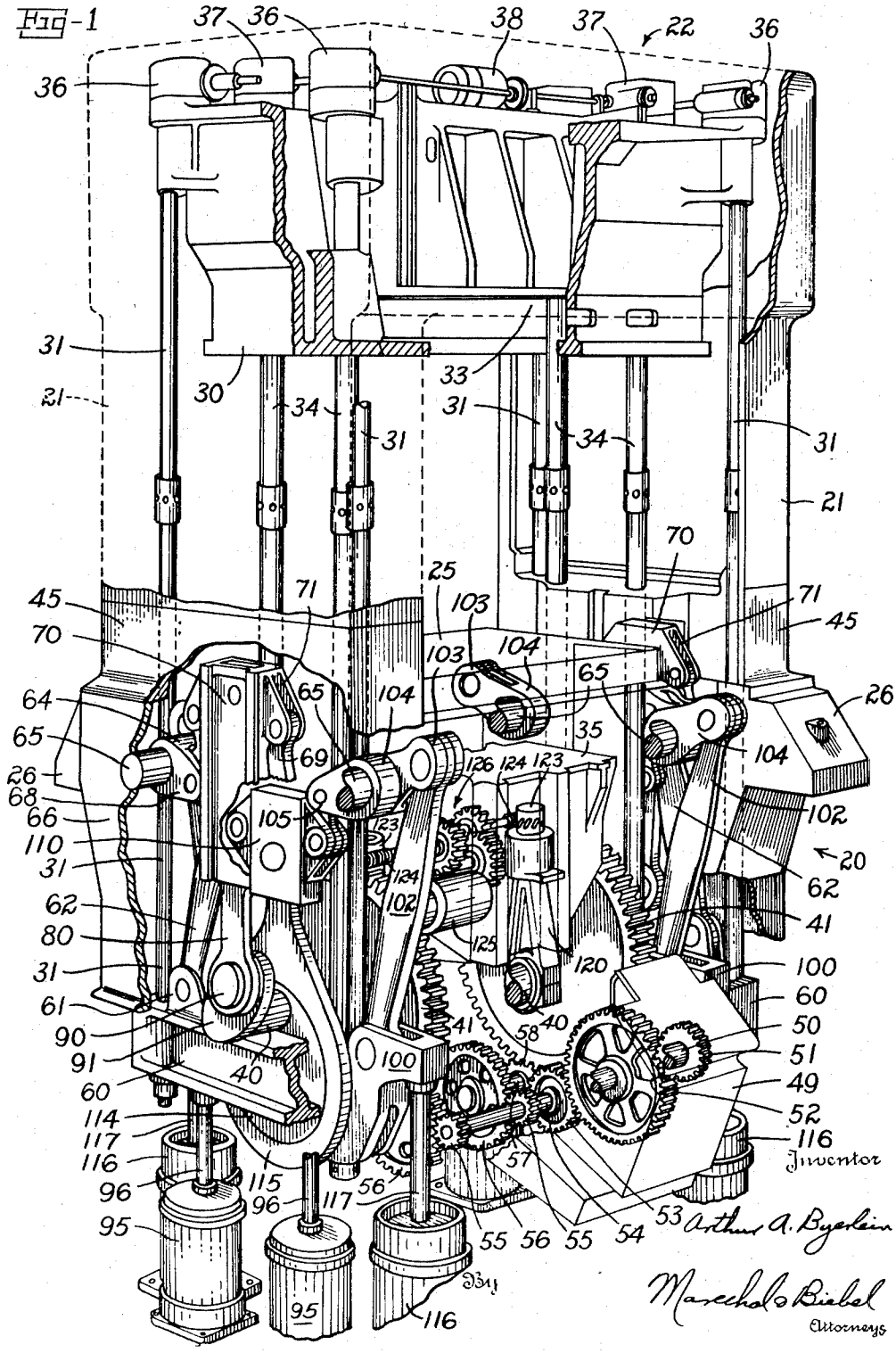
Sept. 19, 1950 A. A. BYERLEIN 2,522,746

PRESS

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Fig-1



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Fig-2

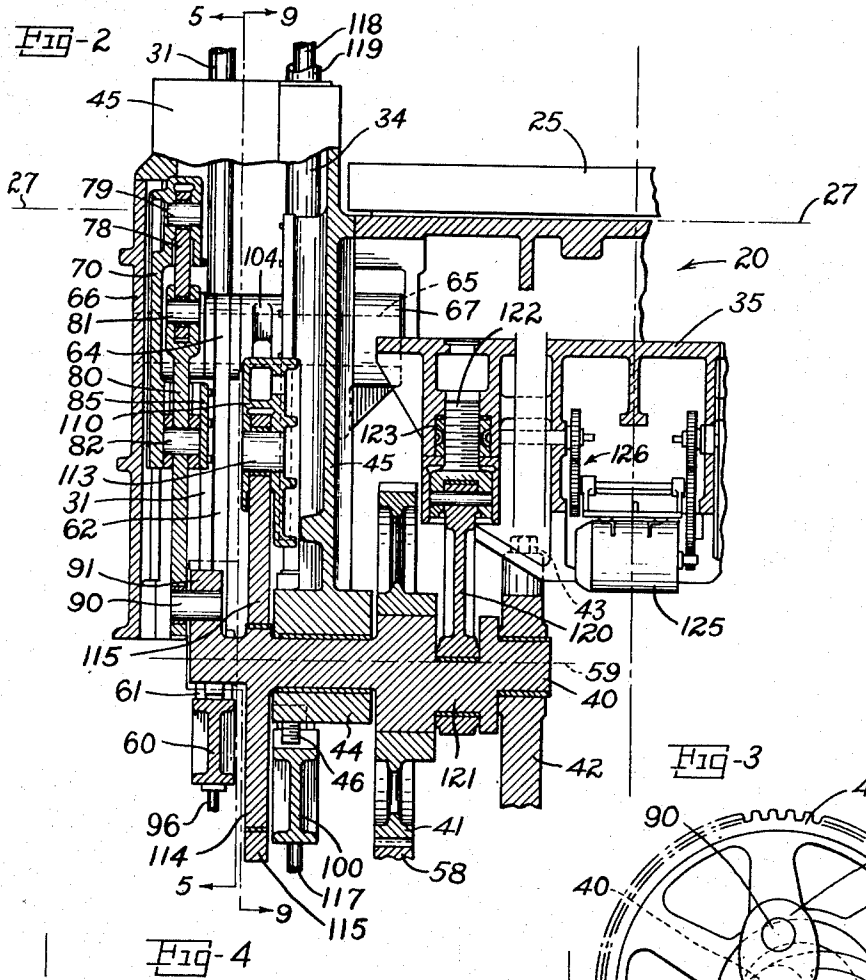


Fig-3

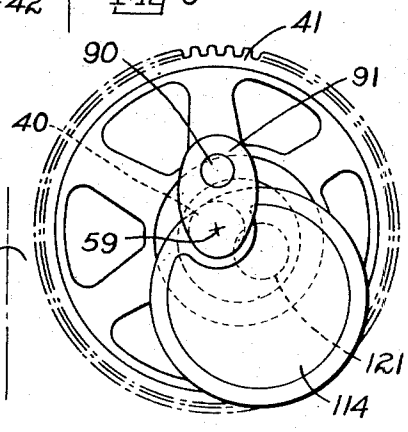
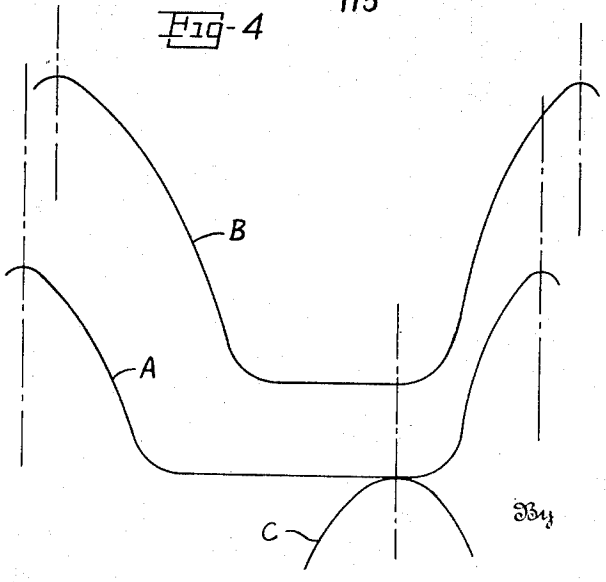


