Sept. 19, 1944. J. H. MAUDE 2,358,759

HYDRAULIC PRESS

Original Filed Oct. 7, 1941 4 Sheets-Sheet 1

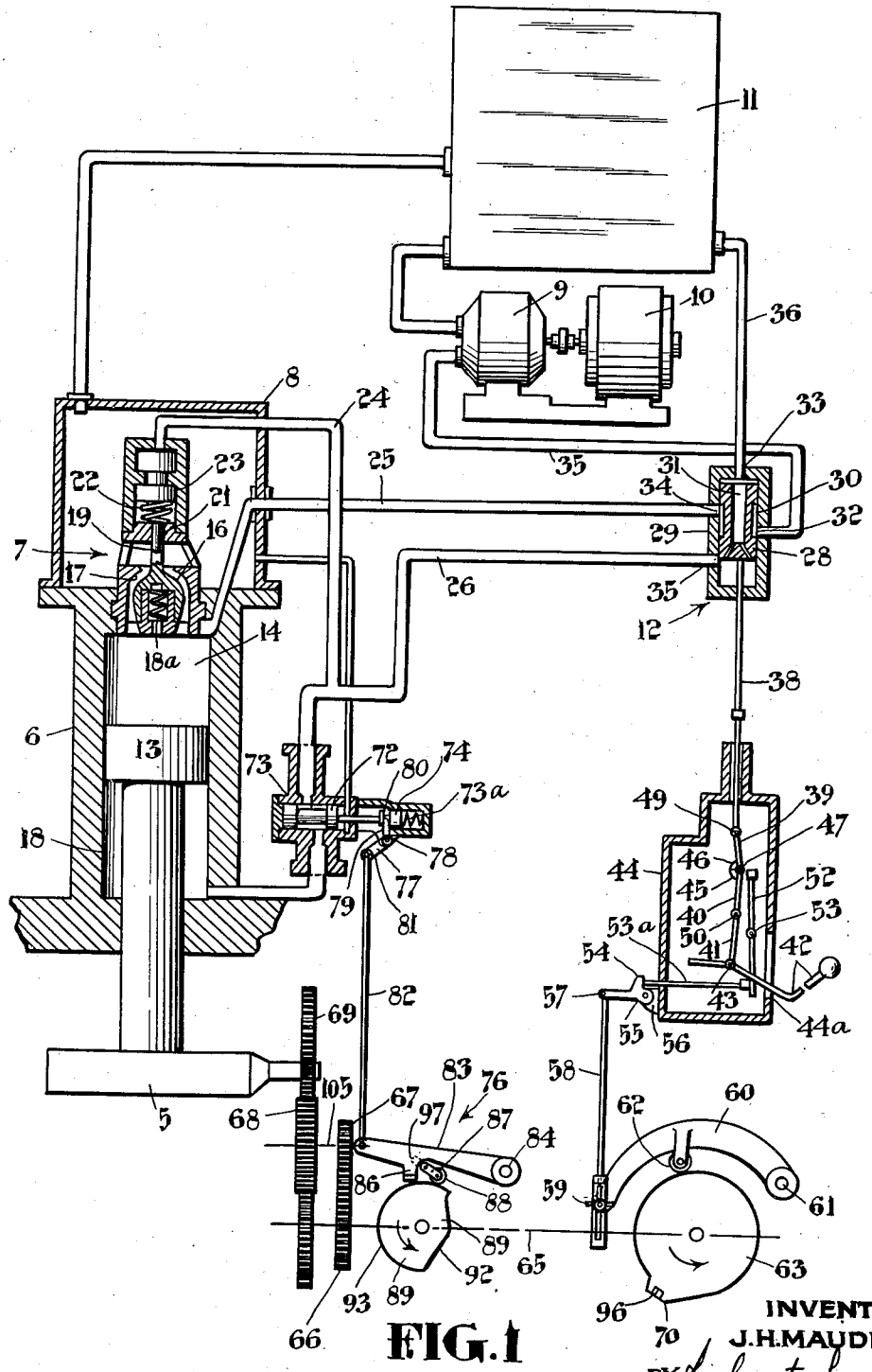


FIG. 1

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Original Filed Oct. 7, 1941 4 Sheets-Sheet 2

