Sept. 7, 1954 P. H. DANLY ET AL 2,688,296

TRIPLE ACTION RECIPROCATING CROWN PRESS

Filed July 22, 1950 4 Sheets-Sheet 1

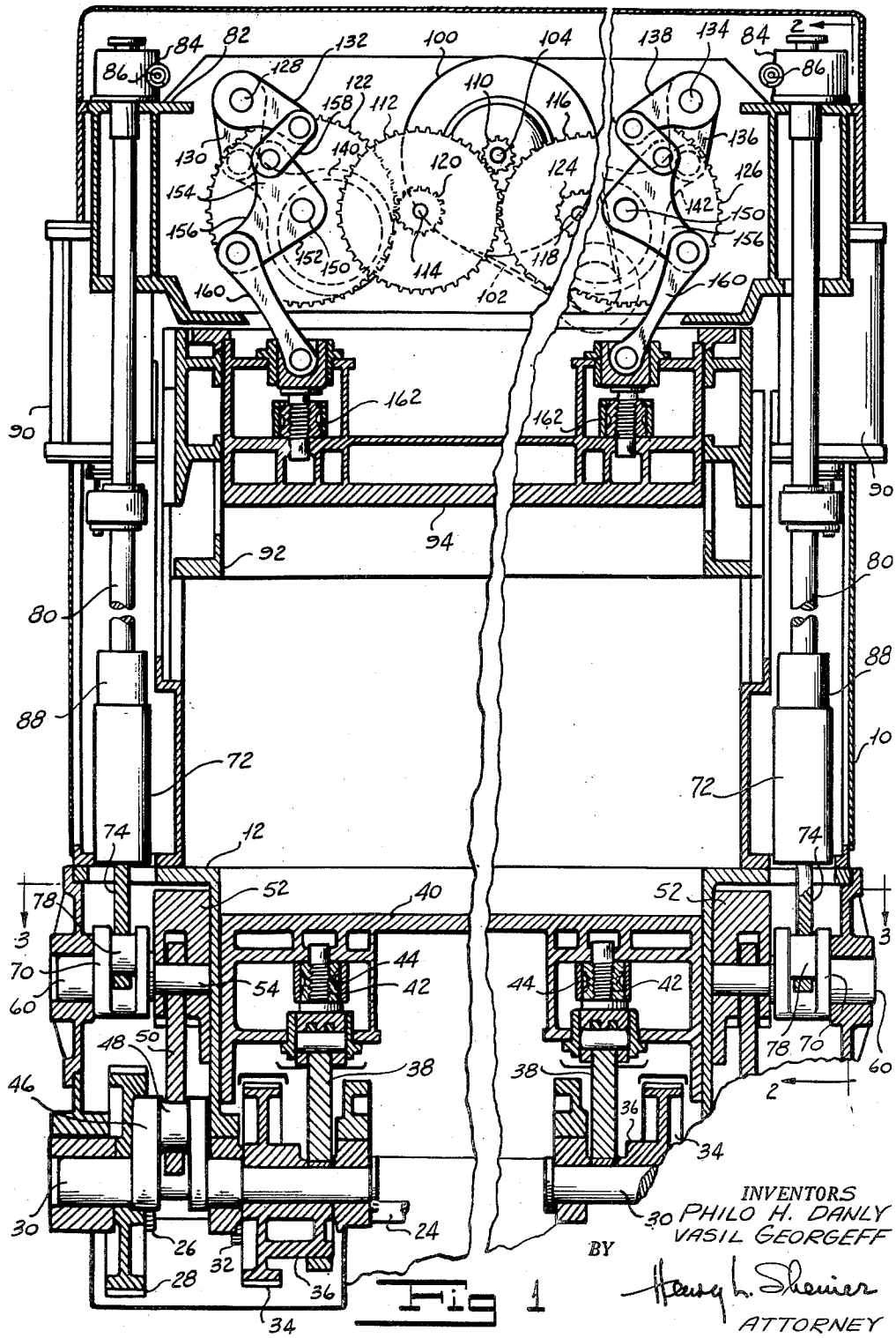


Fig 1

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TRIPLE ACTION RECIPROCATING CROWN PRESS

