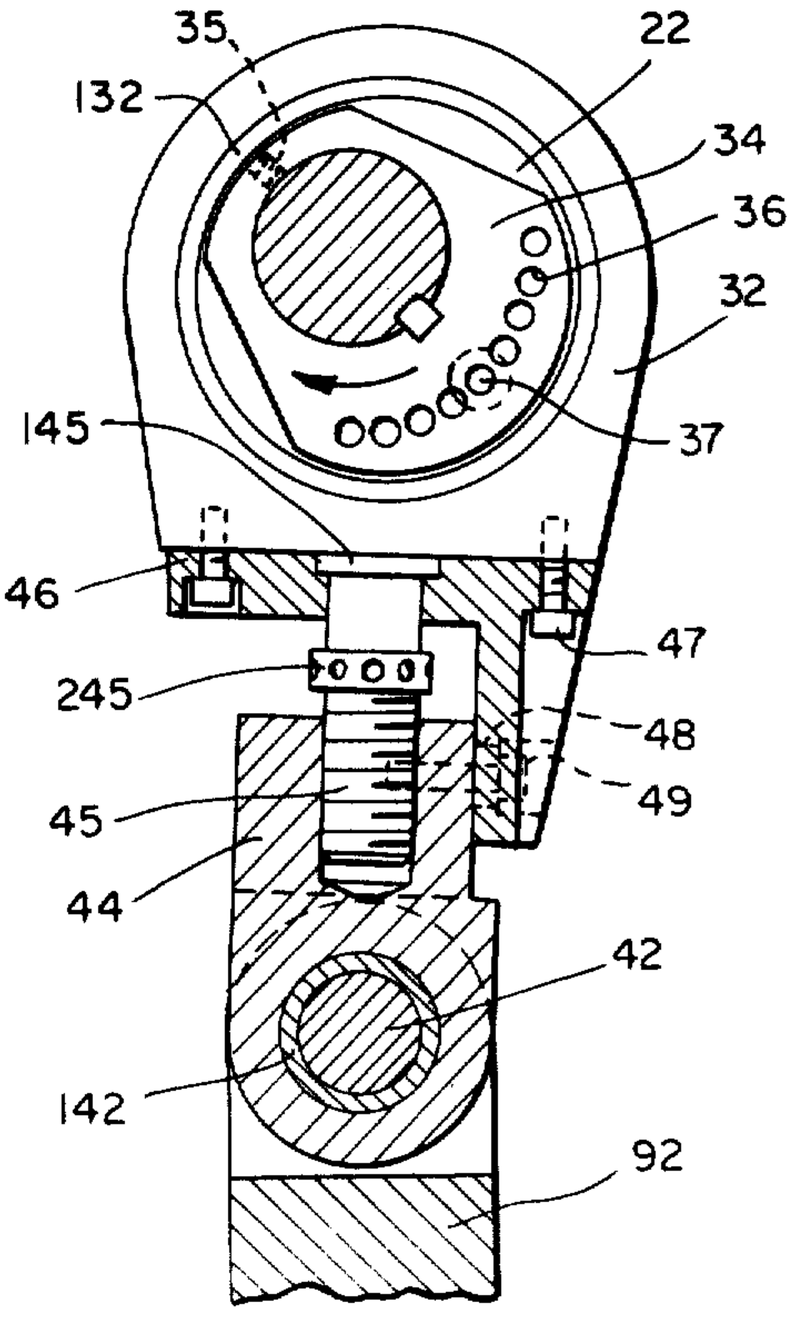


Fig. 4

Fig. 2



ADJUSTABLE DIE AND PUNCH FOR SHEET MATERIAL FASTENING MACHINES

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

CROSS-REFERENCE TO RELATED APPLICATION

[This application is a continuation-in-part application of my earlier-filed pending application, Ser. No. 275,946, filed July 28, 1972, now abandoned in favor of the present application.] *This application is a reissue of U.S. Pat. No. 3,862,485, issued Jan. 28, 1975, and a continuation-in-part of Ser. No. 275,946, filed July 28, 1972, abandoned.*

BACKGROUND OF THE INVENTION

This invention relates to a machine for fastening together overlying sheets of deformable metal or other material having the property of yielding or flowing under load and of sustaining appreciable permanent deformation without rupture. In some instances there may be an intervening layer or film of another material between the sheets to be fastened.