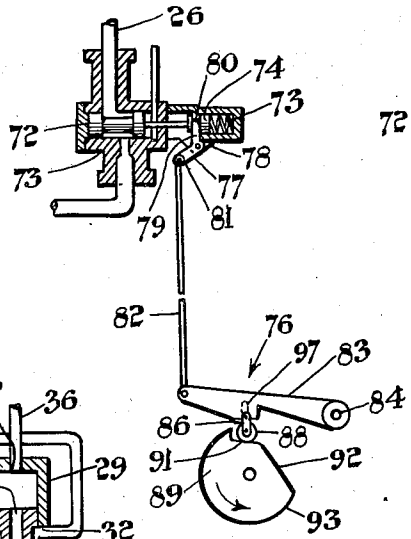


FIG.2

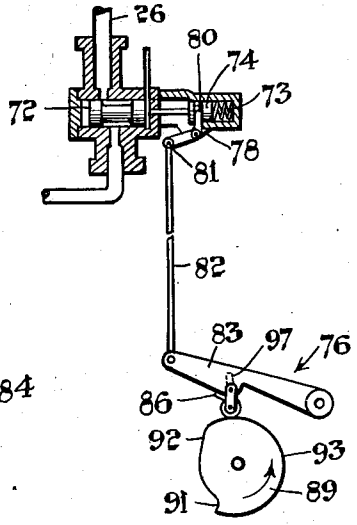


FIG.3

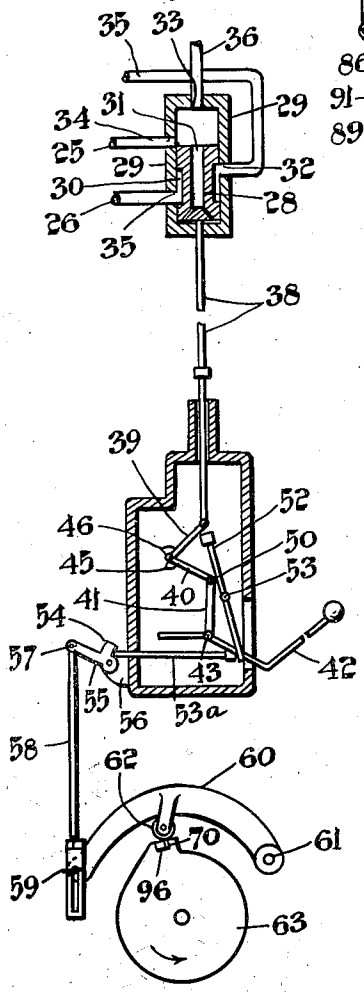


FIG.4

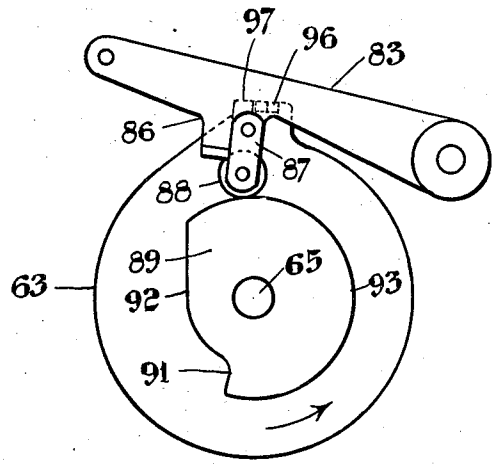


FIG.7

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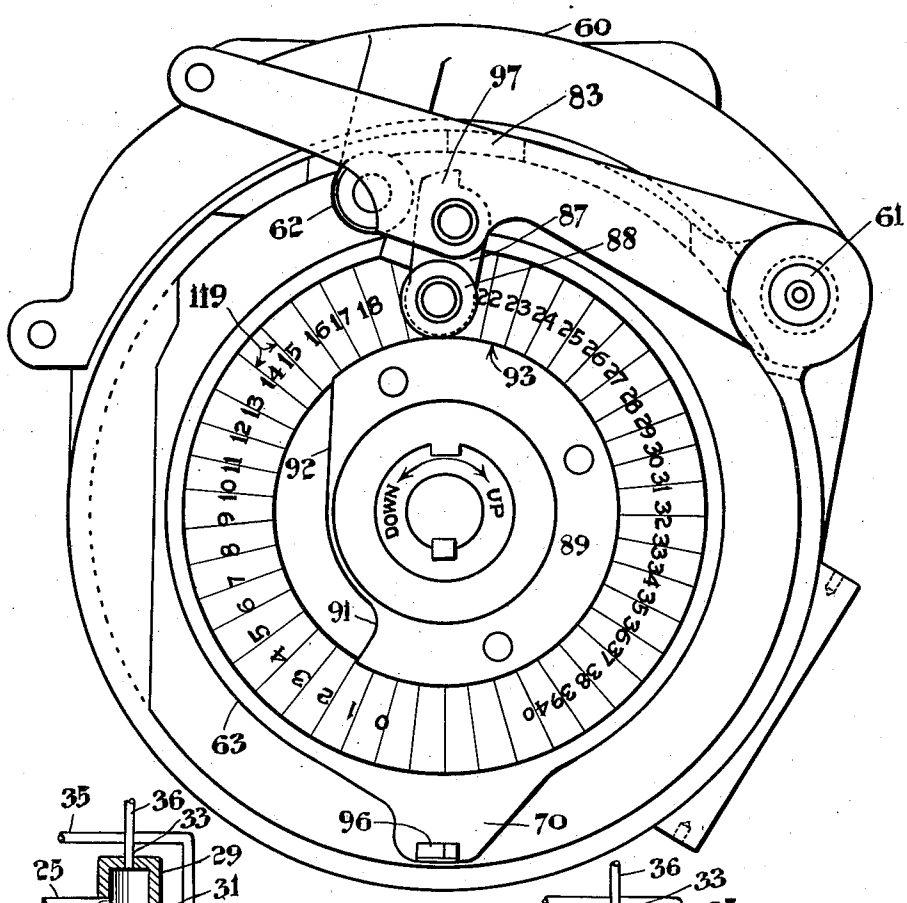