Fig-4



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PRESS

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Fig-5

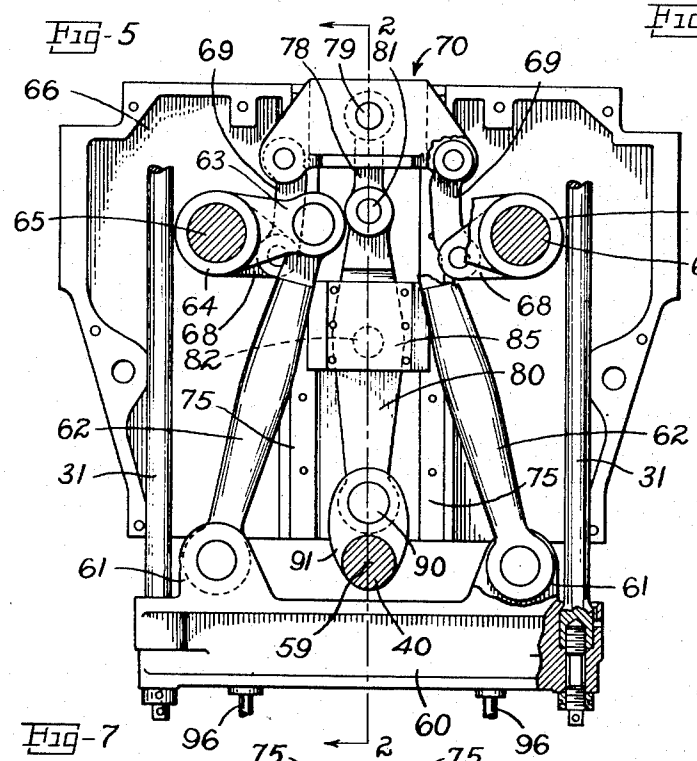


Fig-6

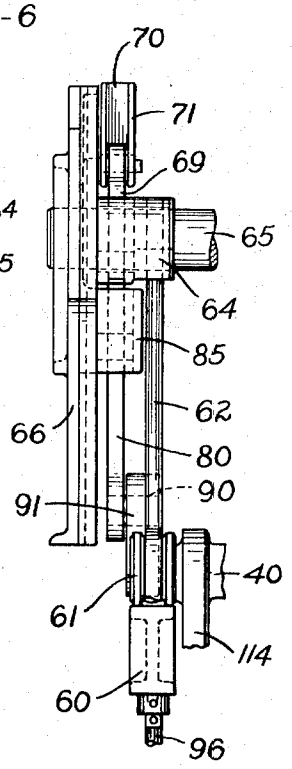


Fig-7

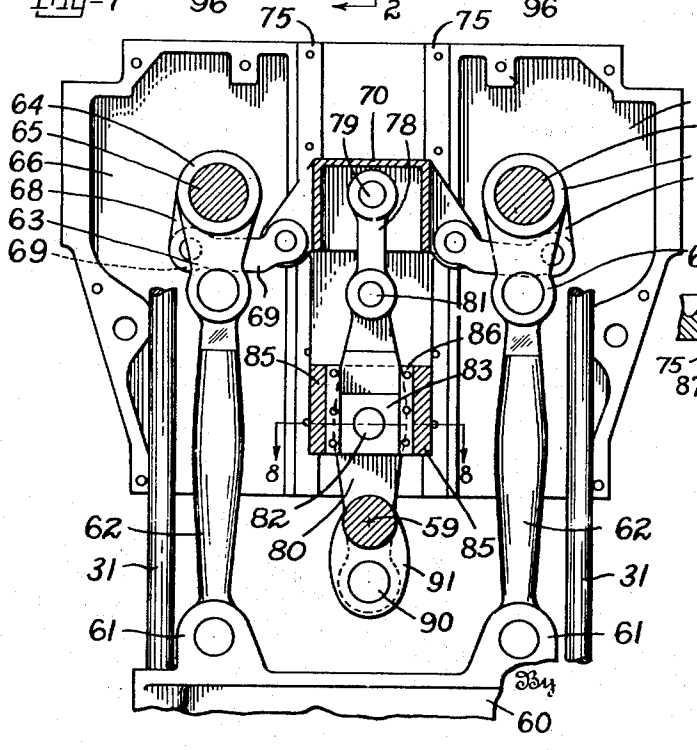
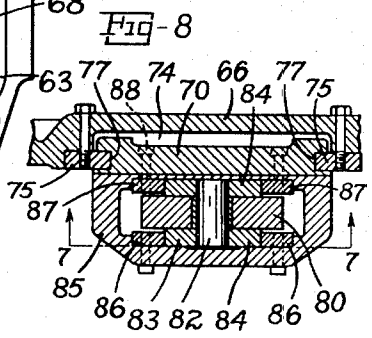