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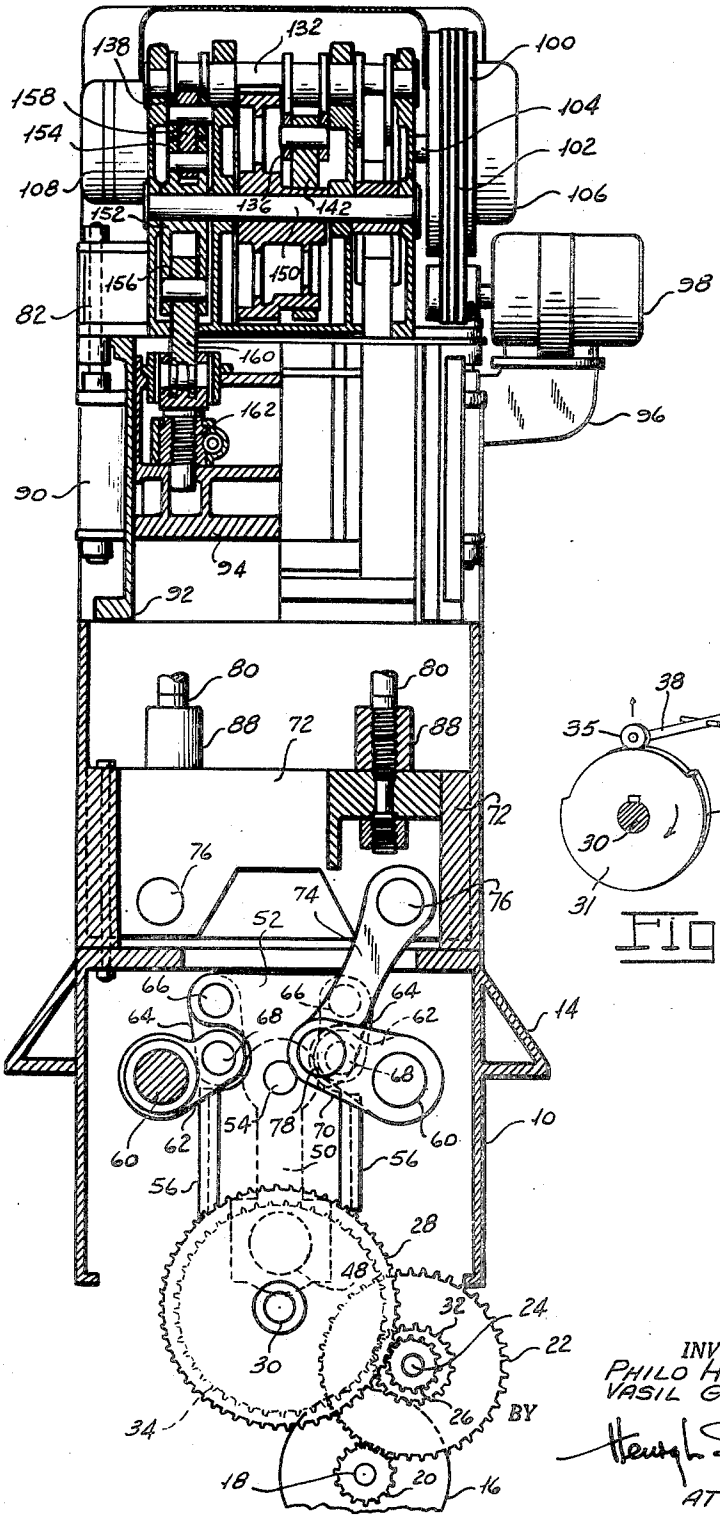


Fig. 2

Fig. 5.

