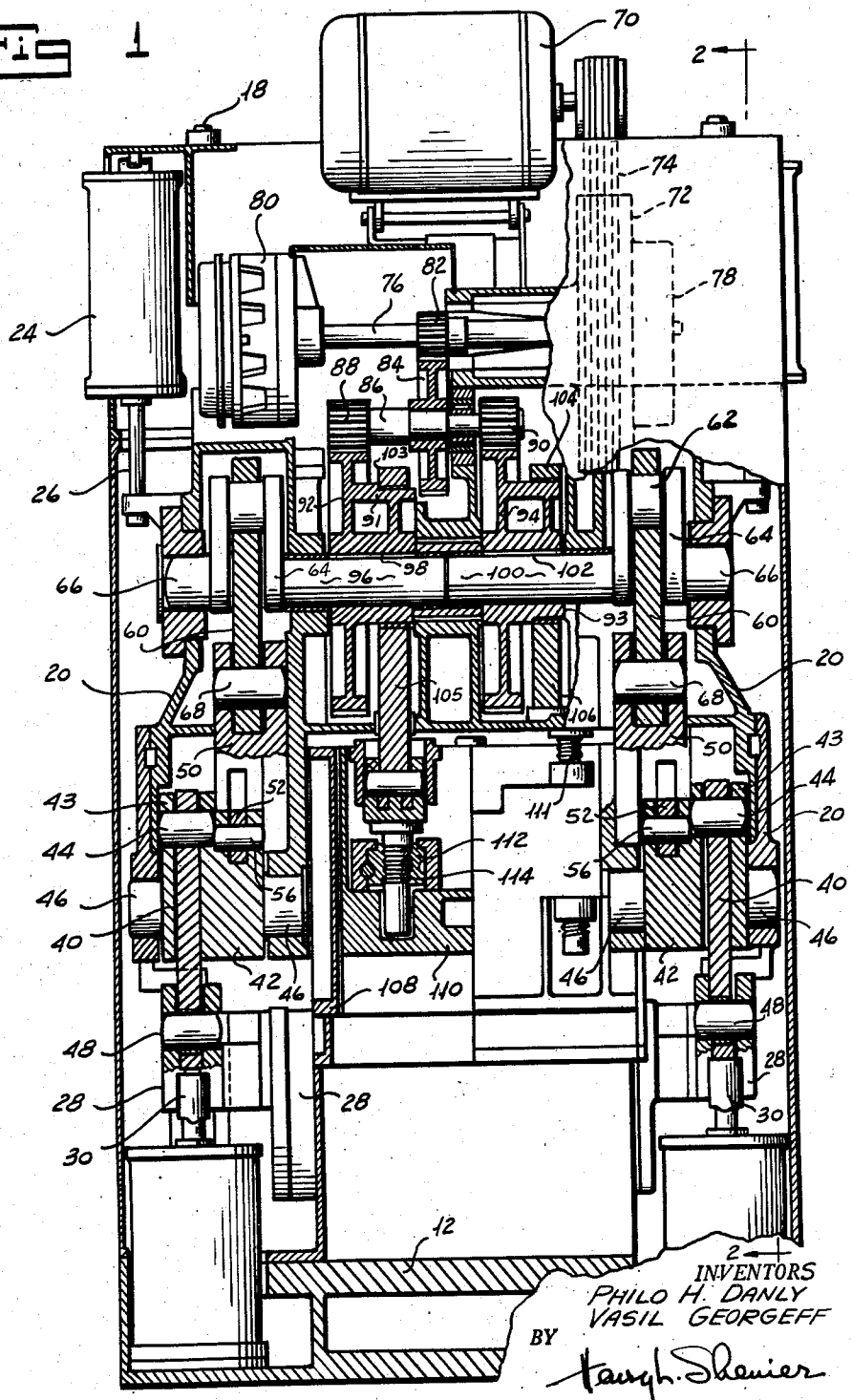
Nov. 2, 1954 P. H. DANLY ET AL 2,693,158