Fig-8



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PRESS

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Fig-9

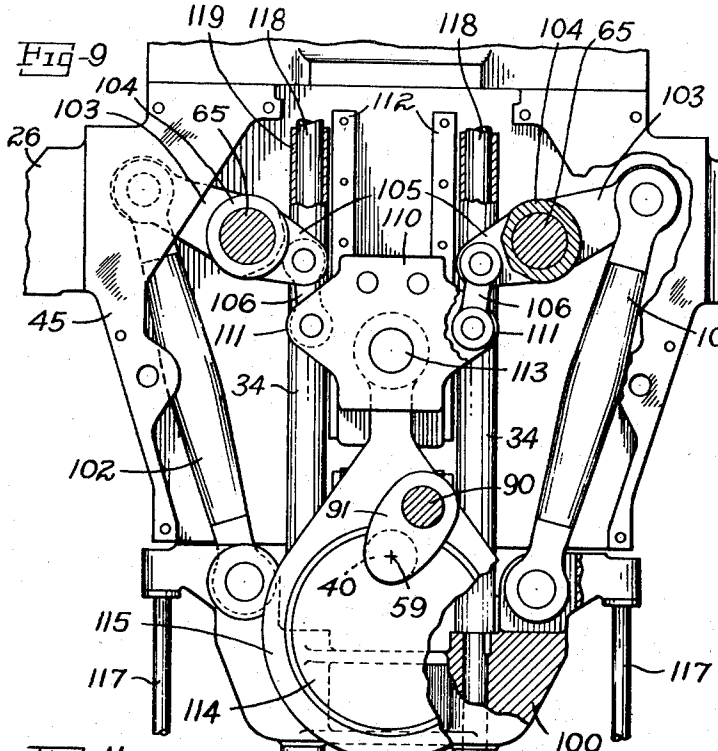


Fig-10

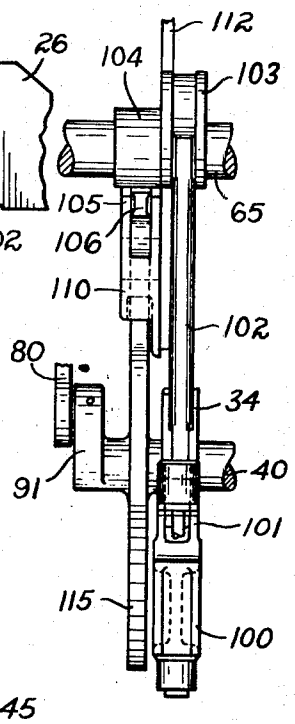
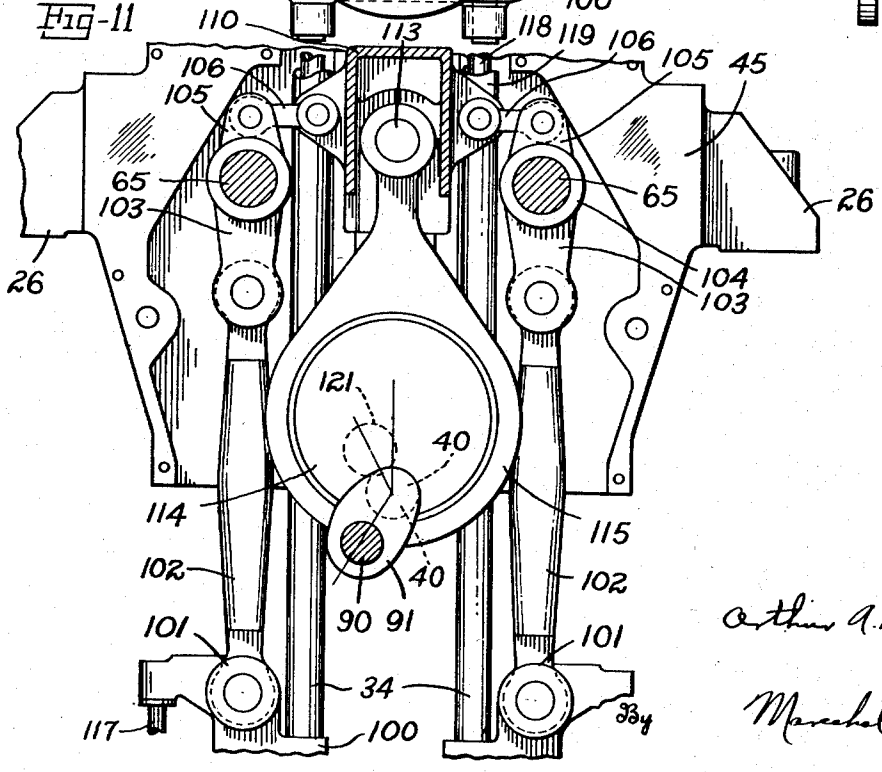


Fig-11



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Patented Sept. 19, 1950

2,522,746

UNITED STATES PATENT OFFICE

2,522,746

PRESS

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Application August 22, 1947, Serial No. 770,002

15 Claims. (Cl. 113—38)

1

This invention relates to presses, and more particularly to drawing, forming and stamping presses such as are used for forming metal sheets in the manufacture of automobile bodies and parts thereof, and the like.

One of the objects of the invention is to provide a multiple action press which is simple in construction, highly accurate in operation, and which includes a plurality of relatively movable upper slides and a drive mechanism supported in the press bed for operating the slides through tie rods to provide proper operating pressures notwithstanding variations in the thickness of the sheets being fabricated thereby.

Another object is to provide a multiple action press of improved construction including a blank-holder operated through tie rods which are placed in elastic tension during the forming stroke or strokes of the die slide or slides of the press to provide the desired uniform pressure on the sheet being fabricated even though there are substantial variations in thickness from one sheet to the next and within different portions of the same sheet.

An additional object is to provide a multiple action press having a plurality of relatively movable slides located above the bed and a drive mechanism supported in the bed and including a plurality of beams arranged for vertically reciprocating movement and connected through tie rods with the slides to effect proper actuation thereof in the operation of the press

It is also an object of the invention to provide a multiple action drawing press wherein the blank holder can be initially adjusted while in contact with the die against which it is to hold the sheet in the operation of the press and which will thereafter continue to provide proper operating pressure without further adjustment irrespective of substantial variations in sheet thickness.

Another object is to provide a multiple action toggle press wherein the toggle linkages for operating a slide or slides in the upper part of the press are located in opposite ends of the press bed and have a closely coupled drive mechanism associated therewith free of complicated levers and long shafts subject to torsional stresses in use.

Other objects and advantages of the invention will be apparent from the following description, the accompanying drawings and the appended claims.