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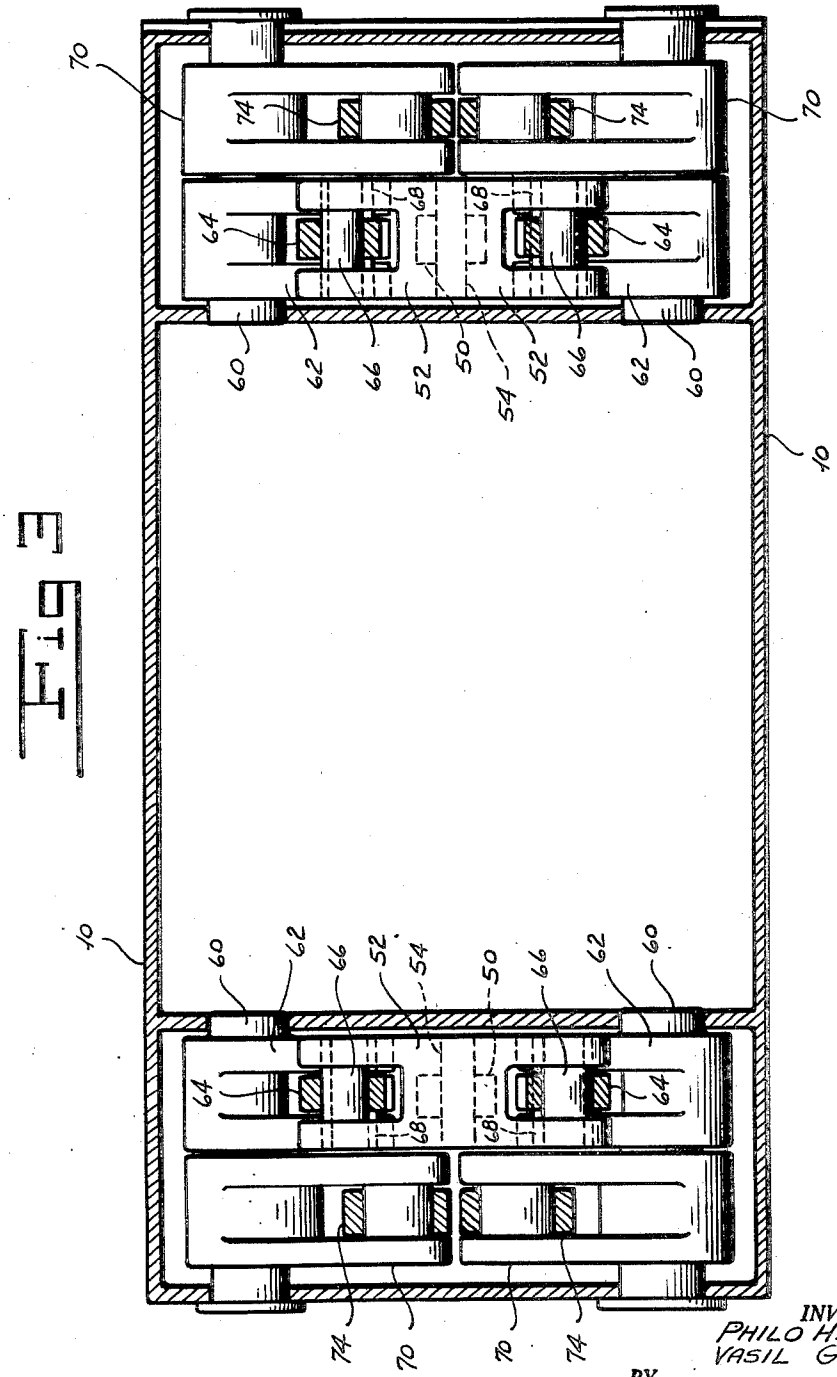