SINGLE DRIVE RECIPROCATING CROWN DOUBLE ACTION PRESS

Filed Dec. 23, 1950 5 Sheets-Sheet 1

Fig 1




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SINGLE DRIVE RECIPROCATING CROWN DOUBLE ACTION PRESS

Filed Dec. 23, 1950 5 Sheets-Sheet 2

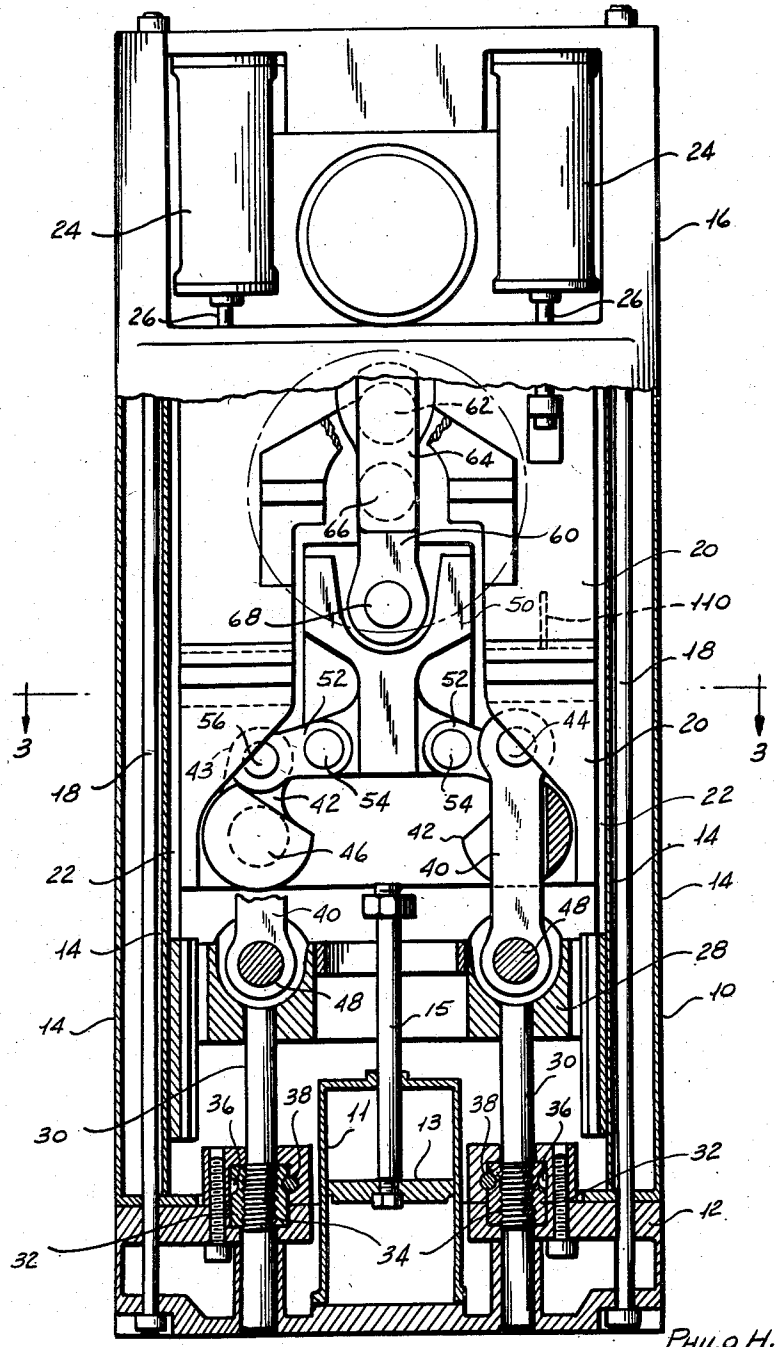



Fig 2

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SINGLE DRIVE RECIPROCATING CROWN DOUBLE ACTION PRESS

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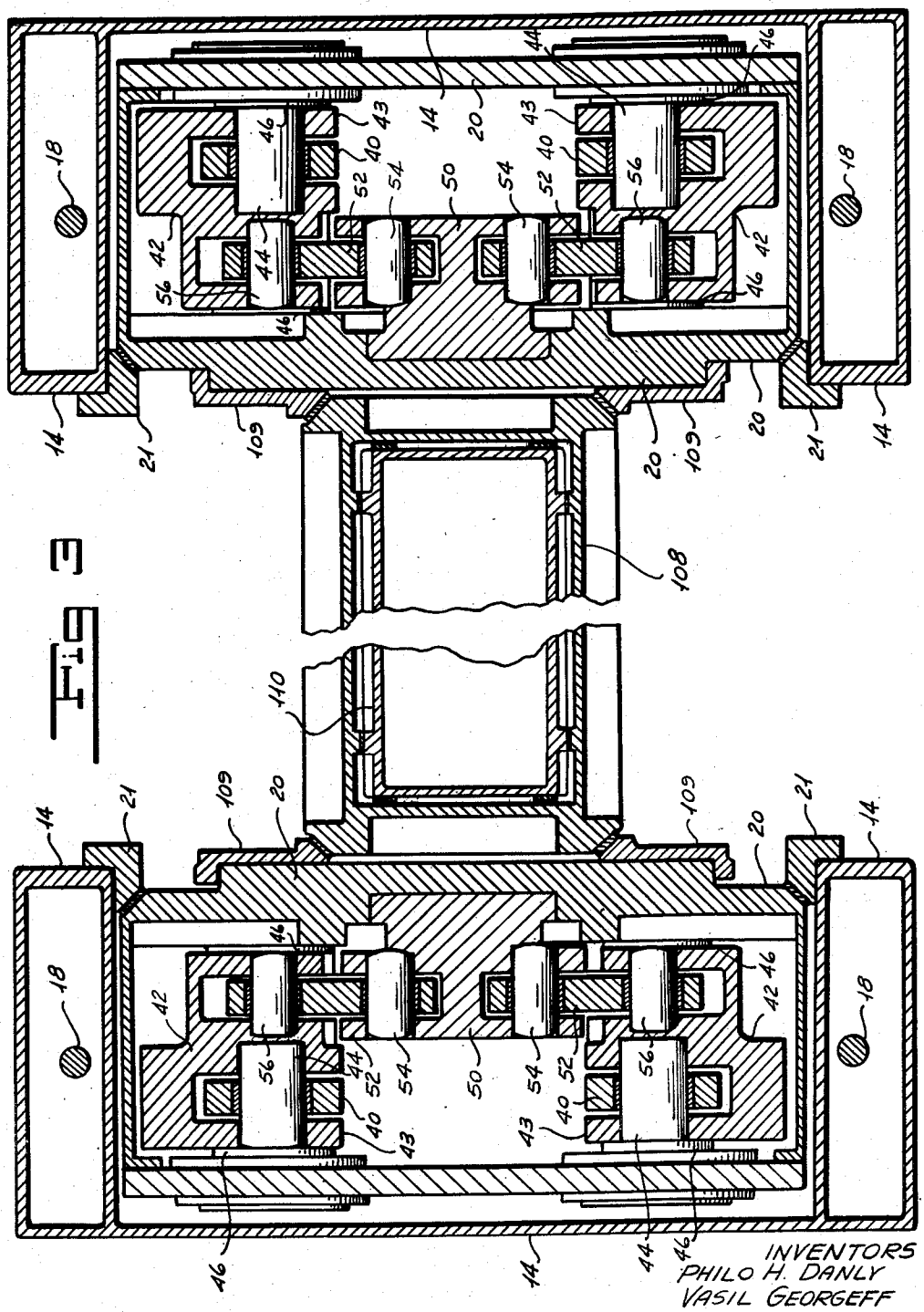