In the drawings, in which like characters of reference designate like parts throughout:

Fig. 1 is a diagrammatic view in the nature of a perspective illustrating a triple action toggle press constructed in accordance with the present invention, with parts being broken away and other parts shown in somewhat phantom outline in order to illustrate details of internal construction and arrangement;

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Fig. 2 is a fragmentary view in longitudinal section through the bed of the press shown in Fig. 1, the view being taken approximately on the line 2—2 of Fig. 5;

Fig. 3 is a detail view in elevation of one of the crankshafts of the press, the view being taken from the outer end of the crankshaft;

Fig. 4 is a graph showing diagrammatically the relative sequential travel of the die slides of the press during a complete cycle thereof;

Fig. 5 is a detail view of the toggle mechanism and associated structure for operating the blank holder of the press shown in Figs. 1 and 2, the view being taken approximately on the line 5—5 of Fig. 2 and showing the parts in their relative positions corresponding to the upper dead center position of the blank holder;

Fig. 6 is a view in side elevation of the mechanism shown in Fig. 5;

Fig. 7 is a view similar to Fig. 5 but showing the parts in their relative positions corresponding to the lower dead center position of the blank holder, certain parts in this view being broken away and in section substantially on the line 7—7 of Fig. 8;

Fig. 8 is an enlarged detail view in horizontal section taken substantially on the line 8—8 of Fig. 7;

Fig. 9 is a view similar to Fig. 5 showing the toggle mechanism and associated structure for operating the inner slide or plunger of the press shown in Figs. 1 and 2, this view being taken substantially on the line 9—9 of Fig. 2 and showing the relative positions of the parts corresponding to the upper dead center position of the plunger;

Fig. 10 is a view in side elevation of the mechanish shown in Fig. 9; and

Fig. 11 is a view similar to Fig. 9 but showing the parts in their relative positions corresponding to the lower dead center position of the slide or plunger operated thereby.

In the drawings, which illustrate the preferred embodiment of the present invention, and referring more particularly to Fig. 1, the press bed is designated generally by the reference character 20. Spaced uprights or side frame portions 21 are mounted on the bed and connected by an upper or arch portion designated generally by the reference character 22, these side and upper

frame portions supporting and guiding the two upper slides for reciprocating movement with respect to the bed and the bolster plate 25 thereon. The bed includes laterally projecting portions 26 which are adapted to rest on suitable supporting columns or the like, with the floor line being represented by the dotted line 27 in Fig. 2 and passing substantially just below the bolster plate as shown.

The outer slide or blank holder of the press is designated generally by the reference character 30 and is provided with four tie rods 31, which are connected to the slide adjacent each corner thereof and extend downwardly to positions below the upper level of the bed 20. The inner slide is designated by reference character 33, and it is similarly provided with four tie rods 34 extending downwardly to positions within or below the bed. The lower slide 35 is located within the bed and below the bolster plate 25, as indicated in Figs. 1 and 2, and it will be understood that the bolster plate is shown diagrammatically and in practice is provided with the usual holes for accommodating the pressure pins through which the action of the lower slide is transmitted to the work.

The connections between the tie rods and slides preferably provide for axial adjustment in order to vary the starting position of each slide and hence its depth of draw. A suitable such adjustable connection is one similar in construction to that illustrated in Patent No. 2,378,062, issued June 12, 1945 to A. A. Byerlein and assigned to the same assignee as this application, which includes a cylindrical nut threaded on the tie rod and rotatably mounted in a suitable housing on the slide. When such nuts are rotated, as through worm gears and suitable drive connections to a common motor as described in said Patent 2,378,062, corresponding axial adjustment between the nuts and tie rods will take place. Fig. 1 illustrates each upper slide as having such adjustable connections for the tie rods, cylindrical housings for the adjusting nuts being shown at 36 on slide 30 and at 37 on slide 33, and a motor for operating these nuts on the inner slide being shown at 38, there being a similar motor, not shown, for operating these nuts on the outer slide.

In the working operation of this press, the upper slides 30 and 33 are mounted for reciprocating movement with respect to each other and to the bed and bolster plate, and the drive mechanism is so constructed and arranged that the outer slide 30 or blank holder performs its working stroke first, during which it descends to a predetermined position above the bed and then dwells in that position to serve as a blank holder with respect to the die or dies mounted on the bolster plate. The inner slide or plunger 33 operates in timed relation with the blank holder, descending after the blank holder and performing its drawing operation during the period of dwell of the blank holder. After this drawing stroke is completed, the slide 33 also dwells and acts as a blank holder, and during this dwell period of both upper slides, the lower slide 35 rises to perform its drawing operation, which will be a reverse draw relative to the operations of the first two slides and which is effected through pressure pins traversing the bolster plate 25, as already pointed out. Thereafter the cycle is completed by the return of all three slides from their working positions to their original or upper dead center positions. These operations are illustrated by and will be readily understood from the curves shown in Fig. 4, which illustrate the relative sequential movements of the three slides during a complete cycle of the press, the curve A representing the blank holder 30, curve B the plunger or inner slide 33 and curve C the lower slide 35.

The main drive system for the press is shown in Figs. 1 and 2. There are two identical crankshafts 40 mounted at opposite ends of the bed and each carrying a large gear 41. Each crankshaft is supported at its inner end by a beam 42 which is bolted or otherwise secured to the frame of the bed as indicated at 43 in Fig. 2, and each crankshaft is also supported adjacent its midportion by means of a bearing bracket shown fragmentarily at 44 and secured to the frame portion 45 by means such as bolts 46. The main power source for the press has been removed from Fig. 1 in order to show parts which would otherwise be concealed behind it, but the mounting bracket and cover for the drive are indicated fragmentarily at 49. Also, a fragment 50 of the power drive shaft is shown and carries a pinion 51 meshing with intermediate gear 52 which in turn meshes with the pinion 53 on an intermediate shaft 54. There are two smaller pinions 55 on this shaft 54, and each meshes with one of the spur gears 56 on the two intermediate shafts 57, each of which in turn carries a pinion 58 meshing with the large gear 41 on the adjacent crankshaft 40. The motor bracket and these various intermediate shafts are all supported by the beams 42 and by the bearing brackets 44, and this construction thus provides for transmission of the drive from the drive motor equally to each of crankshafts 40 to cause rotation of the crankshafts and the parts carried thereby about the axis indicated by the dotted line 59 in Fig. 2.