FIG. 5

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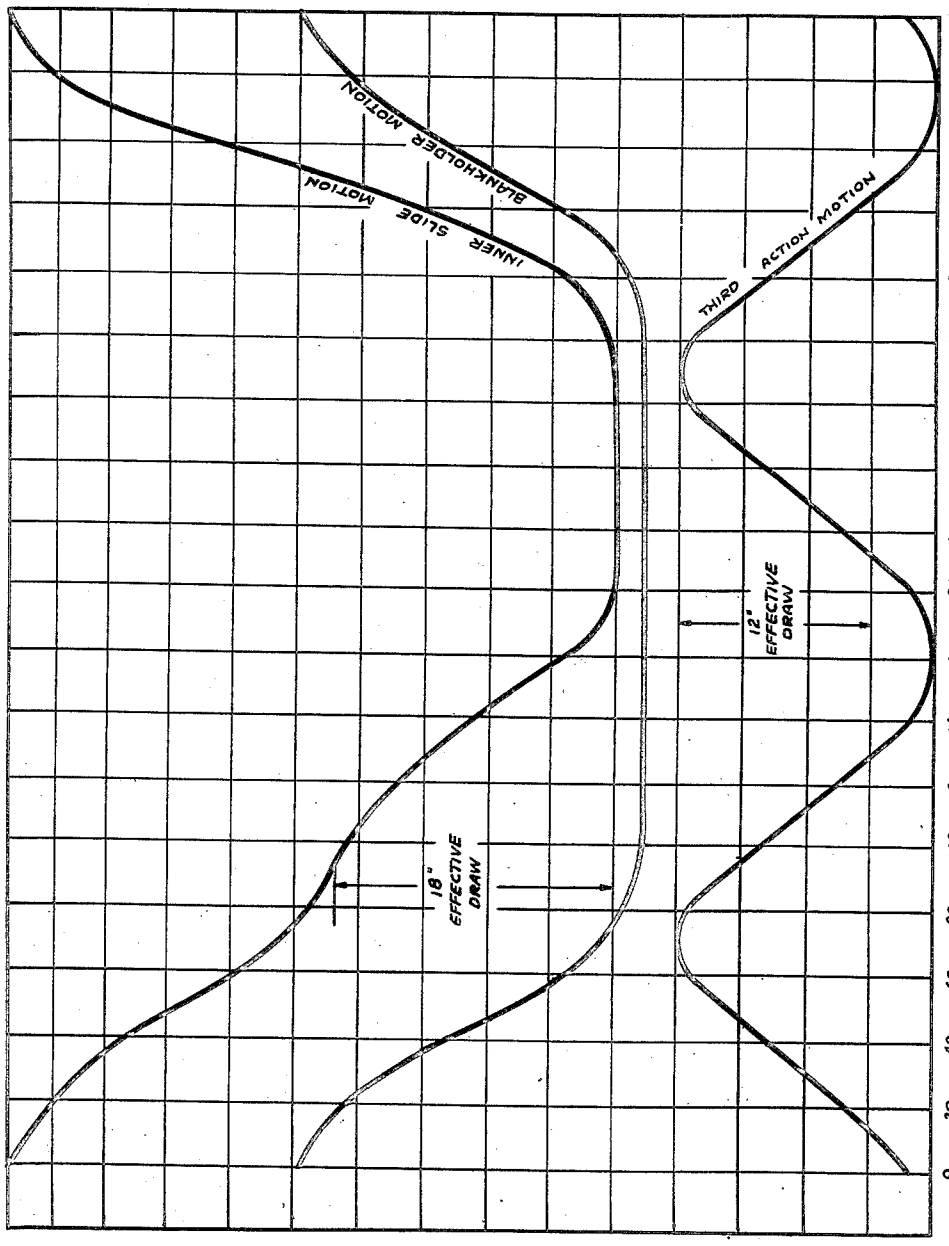


FIG. 4

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TRIPLE ACTION RECIPROCATING CROWN PRESS

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2 Claims. (Cl. 113—38)

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Our invention relates to triple action reciprocating crown presses, and more particularly to a triple action press of improved construction in which a greatly increased output of work may be obtained.

In the triple action presses of the prior art, for a given depth of draw a stroke for the inner slide more than twice the depth must be used. The third action requires a much larger stroke than employed for the inner slide. For example, for a twelve-inch draw in a conventional triple action press the third action must move through an amplitude of forty inches. In the instant invention we are enabled to get a twelve-inch effective draw with only a sixteen-inch motion for the third action. Then, too, the blank holder in the prior triple action presses has been constrained to move through a considerably large amplitude with respect to the depth of the draw. The necessity for moving the blank holder, the inner slide and the third action slide through large amplitudes has seriously reduced the quantity of work which can be performed by the press. The amount of work cannot be increased by speeding the motion of the parts. For average steels, a draw of sixty feet per minute is a limiting speed. If it is attempted to exceed this speed the metal will tear and imperfect work results. The speed of draw, therefore, being limited, the length of time to traverse the comparatively large amplitudes of motion of the slides which is necessary in a triple action press of conventional design circumscribes the number of strokes which the press may perform in a given length of time. In a conventional triple action press, for example, a maximum of four strokes per minute cannot be exceeded without arriving at a speed of draw in excess of sixty feet per minute. Accordingly, the rate of work which can be performed by a given press is greatly reduced. If large production is required, it has been necessary to install an increased number of triple action presses. This necessitates not only a large capital investment in the presses themselves, but also requires factory space, which must be built and maintained.

In conventional triple action presses the draw starts at a time when the slides are moving at substantially their greatest speed, which speed is reduced toward the end of the draw. This arises from the fact that the parts are usually moved by cranks or eccentrics in simple harmonic motion in which the deflection in amplitude proceeds at the slowest rate at the bottom dead centre. The speed at which the press can be run is therefore further limited since the initial speed acts as the limiting factor.