Fig 3

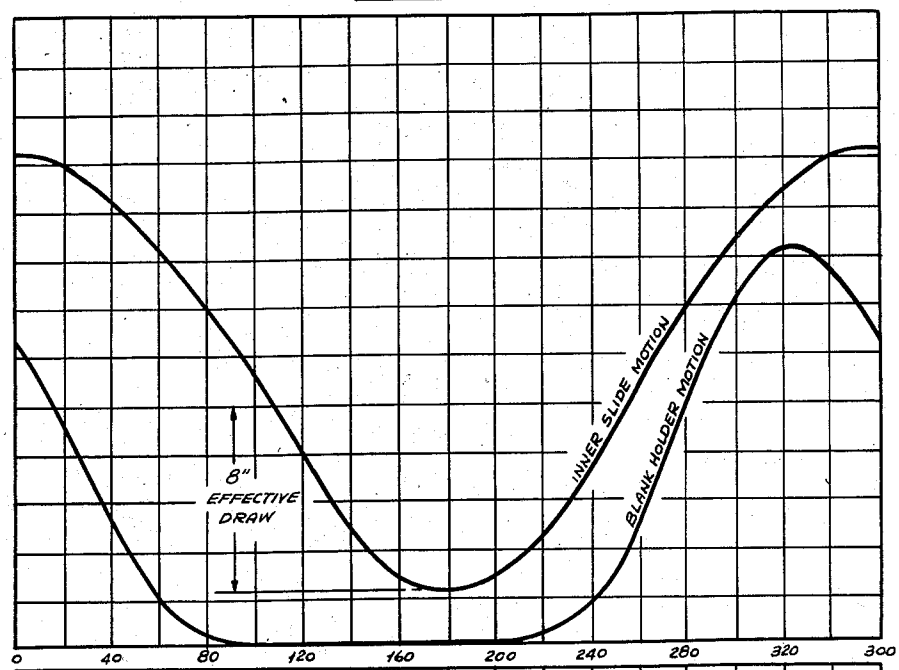
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Nov. 2, 1954 P. H. DANLY ET AL 2,693,158