The toggle linkages and driving connections for operating the outer slide 30 are mounted in the frame portions 45 which form the ends of the bed, and they are shown in detail in Figs. 2 and 5 to 8. The lower ends of the tie rods 31 are connected as shown in Fig. 5 to a beam 60 extending across the outer end of the press from front to back, it being understood that there are two of these beams 60 as shown in Fig. 1 and that the structure described in connection with Figs. 5 to 8 is duplicated at opposite ends of the press. Each of these beams 60 is formed adjacent opposite ends of its upper portion with a yoke 61 to which is pivotally connected one end of one of a pair of elongated links 62. The upper end of each of these links is pivotally connected to the bifurcated end of one arm 63 of a bell crank lever 64 which in turn is pivotally mounted on a pin 65 mounted at its outer end in the frame portion 66 and its inner end in a boss 67 on frame portion 45. The other arm 68 of the bell crank lever 64 is also bifurcated and pivotally connected to one end of a link 69 which has its other end pivoted to a member 70 mounted for vertical sliding movement on the frame portion 66, the sides of this sliding member 70 being bifurcated at 71 to receive the links 69 as shown most clearly in Fig. 1.

The construction of the sliding member 70 and the parts carried thereby is shown most clearly in Figs. 2, 7 and 8. The inner face of the frame portion 66 is formed with a vertical channel 74, and the sliding member 70 engages in this channel and is supported for sliding movement therein by gibs 75 which are bolted or otherwise secured to the frame portion 66 adjacent the channel 74 and extend into complementary grooves 77 in the sides of sliding member 70. This construction provides for vertical reciprocal movement of the sliding member 70 relative to frame portion 66,

and this sliding movement is transmitted through the links 69 to bell crank levers 64 and thence to the elongated links 62 and beams 60 to operate slide 30 through tie rods 31. The driving connection for such reciprocal movement of sliding member 70 is shown most clearly in Figs. 2, 7 and 8.

The upper portion of sliding member 70 is hollow and the upper end of a link 78 is pivotally mounted therein by a pin 79, the lower end of this link 78 being pivoted at 81 to the bifurcated upper end of a somewhat longer link 80. This link 80 is in turn pivotally mounted on a pin 82 supported for vertical sliding movement in the sliding member 70. As shown most clearly in Figs. 7 and 8, the pin 82 has its opposite ends received in rectangular blocks 83 and 84, and these blocks 83 and 84 are in turn supported for sliding movement in a casing 85 which is bolted or otherwise secured to the sliding member 70. As shown in Fig. 8, the blocks 83 and 84 are positioned between pairs of vertical gibs 86 and 87 which are bolted to the casing 85, the bolts 88 which secure the gibs 87 to casing 85 being shown as also securing this casing to the sliding member 70. The lower end of the link 80 is pivotally connected to a crank pin 90 set in a crank arm portion 91 integrally formed or otherwise secured to the outer end of the crankshaft 40.

In operation, rotation of crankshaft 40 will cause similar rotation of the crank pin 90 about the axis 59 of the crankshaft, thus causing rotational movement of the lower end of link 80 which will be translated into reciprocal movement of the sliding member 70 to operate slide 30 through the toggle linkages with a prolonged dwell in its movements. Fig. 5 illustrates the positions of these parts when the slide is in its upper dead center position, and as the crankshaft rotates from this position, link 80 will be drawn downwardly and will pull the sliding member 70 similarly downwardly to its lowermost position as shown in Fig. 7. During this downward movement, member 70 will operate through links 69 to rock levers 64 downwardly and outwardly, thus straightening the linkages composed of lever arms 63 and the elongated links 62 until they are in substantial alignment and parallel with tie rods 31, as shown in Fig. 7. This straightening movement of linkage 62—63 results in pushing downwardly on beams 60, and since these beams are secured to the lower ends of tie rods 31, the downward movement of the beams will place tension on the tie rods, pulling them downwardly and thus causing operating movement of the upper slide 30. Beams 60 also provide for ready connection between slide 30 and the air cushions 95, such connection being shown as formed by the rods 96 secured to beams 60 and extending into the air cushions as illustrated in Fig. 1.

The arrangement of toggle links and levers is such that beams 60 and slide 30 will reciprocate with a prolonged dwell in their movements, as illustrated by the curve A in Fig. 4. As shown by this curve, the movement of the slide is first relatively rapid, but is then retarded as the crankshaft and member 70 approach their lower dead center positions until it stops completely as the slide enters its dwell period, which corresponds to the flattened middle position of curve A. It will also be noted that prolongation of this dwell is facilitated by the slidable mounting of the pivot pin 82 for link 80 in member 70, which permits appreciable upward movement of link 80 before member 70 begins its upward travel.

It will thus be seen that the mechanism shown

in Figs. 5 to 8 provides for the transmission of a balanced operating force to the blank holder. The arrangement of toggle links and levers is highly compact and requires only relatively short connecting shafts at opposite ends of the bed, and these shafts are substantially free of torsional stress since they serve merely as pivotal supports for the levers 64, the drive being transmitted to the lever arms 68 at points radially spaced from shafts 65 through the sliding member 70 and links 69, and each lever arm 68 being closely spaced axially from its associated lever arm 63. Also, the toggle linkages, tie rods and beam 60 all have their central planes in substantially the same vertical plane, and since the angularly directed forces in the linkages are absorbed in the beam and press frame, the only forces applied to the slide are substantially directly in line with the tie rods 31, and are applied equally to each tie rod and hence equally to each corner of the slide, thus causing its operating movement to follow a straight line course with minimum side thrust, even under conditions of unbalanced loads on the die carried thereby.

In addition, since the tie rods 31 are free and unstressed except for the tension developed in them during the downward stroke and dwell period of the blank holder, they are capable of stretching individually or collectively as required to adjust the pressure of the blank holder on the sheet and to prevent tearing or wrinkling of the sheet during the forming operation as a result of improper pressure and even though there are substantial variations in sheet thickness from one sheet to the next and within different portions of the same sheet. In presses of this type as heretofore constructed, and wherein the blank holder is operated mechanically through screws which are in compression during the dwell period, the operating mechanism for the blank holder commonly requires highly accurate adjustment in accordance with the thickness of the sheets to be drawn, and unless this adjustment is properly controlled to compensate for variations in sheet thickness as they occur, spoilage of the sheet may result. Thus if a sheet should be run which is as little as 0.005 inch over the thickness for which the blank holder is set, it may be torn during the forming stroke or strokes of the press as a result of too great pressure by the blank holder to permit proper drawing. Conversely, a sheet which is as little as 0.005 inch under the thickness to which the press is adjusted may be drawn in too easily and wrinkled as a result of insufficient pressure by the blank holder. Thus in the absence of constant attention to the adjustment of the blank holder of such a press relative to the sheet thickness, a substantial amount of spoilage may result.