FIG. 9

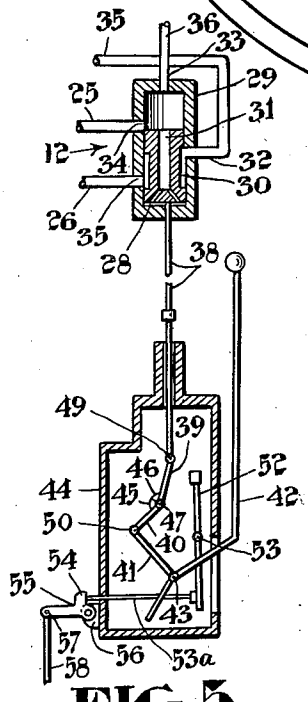


FIG. 5

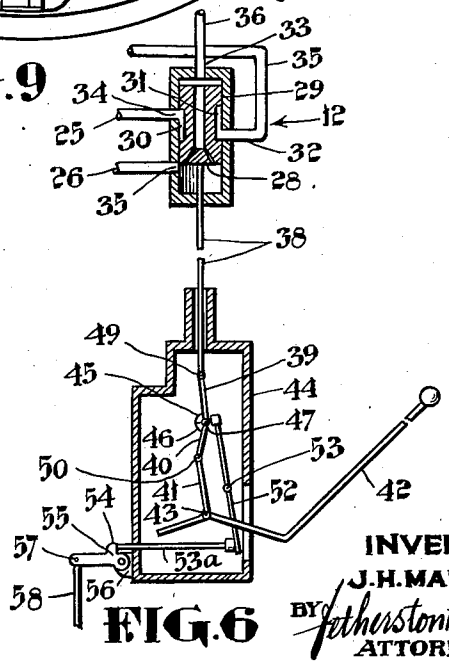


FIG. 6

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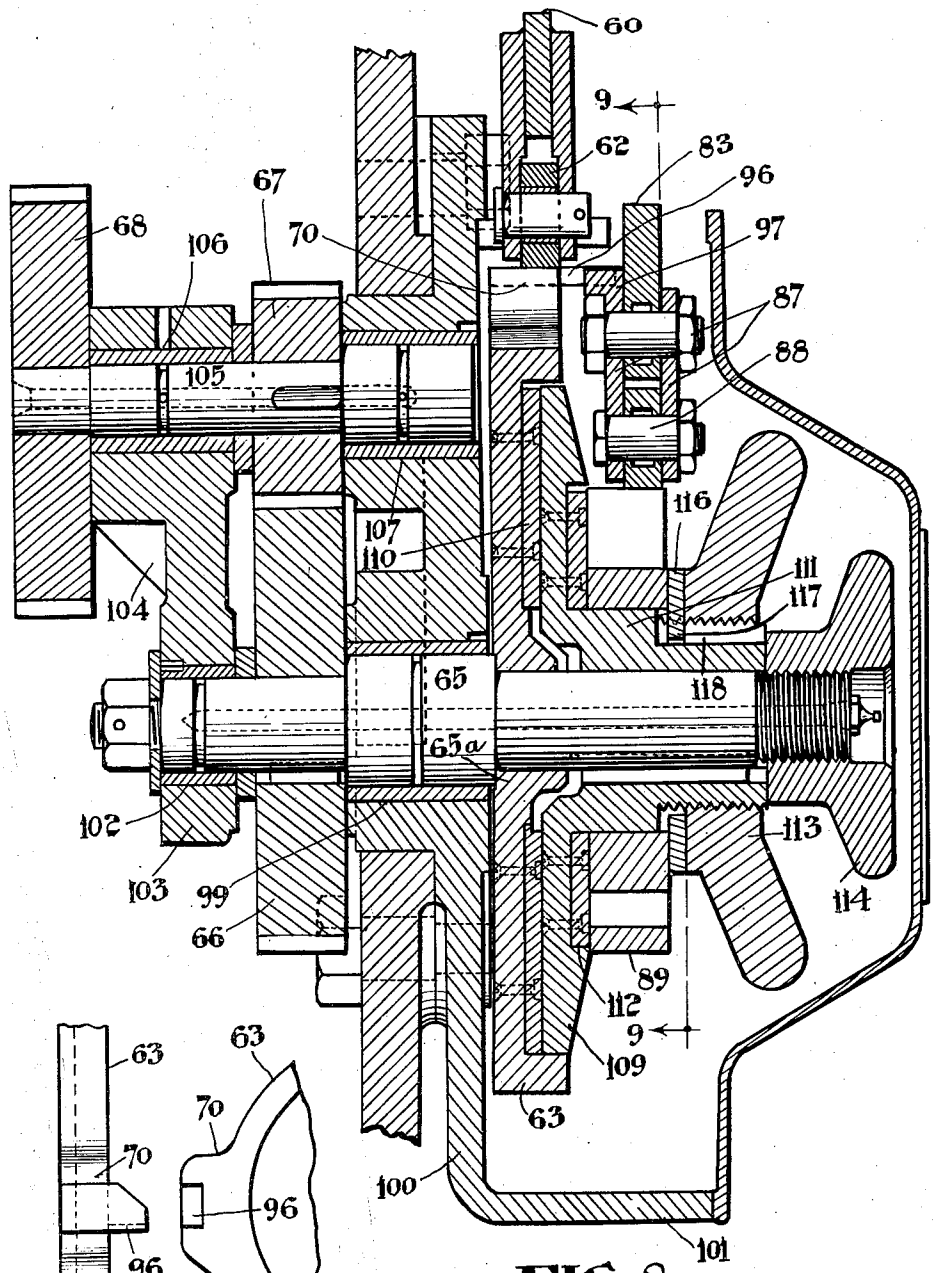


FIG. 8

FIG. 11

FIG. 10

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UNITED STATES PATENT OFFICE

2,358,759

HYDRAULIC PRESS

John H. Maude, Verdun, Quebec, Canada, assignor to Dominion Engineering Works Limited, Lachine, Quebec, Canada

Original application October 7, 1941, Serial No. 414,004. Divided and this application December 21, 1942, Serial No. 469,775. In Canada October 11, 1941

7 Claims. (Cl.74—54)

This invention resides primarily in the provision of means for speeding up the pressing cycle of hydraulic presses and is particularly useful in connection with high speed presses in which a prefill valve is provided to facilitate rapid flow of fluid from a storage tank to the pressing cylinder during a working stroke of the pressing ram and rapid return of the fluid from the pressing cylinder to the storage tank during the return stroke of the ram. In such presses the time required to complete the pressing cycle is substantially reduced by the rapid filling and emptying of the pressing cylinder which is made possible by the relatively large flow passage which the prefill valve provides between the pressing cylinder and the storage tank. However, with the presses and control mechanisms now available it is not possible to take full advantage of the maximum extent to which the power stroke of the movable ram or die of the press may be speeded up by improving the design of the prefill valve since this would result in the platen or die coming in contact with the work while travelling at such a high rate of speed as to impose severe shock stresses on the work or on the working parts of the press.