SUMMARY OF THE INVENTION

An object of the present invention is to provide, for a double acting press of the type disclosed in my U.S. Pat. No. 3,726,000, granted Apr. 10, 1973, adjustable support means for the cutting-and-forming die and also the flattening punch so that adjustment may be made for different thickness of sheets to be fastened, as well as to adjust for wear of the die and/or punch.

A more specific object is to provide adjustment means so that the upper sheet or sheets of the displaced section (displaced by the die and fixed punch) is not engaged by the downwardly-moving flattening punch until the lowermost sheet of the displaced section is uncovered by the upwardly-moving die so as to allow the lower sheet of the displaced section to be spread while the upper sheet or sheets are still confined by the die.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an elevational view, largely in section, of the head portion of a fastening machine incorporating the present invention.

FIG. **2** is a fragmentary view, largely in section, looking along the lines **2—2** of FIG. **1**.

FIG. **3** is an enlarged fragmentary view, in section, of the lower portion of the structure shown in FIG. **1**.

FIG. **4** is a view looking down along the line **4—4** of FIG. **3**.

FIG. **5** is an enlarged illustration showing that the lower sheet of the displaced section is uncovered by the die at the instant the downwardly-moving flattening punch engages the upper sheet, thereby to spread the lower sheet of the displaced section.

FIG. **6** is a view, in section, looking downwardly along the line **6—6** of FIG. **3**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. **1**, a crank shaft **10**, which is driven rotationally by means not shown, has at its forward end a pair of spaced-apart shear blocks **12** and **13** which are supported by a crank housing **20**.

Supported on crank shaft **10**, within the housing **20**, are three eccentric discs **21**, **22** and **23**. The two outside discs **21** and **23** are keyed to the crank shaft. The holes of the two outside eccentric discs **21** and **23** are identically positioned and hence these two outside eccentrics move in timed coincidence with each other. The center eccentric **22** is supported free on shaft **10** and, by means to be described, is maintained in out-of-phase relation with the two outside eccentrics. This phase relationship is adjustable by a phase selector drive plate **34**. In typical case, for particular metal thickness, the center eccentric may, for example, have a delay angle of the order of 37°.

As clearly seen in FIGS. **1** and **2**, the angular position of the center eccentric disc **22** is determined and controlled by the phase selector drive plate **34** which is fixed to crank shaft **10**, as by set screw **35** and key in keyway. Plate **34** is provided with a series of holes **36** for receiving selectively a pin **37** which extends through a hole in eccentric disc **22** and is spring-loaded by a spring **39** which thrusts against a flange **38** on the pin. It will be seen that by withdrawing pin **39** from the plate **34**, moving the disc **22** angularly, and then reinserting the drive pin **39** in a different hole **36**, the angular position, and hence the phase relationship, of the center eccentric disc **22** may be adjustable relative to the two outside discs **21** and **23**. Spring **39** is retained by retainer **139**.

The three eccentric discs **21**, **22** and **23** carry, respectively, cranks **31**, **32** and **33**, suitably supported on bushings **131**, **132**, **133**. In FIG. **1**, the outside eccentric discs **21** and **23** are illustrated in such position that the outside cranks **31** and **33** are at the bottom of their downward stroke. At this same instant, the center eccentric disc **22** is in the position shown in FIG. **2**. As seen in FIG. **2**, the center crank **32** has started its downward descent, but will not reach its downward limit for another 37°.

The two outside cranks **31** and **33** each carries at its lower end a stub-shaft, **41** and **43**, respective, suitably journalled in bushing **141** and **143**. The inward ends of the stub shafts **41** and **43** project into opposing holes in the walls of a hollow rectangular ram or slide **50** which is slidable up and down within, and is guided by, the hollow rectangular lower guide portion **24** of the housing **20**. Guide portion **24** is secured to the upper portion of the housing, as by bolts and dowels **25**.

Referring now to FIG. **3**, bolted as by bolts and dowels **52** to the lower end of the rectangular slide or ram **50**, and carried thereby, is a hollow neck poriton **53** the upper neck of which adapts to the rectangular opening between rams **50** and the lower portion of which is round having a central bore into which a cylindrical screw and die holder **60** is inserted.

The upper end portion of neck portion **53** has a recess **54** into which is inserted a nut **55** which is non-rotatable in the neck **53**. The non-rotatable nut **55** is provided with fine threads **58** which receive the fine threaded upper end portion **61** of the die holder **60**. The lower end **62** of die holder **60** has an enlarged diameter and is externally threaded at **63** with threads which are much larger than the fine threads of the upper end portion **61**. An internaly threaded clamping ring **65** is screwed onto the external threads **63** and tightened against the end surface **57** of the neck **53**.