In the operation of the present press as described and shown in Figs. 1 to 8, when the pressure on the sheet between the blank holder and the lower die or dies is greater than that for which the press is initially set, it will be compensated for by elastic stretching of the tie rods 31. For example, in the manufacture of automobile bodies, this press will usually handle sheets of the order of 0.040 inch in thickness, and for such use highly satisfactory and uniform results have been obtained with the tie rods 31 formed of a good grade of steel having a high yield point, an example being a rod 5 inches in diameter and approximately 20 feet in length capable of elastic stretch up to a total of approximately 0.125 inch without rupture or permanent deformation.

In the initial adjustment of the press with tie rods 31 of such elasticity and for handling sheet of approximately 0.040 inch in thickness, the blank holder can be set down squarely on the lower die without adjustment of the individual tie rods at each corner and then operated in that setting, or if desired the blank holder can be backed off a fraction of the average sheet thickness, i. e., less than the minimum thickness expected. In operation, the tie rods 31 will thus adjust themselves by elastic deformation, either individually or collectively as required, to the thickness of each sheet, and they will accordingly provide the desired uniform pressure of the blank holder over the whole sheet without further individual adjustments.

The toggle linkages and drive connections for operating the inner slide or plunger 33 are also mounted in the frame portions 45 of the bed and closely adjacent the corresponding mechanism for the outer slide or blank holder 30 as shown in Fig. 2, and they are shown in detail in Figs. 9 to 11. The lower ends of the pair of tie rods 34 at each end of the press are connected to a beam 100 extending from front to back across the press and parallel to but inwardly of the adjacent beam 60, there being one of these beams 100 at each end of the press as shown in Fig. 1. Each of beams 100 includes a pair of yoke portions 101 providing pivotal connections to the lower ends of a pair of elongated links 102 similar to the links 62 and similarly lying in the same vertical plane with the beam 100 and tie rods 34. The upper end of each link 102 is pivoted to the bifurcated end of the arm 103 of one of a pair of levers 104 mounted for rocking movement on the pins 65 which also support the bell crank levers 64. The other arm 105 of each lever 104 is similarly bifurcated and pivotally connected to one end of a link 106, the lever arms 103 and 105 being axially offset as shown in Fig. 10 to provide for operating clearance of the parts connected therewith.

The two links 106 are each pivotally connected to a sliding member 110, which has yoke portions 111 formed on each side thereof to receive these links and which is mounted similarly to member 70 for vertical reciprocating movement between the gibs or guides 112 which are bolted to the frame portion 45. This member 110 is partially hollow, as shown in Fig. 11, and is pivotally connected at 113 to the end of an eccentric strap 115 rotatably mounted on an eccentric portion 114 of the crank shaft 40, this construction thus providing for translating the rotary motion of the crankshaft into vertical reciprocal movement of the sliding member 110. As shown in Fig. 9, the eccentric 114 and crank 91 are relatively angularly arranged, to provide for a properly timed relation between the operation of the two slides 30 and 33 as shown in Fig. 3, the lines connecting the crankshaft axis 59 with the centers of crank pin 90 and eccentric 114, respectively, forming an angle of substantially 147° with each other.

The operation of this mechanism to cause operating movement of slide 33 is similar to that of the mechanism shown in Figs. 5 to 8, as described. Fig. 9 illustrates the positions of these parts when the slide 33 is in its upper dead center position. It will be noted that the sliding member 110 is then in its lowermost position, and also that crank pin 90 is beyond its upper dead center position, this result being due to the angular relation between the eccentric 114 and the crank 91, as described, and being also illustrated by the relation between the uppermost parts of the curves A and B in Fig. 4. As the crankshaft rotates from the position shown in Fig. 9, the eccentric 114 will rise and force sliding member 110 upwardly, thus causing rocking movement of levers 104 through links 105 with resultant straightening of the linkages composed of lever arms 103 and links 102 into substantial parallelism with tie rods 34 as illustrated in Fig. 11. This straightening movement of the linkages 102—103 will produce downward thrust on the beams 100, with accompanying tension on tie rods 34 to pull the slide 33 downwardly towards the bed. As described in connection with slide 30, slide 33 may also operate during its working stroke against suitable air cushions 116 through rods 117 extending downwardly from beams 100 to each of the air cushions.

The operating cycle of slide 33 is illustrated by curve B in Fig. 4, and as shown, the drawing stroke of the slide is similar to that of slide 30 but is in timed relation therewith in accordance with the angular offset of crank 91 and eccentric 114. The slide 30 can thus complete its downward stroke and begin to dwell as the slide 33 begins the forming part of its downward stroke, so that slide 30 can thus serve as a blank holder for slide 33. Also, the arrangement of toggle links and levers is such that after slide 33 completes its working stroke, it also can dwell for a substantial period as shown by the flattened middle portion of curve B in Fig. 4, and it is during this combined dwell period of the two upper slides that the forming stroke of the lower slide 35 takes place. Thereafter the two upper slides return to their upper dead center positions, and as shown by Fig. 4, the angular relation between the eccentric 114 and crank 91 is such that these return strokes being substantially simultaneously.

It will thus be seen that the operation of slide 33 will be similar to that of slide 30 as described, with similar advantages. Since the forces exerted on linkages 102—103 are resolved into straight vertical movement of beams 100, the tension on tie rods 34 will be similarly vertical and will result in a straight and equally balanced pull on slide 33 with minimum tendency to side thrust or other conditions of improper balance such as might cause cocking or jamming of the slide during working movement. However, instead of leaving these tie rods free and unstressed as is the case with the tie rods 31 for the blank holder, the tie rods 34 for the inner slide are preferably prestressed and encased in suitable sleeves to prevent them from such stretching in use as would be likely to cause non-uniform results. This is illustrated in Figs. 2, 9 and 10 by showing the tie rods 34 as composed of an inner core 118 and an outer sleeve 119. It will also be noted that the drive is initially transmitted to the toggle linkages for the plunger through the sliding member 110 and links 106 without torsional stress on the shafts or pins 65, in the same manner as described in connection with the operation of the blank holder.

As pointed out, the lower slide 35 performs its working stroke during the dwell periods of the upper slides and in the opposite direction, so that both upper slides can serve as blank holders relative to the die operated by the lower slide. This lower slide 35 is mounted for vertical reciprocal movement within the bed as shown in Figs. 1 and 2, and it is operated by connecting rods 120 and

a crank portion 121 of crankshaft 40. As shown in Fig. 2, each connecting rod 120 has its upper end pivotally connected to an adjusting screw 122 threaded in a nut 123 which is rotatably mounted in the lower slide 35, this construction being similar to the adjustable connections between the tie rods 31 and 34 and slides 30 and 33 as described. That is to say, the nut 123 can be rotated relative to screw 122 to raise or lower the position of the lower slide in the bed in accordance with the desired depth of draw. This adjusting movement of nuts 123 can be carried out through worms 124 driven by motor 125 through the gearing indicated generally at 126.