With the foregoing in mind an important feature of the invention resides in the provision of means for controlling the operation of the press so that the movable die or platen is caused to travel at an exceptionally high rate of speed during the idling portion of the power stroke and is then slowed down so that it contacts the work while travelling at the proper pressing speed. In this way the maximum speeding up effects obtainable by improvements in the design of prefill valves may be utilized without danger of subjecting the work or press to excessive shock damage due to the movable platen or die coming in contact with the work while travelling at an excessive rate of speed.

In the preferred embodiment of this invention the rate of speed at which the movable platen or die travels during the power stroke of the press is controlled by a "slow down" valve which is held open to permit the platen or die to move at maximum speed until the die or platen approaches within a predetermined distance of the work, whereupon the valve is partially closed to slow down the platen or die so that it completes the idle portion of its pressing stroke and meets the work while travelling at the predetermined pressing speed. The "slow down" valve is preferably interposed in a pressure fluid line through which pressure fluid is supplied to and exhausted from the push back space of the pressing cylinder.

Another feature of the invention resides in the provision of a novel cam mechanism for operating the slow down valve in properly timed relation to the movement of the movable die or platen.

Another feature of the invention resides in the provision of a cam mechanism including cams which, in addition to controlling the action of the slow down valve, also control the operation of the main working or reversing valve through which pressure is alternately supplied to and exhausted from the pressing and push back chambers of the cylinder containing the ram which operates the platen or die.

Another feature of the invention resides in the provision of a novel cam mechanism which while particularly useful for operating the previously mentioned slow down valve, is also intended for general application in connection with hydraulic presses and in any other relations in which it may usefully be employed.

The present application is a division of my copending U. S. application Serial No. 414,004, filed October 7th, 1941.

Other features and advantages of the invention will be more readily understood from the following detailed description and accompanying drawings, in which—

Fig. 1 is a diagrammatic view illustrating the application of my invention to a hydraulic press.

Figs. 2 and 3 are diagrammatic views illustrating different working positions of the cam mechanism which controls the operation of the slow down valve.

Figs. 4, 5 and 6 are diagrammatic views illustrating different operating positions of a cam and toggle mechanism which controls the operation of the main working or reversing valve.

Fig. 7 is a diagrammatic view illustrating the manner in which the cam controlling the operation of the main working or reversing valve cooperates with the cam controlling the slow down valve to effect the resetting of the slow down valve after each operation thereof.

Fig. 8 is a vertical sectional view illustrating a preferred construction and assembly of the component parts of the cam mechanism provided for controlling the slow down valve and the main working or reversing valve.

Fig. 9 is a sectional view taken substantially along the line 9—9 of Fig. 8. In this view the reversing cam is shown rotated through an angle

of approximately 180° from the position shown in Fig. 8.

Fig. 10 is an enlarged detail view of a portion of the cam which controls the main working or reversing valve, and

Fig. 11 is a side elevation of the cam portion appearing in Fig. 10.

In the present drawings I have shown only those parts of a hydraulic press which are necessary to an understanding of my invention. Such parts comprise the movable platen 5, main cylinder 6, prefill valve 7, prefill tank 8, pump 9, pump driving motor 10, storage tank 11 and the main working or reversing valve assembly 12. Platen 5 is carried by the main ram 13 which divides cylinder 6 into an upper pressing chamber 14 and a lower push back chamber 18. In the present instance I have shown a prefill valve 7 of the type described and claimed in the co-pending application of W. P. Muir and J. H. Maude, filed June 28, 1938 under Serial No. 216,318. Since this valve is fully described in said copending application the following brief reference thereto is deemed sufficient for present purposes.