SINGLE DRIVE RECIPROCATING CROWN DOUBLE ACTION PRESS

Filed Dec. 23, 1950 5 Sheets-Sheet 4

Fig 4



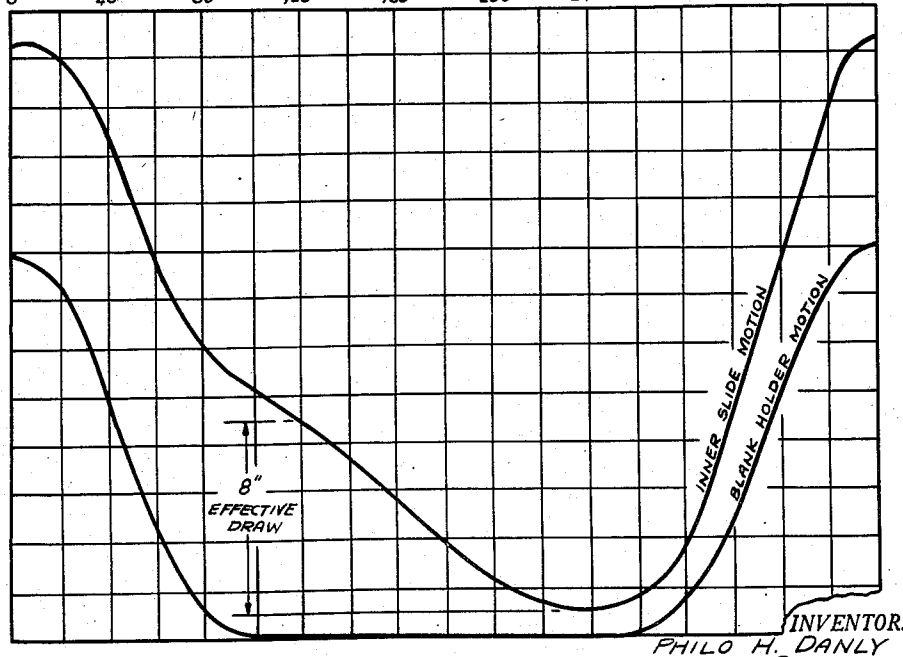




Fig 5

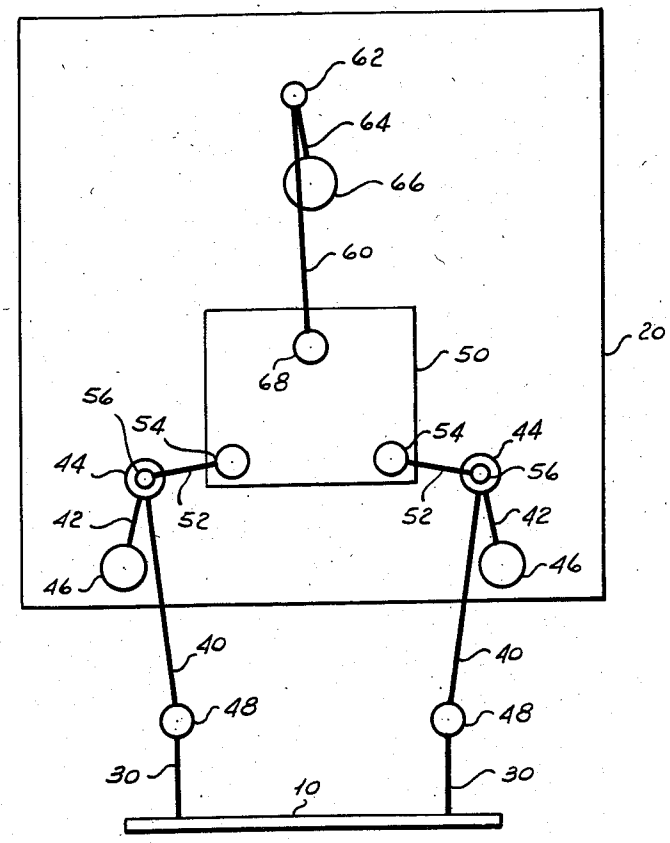
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SINGLE DRIVE RECIPROCATING CROWN DOUBLE ACTION PRESS

Filed Dec. 23, 1950 5 Sheets-Sheet 5

Fig 6




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United States Patent Office 2,693,158 Patented Nov. 2, 1954



2,693,158

# SINGLE DRIVE RECIPROCATING CROWN DOUBLE-ACTION PRESS

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Application December 23, 1950, Serial No. 202,546

7 Claims. (Cl. 113—38)

Our invention relates to a single drive reciprocating crown double action press and more particularly to an improved double action press in which the inner slide and the blank holder are reciprocated by a prime mover carried by the crown to which the blank holder is fastened and in which the prime mover drives both the blank holder and the inner slide.

In double action presses of the prior art a blank holder is adapted to be reciprocated with respect to the bed of the press in a manner so that the blank holder will clamp the work on the bed in a position to permit dies carried by the inner slide and the bed to do their work. The arrangement is such that the blank holder dwells during the period in which the inner slide moves downwardly and performs its operation. In the presses of the prior art a large stroke is necessary for a predetermined draw. For example, if a sixteen-inch draw is desired, the known double action presses require a stroke in the vicinity of thirty-seven inches for the inner slide. The time required for moving the press parts through this long stroke circumscribes the number of operations which can be performed by the press in a given period of time. This is due to the fact that the rate of draw is limited by the characteristics of the steel being worked upon. For example, it is a rule of thumb in the metal drawing art that the speed of draw is limited to the linear drawing velocity of approximately sixty feet per minute. If it be attempted to draw at a faster rate than this, in the case of average steels the metal will tear. Accordingly, the limit of the linear drawing velocity is such that a maximum speed of about six strokes per minute for the presses of the prior art can be attained. In case it is desired to produce a large number of pieces within a given period of time, as in the case of a press forming part of a production line, it is necessary to use a plurality of presses in order to attain the rate of production desired. It will be appreciated that double action presses are large, heavy and expensive pieces of machinery. Accordingly, the use of a plurality of presses requires not only an additional capital investment in the presses themselves but also capital investment in the factory space taken up by the additional presses. Furthermore, the increase in the number of presses increases the cost of maintenance of the production machinery.