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One object of our invention is to provide a triple action press having a reciprocating crown, which crown carries the blank holder.

Another object of our invention is to provide a triple action press in which the number of strokes in a given period of time may be substantially doubled, thus giving a press capable of producing a greater rate of work.

Another object of our invention is to provide a triple action press in which the draw for the inner slide starts at a slow speed and is then increased in velocity, thus minimizing the tendency to tear.

Another object of our invention is to provide a third action which may perform a number of strokes to one stroke of the inner slide and blank holder.

Other and further objects of our invention will appear from the following description.

In general our invention contemplates the provision of a press frame having a crown mounted for reciprocating movement and supported by a plurality of rods. The crown carries the blank holder for movement therewith and the inner slide for movement relative thereto. The driving means for the inner slide are mounted on the crown and are adapted to actuate the inner slide with respect to the crown. The third action is driven by an independent prime mover in simple harmonic motion. A toggle linkage is adapted to be driven from the third action prime mover through a suitable gear train such that the third action will perform a number of reciprocations to one reciprocation of the crown, depending upon the particular gear ratio between the drive for the third action and the drive for the crown with respect to the prime mover. In the employment of the invention described herein this ratio will be two to one, that is, the third action will perform two cycles while the crown and blank holder perform one cycle. The toggle linkage is such that the blank holder will move downwardly and then dwell the time in which the inner slide performs its work. The inner slide is driven by a toggle linkage which will also dwell at the bottom of its stroke during the period of dwell of the blank holder such that while both the inner slide and blank holder are dwelling, the third action can perform its work. The inner slide is controlled by a clutch which is engaged so that the inner slide will perform its work while the blank holder is dwelling. The third action is driven by a pinion which is splined to the drive shaft. The pinion may be disengaged so that the third action may be idle while the crown is being reciprocated, thus converting a triple action press into a double

action press. The phase of the third action may be readily varied by rotating the drive shaft with the drive pinion for the third action disconnected from the third action drive. If desired, advantage may be taken of the multiple strokes of the third action with respect to the inner slide and blank holder by using the third action as a knockout. A change in phase of the third action may be employed when it is desired to vary the length of the third action draw.

In the accompanying drawings which form part of the instant specification and which are to be read in conjunction therewith and in which like reference numerals are used to indicate like parts in the various views:

Figure 1 is a sectional elevation with parts broken away of a triple action reciprocating crown press containing one embodiment of our invention.

Figure 2 is a sectional view taken along the line 2—2 of Figure 1.

Figure 3 is a sectional plan view taken along the line 3—3 of Figure 1.

Figure 4 is a graph showing the curves of motion of the inner slide, the blank holder and the third action for an illustrative eighteen-inch effective draw for the inner slide and a twelve-inch effective draw for the third action.

Figure 5 is a diagrammatic view showing the means for controlling the engagement and disengagement of the clutch which controls the inner slide.