The movable valve member 16 is urged to its seat 17 by the valve closing spring 18*a*. Located directly above the valve stem 19 is a pressure operated plunger 21 which is normally held in a raised position by a spring 22 acting against a piston head 23 provided at the upper end of the plunger. When ram 13 commences to move downwardly on its working stroke valve 16 opens automatically against the resistance of spring 18*a* to permit flow of fluid from tank 8 to the upper end of cylinder 6. During the working stroke of ram 13 the prefill valve 16 remains open until further downward movement of the platen 5 is resisted by engagement with the work. The resulting rise in pressure in cylinder 14, to which fluid pressure is being pumped through line 25, causes valve 16 to close against its seat 17 and to remain closed until the movable valve member of the main control valve assembly 12 is shifted to a return stroke position. When this occurs part of the pressure fluid supplied to the push back chamber 18 through the fluid pressure line 26 passes through line 24 and serves to force the piston 23 and plunger 21 downwardly to open valve 16 so that during the return stroke of the ram 13 part of the fluid previously supplied to the pressing chamber 14 is returned to the tank 8. This operation of the prefill valve 7 will be more clearly understood from the following description of the construction and operation of the main working valve 12.

As here shown the main working valve assembly 12 comprises a valve member 28 working in a valve casing 29. Member 28 is provided with an annular port 30 and a full length axial port 31. These ports cooperate with the valve casing ports 32, 33, 34 and 35 in the following manner.

When valve member 28 is in the position shown in Fig. 1 pressure fluid is pumped to the main pressing chamber 14 from the pressure side of pump 9 through supply line 35*a*, ports 32, 30 and 34 and line 25. At the same time fluid previously supplied to the push back chamber 18 is exhausted from said chamber through line 26, ports 35, 31, 33 and line 36 to the pump storage tank 11. In this position of valve 28 a working stroke of the press ram 13 is effected by the pressure fluid supplied to the pressing cylinder 14. As previously stated the prefill valve 7 opens during the downward movement of the ram 13 to ensure a rapid filling of the pressing chamber 14, the prefill valve remaining open until it is forced closed by the increased pressure developed in the pressing chamber 14, when the platen 5 or the pressing die carried by the platen comes in contact with the work.

When valve member 28 is shifted to the return stroke position shown in Figs. 4 and 5 pressure fluid is pumped to the push back chamber 18 through the supply line 35*a*, ports 32, 30 and 35 and line 26. At the same time part of the fluid previously supplied to the pressing chamber 14 is exhausted therefrom through line 25, upper part of valve casing 29 and line 36. In this position of valve member 28 a return stroke of the pressing ram 13 is effected by the pressure fluid supplied to the push back chamber 18 and a part of this pressure fluid is diverted, as previously described, through line 24 to hold the prefill valve 7 open so that part of the fluid previously supplied to the pressure chamber 14 is permitted to pass rapidly into the prefill tank 8.

Valve member 28 is secured to the upper end of an operating plunger 38. The lower end of this plunger is connected by toggle links 39 and 40 to a toggle arm 41 formed integral with a manually operable valve actuating lever 42. The lever 42 is loosely mounted on a pivot shaft 43 contained in the lower portion of box 44. Link 40 is provided with a shaped stop 45 which engages a similar stop 46 of link 39 to prevent further anti-clockwise rotation of the latter about the connecting pin 47 when said links are disposed in the position shown in Fig. 1. In the position shown in Fig. 1 clockwise movement of toggle arm 41 of lever 42 from the substantially vertical position shown is prevented by engagement of lever 42 with the lower end of the lever slot 44*a* provided in the control box 44.

When the press is making a power stroke the valve member 28, plunger 38, toggle links 39 and 40, toggle arm 41 and lever 42 are positioned as shown in Fig. 1. In this position of the parts the two links 39 and 40 become, in effect, a single rigid link by reason of the fact that the shaped stop 45 on link 40 is engaged with the shaped stop 46 on link 39 to prevent further anti-clockwise rotation of link 39 with respect to link 40. Consequently, (considering links 39 and 40 as one rigid link in a toggle system having one end pivot at shaft 43 and the other end pivot at the pin 49 connecting plunger 38 with the upper end of link 39) it will be seen that with the toggle arm 41 in the vertical position shown in Fig. 1 the toggle system will be locked against collapse because the pin connection 50 between link 40 and toggle arm 41 is positioned to the right of the center line between shaft 43 and pin 49, it being remembered that lever 42 is held against further clockwise movement by the lower end of the lever slot 44*a* and that stops 45 and 46 are holding link 39 against further anti-clockwise movement relative to links 40. A trip lever 52 is loosely mounted on an intermediate pivot shaft 53 contained in the box 44. The upper end of lever 52 is positioned opposite the pin connection 47 between the links 39 and 40 while the lower end of said lever is positioned to be engaged by the inner end of a horizontally slidable tappet rod 53*a*. Tappet rod 53*a* is slidably mounted in casing 44 in any suitable manner so that the outer end portion of said rod passes outwardly through the wall of the casing and is disposed in the path of movement of the arm 54 of a bell crank lever 55 which is pivoted to a