In our copending application Serial No. 175,424 for a Double Action Reciprocating Crown Press, filed July 22, 1950, we have shown a double action press of novel construction in which the stroke may be greatly shortened for the desired effective draw to an extent that the inner slide need move only a distance substantially equal to the desired draw. In this manner the number of strokes of the improved reciprocating crown press shown in our copending application could be increased over the number of which a conventional press is capable without exceeding the critical maximum drawing velocity. In the reciprocating crown press of our copending application, however, we employ two separate prime movers, one for driving the crown to which the blank holder is attached and the other prime mover carried by the crown for reciprocating the inner slide with respect to the blank holder.

One object of our invention is to provide a double action reciprocating crown press in which the stroke may be greatly shortened for a desired effective draw whereby the double action press may perform substantially double the number of strokes of a conventional double action press without exceeding the critical maximum drawing velocity and do this with a single prime mover.



Another object of our invention is to provide a double action press in which the draw will start slowly, tending to minimize tearing, and then proceed more rapidly after the metal starts to flow, and to employ only a single prime mover together with a reciprocating crown.

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

In general our invention contemplates the provision of a press frame on which a crown is mounted for reciprocation, a blank holder is carried by the crown and moves with it, a prime mover is also mounted on the crown, counterbalance means are provided for taking the weight of the crown and its associate parts, and an inner slide is mounted on the crown for reciprocation with respect thereto. The driving arrangement is such that the blank holder will move downwardly and dwell and during the period of dwell the inner slide will move downwardly with respect to the blank holder, which is dwelling, and perform its work. The common prime mover drives an eccentric gear which reciprocates a pitman connected to the inner slide with simple harmonic motion. The drive and the blank holder are mounted on the crown. The crown in turn is driven from the same prime mover by means of a crank, a reciprocating head and a toggle motion such that the blank holder will move downwardly in proper phase relation and dwell during the period in which the inner slide does its work.

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

Figure 1 is a sectional elevation of a double action press showing 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 drawn on an enlarged scale taken along the line **3—3** of Figure 2.

Figure 4 is a curve showing the motion of the inner slide and the motion of the blank holder of a conventional double action press.

Figure 5 is a curve similar to that shown in Figure 4 showing the motion of the inner slide and the blank holder of the press of the instant invention.

Figure 6 is a diagrammatic view showing the linkage for reciprocating the crown with respect to the frame.

More particularly referring now to Figure 2, the press comprises a frame indicated generally by the reference numeral **10**, having a pedestal member **12**, side members **14** and an upper portion **16** assembled in any suitable manner as, for example, by tie rods **18**. Any suitable framework may be provided. Mounted for reciprocation with respect to the frame **10** we provide a crown indicated generally by the reference numeral **20**, adapted to reciprocate on gibs **22** carried by the press frame. Counterbalance cylinders **24** of any suitable design are carried by the upper portion of the frame **16** and are connected to the crown **20** by piston rods **26**. The counterbalance cylinders serve to take the weight of the crown and its associated parts while permitting movement of the crown with respect to the frame in response to the drive, which will be described hereinafter.

An adjustable member **28** is secured to the pedestal **12** by means of four tension rods **30**. The tension rods are secured to the base member **12** by means of nuts **32** coacting with threads **34** formed in the lower end of the rods **30**. Each of the nuts **32** is provided with an external worm gear **36**. Each of the worm gears engages a worm **38**. The arrangement is such that as the worms **38** are rotated the member **28** is adjusted upwardly and downwardly with respect to the press frame per se. The crown **20** is connected to the adjustable member **28** by means of four connecting links **40** and a toggle linkage arrangement which can best be seen by reference to Figure 1, from which it will be seen that the connecting links **40** are connected to rocker members **42** which are pivotally carried by the lower end of the crown **20**. The upper end of each connecting link **40** is secured to the rocker member **42** by means of a pin **44**. The rocker member is carried in the crown **20** by means of a pair of

trunnions 46. Each link 40 is secured to the adjustable member 28 by means of a pin 48. As each rocker member 42 rocks on its trunnions the crown 20 will move due to the thrust transmitted to the bed 12 through the connecting links 40, the pins 48, the adjustable member 28 and the connecting rods 30.