It will be seen that by means of the above construction, rotary movement of the crankshaft 40 will be translated through the connecting rods 120 and crank portions 121 into vertical reciprocal movement of the lower slide 35. Also, this operation of the lower slide can be controlled in timed relation with the movements of the upper slides by suitable angular positioning of the crank portion 121 relative to crank 91 and eccentric 114. As shown in Fig. 3, the line connecting the crankshaft axis 59 with the center of the crank portion 121 is angularly arranged relative to both of the similar lines to the centers of crank pin 90 and eccentric 114, for example at an angle of 30° relative to the line to the center of eccentric 114. With this construction, the operating stroke of the lower slide 35 will take place during the dwell periods of both of the upper slides, as is illustrated by curve C in Fig. 4, which shows that the lower slide 35 reaches its upper dead center position towards the end of the dwell periods of the upper slides, i. e., just after the eccentric 114 has passed its upper dead center position shown in Fig. 11, and then moves downwardly, as the upper slides begin their return strokes in preparation for the next operating cycle of the press.

The present invention accordingly provides a simple, highly effective and advantageous drive system for a multiple action drawing press. The drive mechanisms are highly compact and are so arranged in the frame as to provide balanced operating forces with comparatively short shafts, and without complicated levers or rock shafts which are required to withstand and transmit torsional forces in the operation of the press. In addition, the angularly directed forces incident to operation are absorbed before the drive is transmitted to the tie rods which operate the slides, thus providing for direct pull on the tie rods during the operating stroke of each upper slide, and this results in operating the slide with minimum lateral thrust even under conditions of unequally distributed load over the work areas of the die or dies carried thereby. In addition, these advantages are obtained in a press having its entire drive system located in or below the bed, thus permitting a lighter and better balanced construction in the upper portion of the frame while providing also for improved absorption of operating stresses in the bed.

While the form of apparatus herein described constitutes a preferred embodiment of the invention, it is to be understood that changes may be made therein without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. A drawing press of the character described comprising, in combination, a frame including a bed, a slide mounted in said frame for vertical reciprocating movement above said bed, a pair of tie rods adjacent each end of said frame and connected at their upper ends with said slide, a beam connected to the lower ends of each said pair of tie rods, and drive means mounted in said frame and including toggle linkages mounted above each said beam and connected thereto and to said driving means for straightening movement effective to push said beams downwardly and to develop tension in said tie rods pulling said slide toward said bed.

2. A drawing press of the character described comprising, in combination, a frame including a bed, a slide mounted in said frame for vertical reciprocating movement above said bed, tie rods connected to said slide adjacent each corner thereof and extending into said bed, a pair of beams positioned one adjacent each end of said frame and extending horizontally across the ends of said frame, means connecting each of said beams to the adjacent pair of said tie rods, toggle linkages mounted in each end of said bed above said beam therein, means connecting two of said toggle linkages to each of said beams, and drive means for straightening said linkages to force down said beams and said tie rods and to pull said slide toward said bed.

3. A drawing press of the character described comprising, in combination, a frame including a bed, a slide mounted in said frame for vertical reciprocating movement above said bed, tie rods connected to said slide adjacent each corner thereof and extending into said bed, rigid means interconnecting the lower ends of said tie rods in pairs, a plurality of toggle linkages mounted in said bed, means connecting the lower ends of said linkages to said rigid means, a sliding member mounted for vertical reciprocating movement in said bed, drive means for causing said reciprocating movement of said sliding member, and means connecting said sliding member to the upper ends of said linkages and effective upon reciprocating movement of said sliding member to straighten said linkages and to cause downward movement of the lower ends thereof and of said tie rods to pull said slide toward said bed.

4. A drawing press of the character described comprising, in combination, a frame including a bed, a plurality of separate slides mounted in said frame for vertical reciprocating movement above said bed, a pair of beams located adjacent each end of said bed, tie rods connecting one beam of each said pair to one of said slides and the other said beam of each said pair to the other said slide, toggle linkages for causing vertical reciprocating movement of said beams to operate said slides, each said linkage including a link connected to one of said beams and a lever mounted for pivotal movement in said bed about an axis above and substantially perpendicular to said beams, each said lever having two arms in closely spaced axial relation, one of said arms being connected to said link, drive means in said frame, and means operatively connecting the other arm of each said lever with said drive means effective to cause relative straightening movement of each said link and said first named arm of each said lever to force said beams downwardly and to develop tension in said tie rods pulling said slides toward said bed.

5. A drawing press of the character described comprising, in combination, a frame including a bed, a plurality of separate slides mounted in said frame for vertical reciprocating movement above said bed, tie rods connected with each said

slide adjacent each corner thereof and extending into said bed, four beams positioned below the top of said bed, two of said beams being positioned adjacent each end of said frame and each being connected with two of said tie rods from one of said slides, separate pairs of toggle linkages mounted in said bed above said beams therein and respectively connected to each said beam, each of said beams and the tie rods and linkages connected therewith having their respective central planes in substantially the same vertical plane to minimize angularly directed forces transmitted to said tie rods and slides, and drive means effective to straighten said linkages into substantial parallelism with said tie rods to force said beams downwardly to develop tension in said tie rods pulling said slides toward said bed and operating said slides in timed relation with dwells in their movements.

6. A drawing press of the character described comprising, in combination, a frame including a bed, a plurality of separate slides mounted in said frame for vertical reciprocating movement above said bed, tie rods connected with each said slide adjacent each corner thereof and extending into said bed, four beams positioned below the top of said bed, two of said beams being positioned adjacent each end of said frame and each being connected with two of said tie rods from one of said slides, a plurality of pairs of toggle linkages mounted in the ends of said bed above said beams therein, one of said pairs of linkages being connected to each said beam, parallel shafts extending lengthwise of said frame and forming common pivotal mountings for a linkage of each said pair and a linkage of the adjacent pair, and drive means effective to cause straightening movement of said linkages about said shafts to force said beams downwardly to develop tension in said tie rods pulling said slides toward said bed and operating said slides in timed relation with dwells in their movements.