The enlarged-diameter lower end portion of the die holder **60** has a recess which receives the upper end portion of a hollow cylindrical cutting-and-forming die **70**. The lower end portion **71** of the cutting-and-forming die **70** is of reduced diameter forming, at the junction with the upper end portion, a shoulder **72**. A lock cap **67** is fitted over the reduced-diameter portion **71** of die **70** and abuts against the shoulder **72** of the due **70**. Cap **67** is secured, as by bolts **66**, to the end surface of the die holder **60**.

The cylindrical cutting-and-forming die **70** has cutting edges and recessed portions which function as the forming portions. The die **70** may correspond to that disclosed and illustrated in FIG. **9** of my aforesaid U.S. Pat. No. 3,726,000.

Positioned below the cutting-and-forming die **70** in the base **90** of the press is a pierce-and-forming punch **80**. The pierce-and-forming punch **80** has cutting edges for piercing, and recessed portions for forming. The punch **80** may correspond to the punch described in my U.S. Pat. No. 3,726,000, and may be axially adjustable as there shown. Surrounding the pierce-and-forming punch **80** is a stripper or spring member **81** which may preferably be formed of urethane material.

Positioned within the aligned bores of the die holder **60** and die **70** is the enlongated shank of a flattening punch **92**. As seen in FIGS. **1–3**, flattening punch **92** is supported by a punch holder **292** fastened to a center ram or slide **392** which is carried by pin **42** and adjustable member **44**. Adjustable member **44** is supported adjustably by a bolt **45** which in turn is supported by a plate **46** secured, as by screws **47** (FIG. **2**) to the underside of center crank **32**. Plate **46** has a depending portion **146** having therein a pair of slots **48** which receive screws **49**. In this way, the member **44** is supported against rotation. Bolt **45** has an enlarged portion head **145** which is supported in a recess in plate **46**. Bolt **45** also has an integral enlarged round portion **245** with holes for pin which may be engaged, as by a pin wrench, to turn bolt **45** to raise or lower member **44**, thereby to adjust the position of the head **192** of flattening punch **92** relative to the pierce-and-forming punch **80**. To make this adjustment, it is, of course, necessary to loosen the screws **49**.

To adjust the position of the cutting-and-forming die **70** relative to the fixed pierce-and-forming punch **80**, the operator manually unscrews clamping ring **65** and then manually grasps and moves die holder **60** in one rotational direction or the other. Since nut **55** is non-rotatable in the recess **54** in neck **53**, when the die holder **60** is manually rotated, it turns on threads **58** and is therefore moved adjustably upwardly or downwardly in neck **53**, according to the direction in which holder **60** is rotated. When holder **60** is so adjusted upwardly or downwardly, the cutting-and-forming die **70** is moved adjustably in corresponding manner since it is carried by the holder **60**. And, since threads **58** are fine threads, fine and accurate adjustments may be made of the position of the cutting-and-forming die **70**.

After the fine adjustment just described has been made, clamping ring **65** is replaced and tightened. The threads **63** of clamping ring **65** and of the lower enlarged portion **62** of the die holder **60** are large and heavy in comparison with the fine threads at the upper end of the die holder **60**. Thus, when the cutting-and-forming die **70** is lowered by its slide ram **50** to pierce and form the overlying metal sheets, the reactive load or thrust is upward through the heavy threads **63**. The

thrust path may be traced from the cutting-and-forming die **70** through shoulder **68** of die holder **60**, holder **60**, the large heavy threads **63**, the clamping ring **65**, the abutting end surface **57** of neck portion **53**, the rectangular slide ram **50**, stub shafts **41** and **43** and their associated bushings **141** and **143**, and cranks **31** and **33** and their associated bushings **131** and **133**. It is to be noted that this upward thrust or load during the cutting and forming operation is not placed on the fine threads **58** which are employed for adjusting of the cutting and forming die **70**.

As already indicated, adjusting of flattening punch **92**, relative to the fixed pierce-and-forming punch **80**, is made by loosening scrrews **49** (to allow them to move up or down in the slots **48**) and then rotating the threaded bolt **45** in the member **44**. This is done by inserting a pin in a hole of enlarged portion **245** and rotating the part.

At a section **4—4** of FIG. **3**, the flattening punch **92** may have a shape such as is shown in FIG. **4**. To maintain proper orientation between the flattening punch **92** and the annular terminal end of the cylindrical cutting-and-forming die **70**, the outer surface of the shank of the flattening punch **92** and the inner wall of the hollow cylindrical cutting-and-forming die **70** may each be provided with flats (flat surfaces). These flats are clearly seen in FIG. **4**, which is a view taken along the line **4—4** of FIG. **3**. The flattening punch **92** is maintained in its proper oriented position by punch holder **292** which is secured to the center ram **392**.