A head 50 is mounted for reciprocation with respect to the crown 20. The lower end of the head 50 is connected to the rocker member 42 by means of four links 52. Each link is pivotally secured to the head 50 by means of a pin 54. The other end of each link 52 is secured to the rocker member 42 by means of a pin 56. The upper end of the reciprocating head 50 is connected by a connecting rod 60 to a crank pin 62 carried by a crank 64 secured to a crank shaft 66, the connection being made by means of wrist pin 68. As the crank shaft 66 rotates, the connecting rod 60 will reciprocate the head 50 with simple harmonic motion.

Referring now to Figure 1, the crown supports a prime mover such as an electric motor 70 which drives a flywheel 72 through a plurality of V-belts 74. The flywheel is adapted to be clutched to shaft 76 by means of a clutch within housing 78. The shaft 76 is adapted to be immobilized by means of a brake within housing 80. When the clutch is engaged and the brake released, the motor 70 will rotate the shaft 76 through the flywheel 72 to rotate drive pinion 82 which engages with and drives a gear 84 carried by a shaft 86. The shaft 86 carries a pair of pinions 88 and 90 which engage with and drive a pair of eccentric gears 92 and 94. Eccentric gear 92 is secured to a shaft 96 by means of a key 98. The shaft 96 is integral with a crank shaft 66 formed with a crank 64. The eccentric gear 94 is keyed to a shaft 100 by means of a key 102 and this shaft is integral with a second crank shaft 66 formed with a second crank 64. For purposes of simplicity, each of the cranks has been designated by the reference numeral 64 and each of the connecting rods 60 has been designated by the same reference numeral, though they are disposed on opposite sides of the press.

The eccentric gear 92 is formed with an eccentric 91 and the eccentric gear 94 is formed with an eccentric 93. An eccentric strap 103 is carried by a pitman 105. An eccentric strap 104 is connected to a pitman 106. A blank holder 108 is secured to the crown 20 for movement therewith. Mounted for reciprocation with respect to the blank holder we provide an inner slide 110 which is secured to the connecting rods 105 and 106 by means of adjustable nuts 112 by which the threaded lower end 114 of each connecting rod is secured to the inner slide 110. Adjusment of the nuts 112 will change the relative position of the inner slide 110 with respect to the crown and accordingly with respect to the blank holder.

It will be seen that the operation of the motor 70 will continuously drive the flywheel 72. When this flywheel is engaged with the driving train of the press the inner slide 110 will be reciprocated through the connecting rods 105 and 106 and the eccentrics 91 and 93 with simple harmonic motion. At the same time the cranks 64 will, through crank pin 62, reciprocate the heads 50 by means of connecting rods 60 and wrist pins 68. The reciprocating movement of the heads 50 will rock the four rocker members 42 by means of the four links 52. As the rocker members 42 rock, the crown will be caused to move upwardly and downwardly, depending upon the rotation of the rockers 42, due to the fact that the crank arms 43, formed integrally with the rocker members 42, are connected to the bed of the press by means of wrist pins 44 and connecting links 40.

The arrangement of the linkage for reciprocating the crown (and the blank holder) can readily be seen by reference to Figure 6. The parts are shown in the positions they occupy just as the blank holder is reaching the bottom of its stroke. The view, of course, is somewhat distorted so that the linkages can readily be seen. It will be apparent that the reciprocation of the head 50 oscillates the link 52 without much effect upon rotation of the rocker member 42 at the bottom of the stroke. Similarly, the crank of the rocker member 42 is almost in line with the link 40 so that any motion of the rocker will produce little effect upon the crown. Stated differently, at the bottom of the stroke both the toggle linkage between the rocker arm 42 and the link 40 and the toggle linkage between the rocker arm 42 and the link 52 will be at the small amplitude of motion positions simultaneously, thus causing the blank holder to dwell. As the reciprocating head 50 moves downwardly, the links 52 will rotate the left-hand rocker clockwise and the right-hand rocker 42 in a counterclockwise direction, thus straightening the toggle linkages between rocker arms 42 and links 40, moving the crown upwardly through the thrust transmitted to the frame 10 by way of links 40, joints 48 and rods 30.

Referring now to Figure 3, it will be seen that the reciprocating crown 20 is guided by means of four gibs 21 carried by the sides 14 of the press frame. Reciprocating crown 20 carries four gibs 109 which guide the inner slide 110.