7. A drawing press of the character described comprising, in combination, a frame including a bed, a plurality of separate slides mounted in said frame for vertical reciprocating movement above said bed, a pair of beams located adjacent each end of said bed, tie rods connecting one beam of each said pair to one of said slides and the other said beam of each said pair to the other said slide, a plurality of sliding members mounted for vertical reciprocating movement in said bed, drive means for reciprocating said sliding members, toggle linkages mounted in said bed, each said linkage being positioned above one of said beams and connected therewith, and means connecting said linkages with said sliding members effective in response to movement of said sliding members to straighten said linkages into substantial parallelism with said tie rods to force said beams and tie rods downwardly and to operate said slides through said tie rods.

8. A drawing press of the character described comprising, in combination, a frame including a bed, a plurality of separate slides mounted in said frame for vertical reciprocating movement above said bed, a pair of beams located at each end of said bed and below the top of said bed, tie rods connecting one beam of each said pair to one of said slides and the other said beams to the other said slide, a crankshaft mounted in said bed, a plurality of sliding members in the ends of said bed, means connecting said sliding members with said crankshaft for vertical reciprocating movement in response to rotation of said crankshaft, means including toggle linkages in the ends of said bed interconnecting one beam of each said pair and one of said sliding members and effective upon downward movement of said sliding member to force said interconnected beam downwardly, and means including toggle linkages in the ends of said bed interconnecting the others of said sliding members and the other said beam of each said pair and effective upon upward movement of said other sliding member to force said other beams downwardly.

9. A drawing press of the character described comprising, in combination, a frame including a bed, a plurality of separate slides mounted in said frame for vertical reciprocating movement above said bed, a pair of beams located adjacent each end of said bed, tie rods connecting one beam of each said pair to one of said slides and the other said beam of each said pair to the other said slide, a crankshaft mounted in said bed, a plurality of vertically reciprocable sliding members in said bed, means connecting said sliding members with said crankshaft for reciprocating movement in response to rotation of said crankshaft, toggle linkages mounted in said bed and each connected with one of said beams, each said toggle linkage being mounted above and in substantially the same vertical plane as said beam connected therewith, means connecting said linkages with said sliding members effective in response to movement of said sliding members to straighten said linkages into substantial parallelism with said tie rods and force said beams downwardly and to operate said slides through said tie rods with dwells in their movements, a third slide mounted in said bed for vertical reciprocating movement, and means including a connecting rod operated by said crankshaft for operating said third slide in timed relation with said first named slides.

10. A drawing press of the character described comprising, in combination, a frame including a bed, a plurality of separate slides mounted in said frame for vertical reciprocating movement above said bed, a pair of beams located adjacent each end of said bed, tie rods connecting one beam of each said pair to one of said slides and the other said beam of each said pair to the other said slide, separate pairs of toggle linkages connected to each said beam and each including a lever mounted for pivotal movement in said bed, means in said frame providing a coaxial pivotal axis above and substantially perpendicular to said beams for one said lever associated with one beam of one of said pairs of beams and one lever associated with the other beam of said pair and providing for relative coaxial movement of said levers, and drive means for causing straightening movement of said linkages to force said beams downwardly and to operate said slides through said tie rods.

11. A drawing press of the character described comprising, in combination, a frame including a bed, a plurality of separate slides mounted in said frame for vertical reciprocating movement above said bed, a pair of beams located adjacent each end of said bed, pairs of tie rods connecting one beam of each said pair to one of said slides and the other said beam of each said pair to the other said slide, separate pairs of toggle linkages connected to each said beam and each including a lever, each said pair of toggle linkages being arranged above said beam connected thereto and in substantially the same plane with said

beam and said tie rods connected thereto, parallel shafts mounted in said bed lengthwise of said frame for supporting said levers, each said linkage connected to one beam of one of said pairs of beams having said lever therein mounted for relative rotational movement on the same one of said shafts as said lever in one of said linkages connected to the other beam of said pair of beams, drive means in said frame, and means operatively coupling said drive means to each of said levers for rocking said levers on said shafts and causing straightening movement of said linkages to force said beams downwardly and to operate said slides through said tie rods.

12. A drawing press of the character described comprising, in combination, a frame including a bed, a slide mounted in said frame for vertical reciprocating movement above said bed, drive means mounted in said frame and including toggle linkages for actuating said slide with dwell in its movements, a pair of tie rods adjacent each end of said frame and connected at the upper ends thereof with said slide, means below said linkages interconnecting the lower ends of said tie rods, and means also connecting said interconnecting means to the lower ends of said linkages for downward movement thereof in response to straightening movement of said linkages to effect balancing of transverse forces developed in said linkages and to place said tie rods in tension in pulling said slide toward said bed.

13. A drawing press of the character described comprising, in combination, a frame including a bed, a slide mounted in said frame for vertical reciprocating movement above said bed, a beam extending across each end of said bed, tie rods adjacent each end of said frame and connected at their upper ends with said slide and at their lower ends with one of said beams, drive means mounted in said frame, and toggle linkages above each of said beams connecting the adjacent said beam with said drive means to effect reciprocation of said beam with a dwell in its movements causing said tie rods to be placed in tension upon downward movement of said beam to actuate said slide in substantially direct relation with said movement of said beams.

14. A drawing press of the character described comprising, in combination, a frame including a bed, a slide mounted in said frame for vertical reciprocating movement above said bed, a pair of tie rods adjacent each end of said frame and having their upper ends connected with said slide and their lower ends extending into the

ends of said bed, a beam extending across each end of said bed and connected to the lower ends of the adjacent said pair of tie rods, a pair of toggle linkages mounted in each end of said bed above said beam therein and between said pair of tie rods therein for movement in substantially the same vertical plane as said beam and tie rods, means connecting each said pair of toggle linkages to the adjacent said beam, and drive means for straightening said toggle linkages to push said beams downwardly and to develop tension in said tie rods pulling said slide towards said bed.

15. A drawing press of the character described comprising, in combination, a frame including a bed, a slide mounted in said frame for vertical reciprocating movement above said bed, a beam located at each end of said bed and below the top of said bed, tie rods connecting said slide with said beams, a pair of sliding members mounted for vertical reciprocating movement in said bed, a pair of toggle linkages mounted in each end of said bed, means connecting one end of each of said linkages to the adjacent said beam, means connecting the other ends of said linkages to the adjacent said sliding member, means mounted for vertical reciprocating movement in each of said sliding members, a first link pivotally mounted in each said sliding means, a second link pivotally connected to one end of each said first link and to the adjacent said sliding member, and means for causing rotational movement of the other end of each said first link in a substantially vertical plane to cause said sliding members to reciprocate with a dwell in their movements, said connecting means between said sliding members and said linkages being effective upon downward movement of said sliding members to straighten said linkages into substantial parallelism with said tie rods to force down said beams and tie rods and to operate said slide with a dwell in its movements.

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