The fixed pierce-and-forming punch **80** in the base **90** of the machine is supported in a punch holder **180** which has a flat **181**. The flat on the punch **80** is oriented to correspond with the flat **181** on the punch holder **180**.

FIG. **5** illustrates two overlying sheets **28** and **29** at a time instant in the operating cycle of the fastening machine just after the sections **128** and **129** have been displaced by the downwardly-moving cylindrical cutting-and-forming die **70** in cooperation with the fixed pierce-and-forming punch **80**. In FIG. **5**, the cylindrical cutting-and-forming die **70** is now rising and flattening punch **92** is moving downwardly. The end face **192** of the downwardly-moving flattening punch **92** has just engaged the upper surface of the upper displaced section **128**. At this instant, the upwardly-moving cylindrical die **70** has just cleared the lower displaced section **129**. The upper displaced section **128** is still encased. This represents a desirable timing relationship. It allows the flattening punch **92** to transmit its energy through the still-encased upper displaced section **128** to the lower displaced section **129** to spread the lower section **129** over the upper sheet **28**.

One means for achieving the desirable timing relationship just described between the cylindrical cutting-and-forming die **70** and the flattening punch **92** is illustrated in FIGS. **1** and **2**, and has already been briefly described hereinbefore. It will be seen that the phase relationship between the flattening punch **92** and the cylindrical die **70** is adjustable by means of the phase selector drive plate **34**. To adjust the phase relationship, the drive pin **37** is pulled out of the hole **36** in which it has been positioned, the freely-mounted disc **22** is rotated adjustably on the shaft **10**, and the drive pin **37** is reinserted in a different hole **36** of the series of holes provided in the phase selector drive plate **34**. The phase adjustment allows the desirable timing relationship described above, and illustrated in FIG. **5**, to be maintained for different thicknesses of sheets.

As has already been indicated, the relationship between the pierce-and-forming punch **80** in the base of the machine and the flattening punch **92** may be adjusted for different thickness is of sheets, and/or for wear, either by adjusting the flattening punch **92** as described in the present application or by adjusting the base punch **80** as described in my earlier-filed application. In either case, adjustment of the phase relationship between the flattening punch **92** and the cylindrical die **70**, as by means such as have been described herein, is desirable in order to achieve the advantageous timing relationship illustrated in FIG. **5** and described above.

What is claimed is:

1. Punch and die apparatus for fastening overlying planar sheets of metal or other deformable material, said apparatus comprising:

a. a press having longitudinally movable first and second rams supported on a rigid base;

b. a longitudinally extending pierce-and-forming punch rigidly mounted on said base, said punch having a free end face;

c. a cutting-and-forming die rigidly mounted on said first ram for movement therewith, said die having a longitudinally extending punch-receiving aperture into which said pierce-and-forming punch is receivable when said first ram is extended;

d. a flattening punch rigidly mounted on said second ram for movement therewith, said flattening punch being longitudinally slidably received in said punch-receiving aperture;

e. said flattening punch having an end face cooperable with said end face of said pierce-and-forming punch when said second ram is extended;

f. means for adjusting the spacing between the end faces of said flattening punch and pierce-and-forming punch when said second ram is extended; and

g. means for adjusting the phase relation between the times of extensions of said first and second rams.

2. Apparatus according to claim **1** characterized in that said means for adjusting said phase relation comprises means for adjusting the timing of said second ram.

3. Apparatus according to claim **2** characterized in that:

a. said first and second rams are driven by a common shaft through first and second eccentrics;

b. said means for adjusting said phase relation comprises means for adjusting the angular position of the second eccentric on said common shaft.

4. Apparatus according to claim **2** characterized in that said means for adjusting the spacing between the end face of said punches comprises means for adjusting the position of said end face of said flattening punch.

5. Apparatus according to claim **3** characterized in that said means for adjusting the spacing between the end face of said punches comprises means for adjusting the position of said end face of said flattening punch.

6. Apparatus according to claim **1** characterized in that:

a. said cutting-and-forming die includes a die holder and a hollow die carried by said die holder;

b. said die holder has a first set of fine external threads and a second set of heavy external threads;

c. first threaded means engage with said set of fine threads for supporting said die holder in said first ram against gravitational forces;

d. second threaded means engage with said set of heavy threads for taking the upward thrust imposed on said die during the fastening operation and directing said thrust to said first ram along a path which bypasses and protects said fine threads from said thrust forces;

e. said second threaded means are adapted to permit rotational movement of said holder in said first threaded means to allow for fine adjustment of the free end of said die.