Referring now to Figure 4, which shows the curve of motions of the inner slide and blank holder, respectively, for a conventional double action press, it will be seen that the inner slide moves with simple harmonic motion through a distance of eighteen inches in order to obtain an effective draw of eight inches. The blank holder must move through an amplitude of sixteen inches to accommodate the inner slide motion, and the press is capable of producing only an effective draw of eight inches. It will also be observed that at about 100° of travel of the inner slide at the time the draw begins the blank holder is moving at substantially its greatest velocity. Figure 4 should be compared with Figure 5, which shows the motions of the inner slide and the blank holder in the double action press of our invention. In Figure 1 the parts are shown with the crank pins 62 at their top dead center, that is, in the position at which the blank holder has been moved downwardly and is dwelling while the inner slide is on its way down to perform its operation. Referring now to Figure 5, when the inner slide is adjacent its top dead center, that is, at 0°, very little motion is imparted by the eccentrics to the inner slide since there is very little throw adjacent the dead center position. At this point, however, the arms 43 of the rocker members 42 will have rotated the left-hand rocker member in a clockwise direction and the right-hand rocker member in a counterclockwise direction, as viewed in Figure 2, causing the crown to be adjacent the top of its stroke. Inasmuch as the blank holder is secured to the crown and moves with it, the motion of the blank holder is represented by the motion of the crown. In the position of the beginning of the stroke, therefore, we find the crown in its uppermost position with the cranks 43 making their greatest angle with the vertical. In this position, furthermore, the pins 56 will be above the pins 54 so that the links 52 will likewise make an appreciable angle with the horizontal. At the same time, the pins 44 will be carried toward the center of the press, as viewed in Figure 2, by the clockwise rotation of the left-hand rocker 42 and the counterclockwise rotation of the right-hand rocker 42. Accordingly, the motion imparted to the reciprocating heads 50 will move the crown rapidly downwardly until just after 90° of the press cycle. The inner slide, being supported by the crown, will likewise be carried down along with the crown. It will be observed that as the inner slide drive starts to contribute its increment of motion that the approach curve from about 25° of the press cycle to 80° of the press cycle is extremely rapid, having a steeper slope than the blank holder motion curve. As the angle between the vertical and the direction of the connecting rods 40 becomes less, as the links 52 approach a horizontal position, and as the cranks 43 approach a more nearly vertical direction, the blank holder motion sharply reduces. It will be observed that as the links 52 approach the horizontal position, the reciprocating motion of the head 50 will cause a very slight throw of the rocker members 42. This is due to the fact that at small angles the cosine changes at a very slow rate. The small motion of the rocker shafts imparted by the links 52 will have a very slight effect upon the movement of the crown due to the fact that the connection between each rocker crank 43 and connecting link 40 is approaching dead center. It will be seen that the phasing of the motions of the parts is such that the crown will move rapidly downwardly and start to dwell at about 120° of the press cycle due to the fact that the toggle linkage between each rocker member 42 and link 52 and the toggle linkage between each rocker member 42 and the connecting link 40 arrive at their small amplitude of motion positions at substantially the same time. As soon as the blank holder starts to dwell, the increment of motion imparted to the inner slide by the crown movement

becomes substantially zero so that the inner slide will move only under the drive of the eccentrics. Since the inner slide is carried downwardly by the crown movement it may have a comparatively short stroke, enabling us to retain a comparatively low velocity of draw even though an increased tempo of operation is achieved. The short stroke referred to represents relative movement of the inner slide with respect to the crown. Since the crown moves with respect to the bed, however, the total travel of the inner slide from its top dead center position to the bottom of its amplitude of motion is twenty-four inches. The blank holder travels sixteen inches. It will be seen, therefore, that an effective draw of eight inches is obtained with an actual move of the inner slide with respect to the crown of eight inches. This enables us to obtain a comparatively slow rate of draw for the movements involved so that the speed of operation of the press may be increased without exceeding the critical linear velocity of drawing speed. This is evident, in Figure 5, by the slope of the curve from 120° to 240° during which the draw proceeds. As soon as the draw is finished, the inner slide starts upwardly and shortly thereafter the crown starts upwardly carrying the blank holder with it. Since the motion of the inner slide will be the sum of the motions of the crown and the inner slide itself, an extremely rapid return motion is achieved, as indicated by the sharp slope of the curve between 280° and the end of the press cycle.

For the press shown in the instant case, with an eight-inch draw, as shown in Figure 5, operating the press at twenty strokes per minute, the press cycle is completed in three seconds. For a depth of draw of eight inches, a linear speed of only forty-three feet per minute was reached, which was well within the critical drawing speed. The press had an inner slide capacity of three hundred fifty tons and a blank holder capacity of two hundred fifty tons. The inner slide was adjustable by means of the nuts **112** to an amplitude of ten inches. The crown was adjustable by means of the nuts **32** to an amplitude of eighteen inches. The blank holder, furthermore, can be adjusted with respect to the crown by means of screws **111**, shown in Figure 1, through an additional six inches. These adjustments enable us to obtain various depths of draw. Since the inner slide curve slows down as it reaches its bottom dead center, for a depth of draw of one inch a linear speed of only thirty-six feet per minute is obtained at twenty strokes per minute, and for a depth of draw of one-half inch a linear speed of only twenty-three feet per minute was obtained. Accordingly, at small depths of draw it is possible to operate the press even faster than at the higher depths of draw.

The bed of the press **12** carries the cylinder **11** of a suitable die cushion having a piston **13** and a piston rod **15**, as can readily be seen by reference to Figure 2.