More particularly referring to the drawings, a press frame 10 may be of any suitable type and may be made of steel plates welded together and formed with a bed 12. The frame 10 also carries members 14 shown in Figure 2 which support the press from a suitable foundation (not shown). A motor (not shown) drives a flywheel 16 adapted to be clutched to a shaft 18 by any suitable clutch known to the art. The shaft 18 carries a pinion 20 which meshes with a gear 22 carried by a shaft 24 adjacent the bottom of the press. The shaft 24 carries a pair of pinions 26 which mesh with a pair of gears 28 carried by and secured to a pair of crankshafts 30. The shaft 24 also carries a pair of pinions 32 secured thereto for rotation therewith. These pinions engage a pair of eccentric gears 34. The pinion 32 is secured to the shaft 24 by means of splines so that the pinion may be moved axially of the shaft to disengage it from eccentric gear 34. This permits the third action to be disconnected and also permits various phase relations to be achieved between the third action and the action of the blank holder. As can be seen by a reference to Figure 1, each eccentric gear 34 is formed integrally with an eccentric 36 which coacts with respective pitmans 38. The pitmans are connected to the third action slide 40, which is mounted for reciprocation in the frame 10 below the bed 12. Connection of the pitmans to the slide 40 is made through screws 42 and adjustable nuts 44, through which the third action slide 40 may be adjusted in setting up the work with different dies. The ratio of gear 34 to pinion 32 is such with respect to the ratio of pinion 26 to gear 28 that gear 34 will rotate twice as fast as gear 28. Each of the cranks 46 is secured to each of the gears 28 so that each of the cranks 46 will rotate with each of the gears. In the construction shown, the crank 46 will revolve once while the eccentric 36 will revolve twice. It is to be understood, of course, that any set of gear ratios may be adopted to control the speed of rotation of the eccentric 36 with respect to the speed of rotation of the crank 46. The crankpin 48 is connected by connecting rod 50 to a lower reciprocating head 52 by means of a pin 54. The head 52 is mounted for reciprocation in a pair of guideways 56, it being understood that there is a head 52 on the right side of the press corresponding to the head 52 on the left side of the press. For purposes of convenience we will describe the construction with respect to one side of the press, it being understood that the construction is symmetrical and that there is a duplication of parts on the right side of the press. For example, the pair of rocker shafts 60 which are carried by the left side of the frame of the press find their counterparts on the right side of the press. The rocker shafts 60 carry a pair of arms 62 secured thereto for rotation therewith. A pair of links 64 have their upper ends pivotally connected to the head 52 by means of pins 66. The lower ends of links 64 are pivotally connected to the ends of arms 62 by means of pins 68. Link 64 and arm 62 form a toggle linkage. Each of the shafts 60 has secured thereto for rotation therewith a crankarm 70, the end of which is connected to an upper head 72 by means of a pair of connecting rods 74. The upper end of each connecting rod 74 is pivotally secured to the upper head 72 by means of pins 76. The lower end of each connecting rod 74 is pivotally connected to the end of the crank 70 by means of pins 78. The connecting rod 74 and the crank 70 form a toggle linkage. Each upper head 72 is connected by a pair of crown rods 80 to the crown 82. The upper ends of the rods 80 are attached through adjustable nuts contained in housings 84. Power driven worms 86 are adapted to rotate the nuts to adjust the crown 82 with respect to the heads 72. The lower ends of the rods 80 are secured to the head 72 by means of coupling members 88, as can readily be seen by reference to Figure 2. The crown is thus supported by four rods and is constrained to move with these rods. The weight of the crown and associate parts is counter-balanced by air cylinders 90 so as to relieve the rods of their compressional load and enable the rods to act in tension. The crown supports the blank holder ring 92, which moves with the crown. The crown also supports the drive for the inner slide 94, which moves relative to the blank holder and to the crown whenever driven by its drive.

Referring now to Figure 2, a motor support bracket 96 carries a motor 98 from the crown. The motor drives a flywheel 100 by means of a plurality of V-belts 102. A shaft 104 is adapted to be clutched to the flywheel by means of a clutch mechanism contained within clutch casing 106 and to be braked to the press frame when the clutch is released by a brake contained within housing 108. The clutch may be controlled in any manner known to the art. For example, as shown in Figure 5, a controlling cam 31 is secured to shaft 30 for rotation therewith. A follower lever 33 carries a follower 35 which is adapted to be raised by engagement with the elevated cam surface 37. Whenever the follower 35 is lifted, the circuit across conductors 39 and 41 will be closed to operate a control solenoid, as is well known in the art, to cause the clutch to engage and the brake simultaneously to be released. Whenever the circuit across conductors 39 and 41 is opened the brake will be set and the clutch will be released. The timing of the