7. Apparatus according to claim **6** characterized in that said first ram includes a lower neck portion which receives said die holder.

8. Apparatus according to claim **7** characterized in that said second threaded means includes an internally-threaded clamping ring which when rotated into a locking position abuts against the neck portion of said first ram.

9. Apparatus according to claim **6** characterized in that:

a. said flattening punch has an elongated shank in the aligned center bores of said die holder and die;

b. drive means are provided which include first and second eccentric cranks for said first and second rams;

c. said second eccentric crank for said second ram is out of phase in the delayed direction with said first crank which drives said first ram;

d. the phase relationship between said first crank and said second crank is such that when said flattening punch reaches the downward limit of its stroke said die has been raised above its downward limit to an extent sufficient to uncover only the lower most of the overlying displaced sections of metal sheets.

10. Punch and die apparatus for fastening overlying planar sheets of metal or other deformable material, said apparatus comprising:

a. a press having reciprocatingly movable first and second rams;

b. a pierce-and-forming punch and a cutting-and-forming die opposingly positioned, one of which is mounted on said first ram for movement therewith;

c. said die having a longitudinally extending aperture into which the free end face of said pierce-and-forming punch is received when said first ram is extended;

d. a flattening punch mounted on said second ram for movement therewith, said flattening punch being slidably received in said punch-receiving aperture of said die;

e. said flattening punch having an end face which becomes cooperable with the end face of said piercing-and-forming punch when said second ram is extended to an extent sufficient to bring the end free of said flattening punch beyond the end of said die aperture and outside said die;

f. means for adjusting the spacing between the end faces of said flattening punch and pierce-and-forming punch when said second ram is extended; and

g. means for adjusting the phase relation between the times of extensions of said first and second rams.

11. Apparatus according to claim **10** wherein said die is mounted on said first ram for movement therewith.

12. Apparatus for locking together overlying sheets of deformable material, said apparatus comprising:

a. means for piercing first and second overlying sheets discontinuously along a boundary line defining an area for displacing the material of said first and second sheets within said area out of the planes of the non-displaced first and second sheet material until the exterior surface of the displaced first sheet

material is just beyond the plane of the exterior surface of the non-displaced second sheet material; and

b. means for compressing together the displaced material of said first and second sheets while confining the displaced material of the second sheet to limit its outward spread and to spread outwardly the displaced first sheet material over the outer surface of the non-displaced second sheet material beyond the edges of the piercings therein.

13. Spot clinch tool for forming a spot clinch joint by lancing and swaging two or more materials together using one complete stroke of a power source in a single station, said power source having a power stroke and a retract stroke, said tool utilizing an anvil, die and punch

means for moving one of said punch and anvil while maintaining the other stationary during said complete stroke of said power source,

means for moving one of said punch and anvil toward the other during a first part of said power stroke,

means for piercing said materials with said punch and die to lance them during a second part of said power stroke,

means for holding the die in a first position spaced from the anvil during both said first and second parts of said power stroke,

means for moving the die to a second position in respect to said anvil during a third part of said power stroke,

means for swaging the lanced portions of said materials with said punch and anvil during a fourth and final part of said power stroke,

means for maintaining the die and the anvil in said second position during said fourth and final part of said power stroke and during a first part of said retract stroke, and

means for moving said die relative to said anvil from said second position to said first position during a second and final part of said retract stroke.

14. Spot clinch method for forming a spot clinch joint by lancing and swaging two or more materials together using one complete stroke of a power source in a single station, said power source having a power stroke and a retract stroke, said method utilizing an anvil, die and punch, said method comprising

moving one of said punch and anvil while maintaining the other stationary during said complete stroke of said power source,

moving said one of said punch and anvil toward the other during a first part of said power stroke,

lancing said materials by piercing them with said punch and die during a second part of said power stroke,

holding the die in a first position spaced from the anvil during both said first and second parts of said power stroke,

moving the die to a second position in respect to said anvil during a third part of said power stroke,

swaging the lanced portion of said materials during a fourth and final part of said power stroke,

maintaining the die and the anvil in said second position during said fourth and final part of said power stroke and during a first part of said retract stroke,

and moving said die relative to said anvil from said second position to said first position during a second and final part of said retract stroke.

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