The operation of our press will be clear to those skilled in the art. It is to be understood that during the period of dwell the blank holder will oscillate very slightly adjacent its bottom dead center a number of times through an extremely small amplitude occasioned by the linkages arriving at their small amplitude of motion positions at substantially the same time. The amplitude of this oscillation is very small, in the order of .003 of an inch, and is within the range of elongation of the connecting rods **30** by which the reaction is transmitted from the crown to the bed of the press **12**, so that for all practical purposes the blank holder dwells apparently immovably at the bottom dead center to hold the work during the time the inner slide performs its function.

It will be seen that we have accomplished the objects of our invention. We have provided a double action power press of novel construction in which the stroke of the inner slide is greatly shortened for the desired effective draw and in which the motion of the inner slide need only be of an amplitude equal to the desired draw.

We have provided a double action power press which may be operated at more than double the number of strokes of the conventional double action press without exceeding the critical maximum drawing velocity. Our double action power press accomplishes this with a single prime mover and the motions are so phased that the blank holder will dwell and the inner slide will start the draw at a slower rate than the conventional press, minimizing tear. Our linkages and driving connections from the common prime mover are so phased that the blank holder will move rapidly to dwelling position and dwell during the draw, while the inner slide performs its work at a speed not in excess of the critical drawing speed, even though the press is being operated at a substantially low cycle of time. As soon as the inner slide does its work, both the blank holder and inner slide will move away at a rapid rate. The approach of the inner slide toward the work will likewise be very rapid, since it is being carried to working position by the crown on which it is mounted and with respect to which it moves. The crown, in turn, carrying the blank holder, moves both the blank holder and the inner slide with respect to the bed of the press.

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 double action power press including in combination a press frame, a crown mounted for reciprocation with respect to the frame, a prime mover carried by the crown, a blank holder carried by the crown for reciprocation therewith, an inner slide carried by the crown and mounted for reciprocation with respect thereto, a first transmission including means connecting the prime mover and the frame for reciprocating the crown with a dwell at the bottom of its reciprocation and a second transmission including means connecting the prime mover and the inner slide for reciprocating the inner slide.

2. A power press as in claim 1 including in combination counterbalance means carried by the frame and means connecting the crown and the counterbalance means.

3. A power press as in claim 1 in which said first transmission comprises a head, means for mounting the head upon the crown for reciprocation with respect thereto, means for reciprocating the head, a rocker shaft carried by the crown, a rocker crank carried by the rocker shaft, a rocker arm carried by the rocker shaft, a link pivotally connecting the reciprocating head with the rocker arm and a second link connecting the rocker crank with the press frame, the first link and the rocker arm forming a toggle linkage, the second link and the rocker crank forming a toggle linkage, the construction being such that said toggle linkages will arrive at their small amplitude of motion positions at substantially the same time adjacent the bottom of the stroke of said reciprocating head whereby to cause the blank holder carried by the crown to dwell.

4. A power press as in claim 1 in which said second transmission comprises an eccentric and a connecting rod extending between said eccentric and said inner slide adapted to reciprocate said inner slide with simple harmonic motion.

5. A power press as in claim 1 in which said first transmission comprises a head, means for mounting the head upon the crown for reciprocation with respect thereto, means for reciprocating the head, a rocker shaft carried by the crown, a rocker crank carried by the rocker shaft, a rocker arm carried by the rocker shaft, a link pivotally connecting the reciprocating head with the rocker arm and a second link connecting the rocker crank with the press frame, the first link and the rocker arm forming a toggle linkage, the second link and the rocker crank forming a toggle linkage, the construction being such that said toggle linkages will arrive at their small amplitude of motion positions at substantially the same time adjacent the bottom of the stroke of said reciprocating head whereby to cause the blank holder carried by the crown to dwell, and said second transmission comprises an eccentric and a connecting rod extending between said eccentric and said inner slide adapted to reciprocate said inner slide with simple harmonic motion, the phasing of said first and second transmissions being such that said inner slide moves downwardly to the bottom of the stroke while said blank holder is dwelling.

6. A power press as in claim 1 in which said first transmission comprises a head, means for mounting the head upon the crown for reciprocation with respect thereto, means for reciprocating the head, a rocker shaft

carried by the crown, a rocker crank carried by the rocker shaft, a rocker arm carried by the rocker shaft, a link pivotally connecting the reciprocating head with the rocker arm and a second link connecting the rocker crank with the press frame, the first link and the rocker arm forming a toggle linkage, the second link and the rocker crank forming a toggle linkage, the construction being such that said toggle linkages will arrive at their small amplitude of motion positions at substantially the same time adjacent the bottom of the stroke of said reciprocating head whereby to cause the blank holder carried by the crown to dwell and means for adjustably securing said second link to the press frame whereby to adjust the position of the blank holder with respect to the frame of the press.

7. A power press as in claim 1 in which said second transmission comprises an eccentric and a connecting rod extending between said eccentric and said inner slide



adapted to reciprocate said inner slide with simple harmonic motion and means for adjustably securing the connecting rod to said inner slide whereby to adjust the position of said inner slide with respect to the blank holder.

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