setting of the clutch and the releasing of the brake driven by the flywheel 100 is shown in Figure 4. Referring now to Figure 1, the shaft 104 carries a pinion 110 which engages a gear wheel 112 carried by shaft 114. The gear wheel 112 meshes with a gear wheel 116 carried by a shaft 118. The shaft 114 carries a pinion 120 which meshes with an eccentric gear 122, while the shaft 118 carries a pinion 124 which meshes with a similar eccentric gear 126. A rocker shaft 128 is mounted on the crown and carries a pair of cranks 130 and 132. A rocker shaft 134 similar to rocker shaft 128 is carried by the right side of the crown and this rocker shaft carries a pair of cranks 136 and 138 secured to the rocker shaft 134 for rotation therewith. A pitman 140 is connected to the end of crank 130 and a corresponding pitman 142 is connected to the end of crank 136. The arrangement is such that the rotation of the eccentric gear 122 will rock the crank 130 and hence rocker shaft 128 while the rotation of eccentric gear 126 will rock the rocker shaft 134 through pitman 142 and crank 136. Since the construction of the right-hand of the press is symmetrical with that on the left, except that the rocker shafts will rock in opposite directions of rotation simultaneously due to the fact that gear 126 is driven oppositely from gear 122, we will describe only the left-hand side of the press for purposes of convenience, it being understood that the same construction and the same action are found at the right-hand side of the press as viewed in Figure 1. As the rocker shaft 128 oscillates it will oscillate the crank 132. A shaft 150 supports a bell crank 152 having an upper arm 154 and a lower arm 156. The upper arm 154 of the bell crank 152 is connected by link 158 to the end of crank 132. The lower arm 156 of the bell crank is connected by a link 160 to the inner slide 94 through an adjustable nut 162. Rotation of the nuts 162 serves to adjust the position of the inner slide. It will be observed that the link 158 forms a toggle linkage with the crank 132 and the link 158 forms a toggle linkage with the arm 154 of the bell crank. Similarly, the arm 156 of the bell crank forms a toggle linkage with the link 160. It will be seen that between pitman 140 and the link 160 we have interposed three toggle linkages. When any one of these toggle linkages forms a straight angle there will be no motion of the inner slide for the instant. It is in this manner we obtain the dwell of the inner slide to permit the third action to do its work while the inner slide is dwelling. The phasing of the motions is such that the linkages will arrive in the vicinity of straight angles at substantially the same time. The period of dwell is really a slight oscillatory movement of very small amplitude caused by the linkages oscillating in the vicinity of straight angles during the period of dwell. This movement is in the order of a few thousandths of an inch and well within the elongation of the crown rods 80. Accordingly, during the period of dwell the inner slide will rest against the work while the third action operates, as will be pointed out more fully hereinafter.

Referring now to Figure 2, it will be observed that there are a pair of toggle linkages interposed between the lower head 52 and the crown. These toggle linkages are so phased as to arrive in the vicinity of positions of small amplitudes of motion at substantially the same time so that the slight oscillation produced by one or the other of the toggle linkages will be within the amplitude of elongation of the rods 80 causing the blank holder to dwell as it reaches the bottom of its stroke. When the lower head 52 moves downwardly, the arm 62 will move to substantially vertical position at about the time when the link 64 is substantially horizontal. At this point the motion of the head will produce a substantially negligible rotation of the rocker shaft 60 due to the fact that in the vicinity of 0° a variation of the angle will produce substantially no change in the length of the cosine. When the arm 62 is substantially vertical, the crank arm 70 will likewise be substantially vertical and form a 0° angle with its coacting connecting rod 74. Accordingly, the slight oscillation of the rocker shaft 60 will produce substantially no motion of the upper head 72 due to the fact that sines of small angles are substantially zero.

The operation of the press can best be understood by reference to Figure 4. When the crown is in the uppermost position the third action will be adjacent its bottom dead center but slightly in advance thereof. When the lower clutch is engaged, the flywheel 16 will drive the pinion 20 and reciprocate the third action slide with simple harmonic motion, as shown by the lower curve. The amplitude of this motion is to an extent of sixteen inches to obtain a twelve-inch effective draw. Due to the gear ratios between pinion 26 and gear 28 and between pinion 32 and gear 34 the crank 46 will make one rotation while the eccentric 36 makes two. As the crank 46 rotates, the crown and the blank holder will move downwardly rapidly to about eighty degrees of motion of the crank 46. The blank holder is secured to the crown so that the blank holder curve represents the crown motion. The inner slide is likewise carried by the crown and will move with it. Due to the fact that the clutch within casing 106 is not engaged, the inner slide will move downwardly with the blank holder in a parallel curve. At about eighty degrees of motion the toggle linkages approach positions of small amplitudes of motion and the rate of change in motion sharply decreases. Shortly after this point the clutch within casing 106 is engaged and the inner slide is driven through its toggle linkages, moving relative to the blank holder which is dwelling and finishing its work at about one hundred eighty degrees of travel of the crank 46. At this point the inner slide will dwell along with the blank holder and during this period of dwell the third action reaches the top of its stroke and does its work. During the dwell the blank holder oscillates a number of times through a very small amplitude of a maximum of about .003 of an inch, which is well within the elongation of the rods 80. By altering the phase of pinion 32 with respect to gear 34 the phase of the third action with respect to the blank holder may be varied so that the third action will reach its upper limit of motion at different points of the cycle, depending on the phase adjustment. This phase may be shifted so that the third action will reach its maximum after the inner slide has done its work and has started upwardly, so that the third action may be used as a knockout. By disconnecting pinion 32 from gear 34 the third action may be disengaged and the press will act as a double action press. As soon as the third action starts moving downwardly the blank holder will move upwardly relative to the frame of the press. The inner slide will move upwardly relative to the blank holder so that its upward motion is extremely rapid, arriving at its upper

portion at the same time that the blank holder arrives at its uppermost portion at a point shortly after the third action passes its bottom dead center. In Figure 4 the actual stroke of the blank holder is twenty-two inches. The stroke of the inner slide is eighteen inches, the inner slide having an effective stroke during its entire period of traveling, if desired. It will also be observed by reference to Figure 4 that the start of the draw of the inner slide is comparatively slow, enabling it to complete its work at a comparatively high rate of drawing speed without tearing the metal. While the inner slide moves a total of forty inches with respect to the bed, it moves only eighteen inches with respect to the crown and the crown itself moves only twenty-two inches, which is the largest amplitude of motion of our press. Accordingly, we are enabled to operate our triple action press at substantially twice the speed of conventional triple action presses, in which a much greater amplitude of motion of the parts is required for the same depth of draw. In this way we are enabled to increase the output of a press without affecting the quality of the work.

It will be seen that we have accomplished the objects of our invention.

We have provided a triple action press having a reciprocating crown in which the crown carries the blank holder. The crown also carries the inner slide so that the motion of the inner slide relative to the bed is the cumulative motion of the crown and of the inner slide with respect to the crown.

We have provided a triple action press in which the number of strokes in a given period of time may be greatly increased, thus giving a press capable of producing work at a greater rate.

We have provided a triple action press in which the draw for the inner slide starts at a comparatively slow speed and increases in velocity, thus minimizing the tendency of the work to tear during the draw.

We have provided a triple action press in which the third action may perform a number of strokes to one stroke of the inner slide and blank holder.

We have provided a triple action press in which the blank holder, crown and third action are driven from a single prime mover.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of our claims. It is further obvious that various changes may be made in details within the scope of our claims without departing from the spirit of our invention. It is therefore to be understood that our invention is not to be limited to the specific details shown and described.

Having thus described our invention, what we claim is:

1. A triple action power press including in combination a frame, a crown, means for mounting the crown on the frame for reciprocation with respect thereto, a blank holder carried by the crown for movement therewith, an inner slide carried by the crown for reciprocal movement with respect thereto, means including a motor carried by the crown for reciprocating the inner slide, means including a separate motor carried by the frame for reciprocating the crown, a third action slide carried by the frame for reciprocation with respect thereto, and means carried by the frame for reciprocating the third action slide from said separate motor, in which said means for reciprocating the inner slide includes an eccentric, a gear train between the motor and the eccentric for driving the same, a rocker shaft having an arm carried thereby for rotation therewith, a pitman extending between the eccentric and said rocker shaft arm forming a first linkage, a crank carried by said rocker shaft for rotation therewith, a bell crank rotatably supported by the crown, a link extending between said rocker shaft crank and one of said bell crank arms forming a second linkage, and a link extending between the other of said bell crank arms and said inner slide, the construction being such that the first and second linkages will arrive at their small amplitude of motion positions at substantially the same time whereby to cause the inner slide to dwell at the bottom of its stroke.

2. A triple action power press including in combination, a frame, a crown, means for mounting the crown on the frame for reciprocation with respect thereto, a blank holder carried by the crown for movement therewith, an inner slide carried by the crown for reciprocal movement with respect thereto, means including a motor carried by the crown for reciprocating the inner slide, means including a separate motor carried by the frame for reciprocating the crown, a third action slide carried by the frame for reciprocation with respect thereto, and means carried by the frame for reciprocating the third action slide from said separate motor, in which said means for reciprocating the inner slide includes an eccentric, a gear train between the motor and the eccentric for driving the same, a rocker shaft having an arm carried thereby for rotation therewith, a pitman extending between the eccentric and said rocker shaft arm forming a first linkage, a crank carried by said rocker shaft for rotation therewith, a bell crank rotatably supported by the crown, a link extending between said rocker shaft crank and one of said bell crank arms forming a second linkage, and a link extending between the other of said bell crank arms and said inner slide, the construction being such that the first and second linkages will arrive at their small amplitude of motion positions at substantially the same time whereby to cause the inner slide to dwell at the bottom of its stroke, and means for varying the effective length of the link attached to the inner slide with respect to the crown.

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