suitable bracket 56. The remaining arm 57 of the bell crank lever is connected to the upper end of a link 58 the lower end of which is adjustably connected as at 59 to one end of a cam operated lever 60. The cam operated lever 60 is mounted to swing about a pivot 61 and carries a roller 62 which rides the surface of a reversing cam 63. Cam 63 is fixed to rotate with a shaft 65 which is driven by gears 66, 67, 68 from a rack 69 carried by and movable with the platen 5.

When the ram 13 has completed its power stroke, or a predetermined portion thereof, as determined by the setting of the cam 63, the lift portion 70 of said cam engages the roller 62 and lifts the free end of the link 60. The resulting upward movement of link 58 moves the bell crank lever 55 in a clockwise direction so that the arm 54 of the bell crank lever acts against the tappet rod 53a to move the latter to the right against the lower end of lever 52. The upper end of lever 52 is thus swung to the left and acts to shift the pivotal connection 47 between the links 39 and 40 to the left of the center line between the shaft 43 and the toggle pin 49 (see Fig. 6). The toggle links 39 and 40 then collapse to the position shown in Fig. 4 permitting the valve 28 to move downwardly from the power stroke position shown in Fig. 1 to the return stroke position shown in Figs. 4 and 5. The instant at which the toggle links are collapsed to permit shifting of valve 28 from the position shown in Fig. 1 to the position shown in Figs. 4 and 5 may be varied in relation to the power stroke of the ram 13 by changing the angular setting of the cam 63 as hereinafter described.

The shifting of the valve member 28 from the return stroke position shown in Figs. 4 and 5 to the power stroke position shown in Fig. 1 may be accomplished in the following manner: With the parts in the position shown in Fig. 4 the lever 42 is first raised to shift the toggle arm 41 and the links 39 and 40 to the position shown in Fig. 5. With the parts in this new position lever 42 is then swung downwardly to successively shift the arm 41 and the links 39 and 40 to the position shown in Fig. 6. During this last motion plunger 38 and valve 28 are moved upwardly since the two links 39 and 40 become rigid in the position shown in Fig. 5 by reason of the fact that the shaped stops 45 and 46 prevent further counter-clockwise rotation of link 39 with reference to link 40. In connection with this resetting of the toggle mechanism it will be understood that the lever 52, tappet rod 53a, bell crank 55, link 58 and cam operated lever 60 resume the position shown in Fig. 1 as soon as the cam lift 70 passes beyond the roller 62.

The slow down valve provided in accordance with this invention comprises a valve member 72 working in a valve casing 73 included in the fluid line 26. Valve member 72 is normally held in a fully open position by a spring 73a working against the valve stem 74. As long as this valve remains open during the power stroke of the ram 13, the exhaust of fluid from the push back casing 18 via fluid line 26 is unobstructed and permits the ram 13 to descend at maximum speed. At a suitable instant prior to engagement of the work by the platen 5 or the tool carried thereby the valve 72 is shifted from the fully open position shown in Figs. 1 and 2 to the throttling or partially closed position shown in Fig. 3. In this latter position of valve 72 the flow of fluid from the push back chamber 18 through the valve casing 73 is throttled down so that the descending speed of the ram 13 and the platen 5 is sufficiently reduced so that the platen 5 or the tool carried thereby is brought in contact with the work while travelling at pressing speed. The shifting of the valve 72 from the position shown in Fig. 1 to the position shown in Fig. 3 is accomplished through the agency of the control cam mechanism generally indicated at 76. This mechanism includes a bell crank lever 77 pivoted to a bracket portion 78 of the valve casing 73. One arm 79 of lever 77 is fitted in a groove 80 provided in the valve stem 74. The other arm 81 of lever 77 is connected by a link 82 to the free end of a cam operated lever 83, the remaining end of the last mentioned lever being pivoted as indicated at 84. Lever 83 is provided with a stop 86 and with a pair of swinging links 87 the latter having their upper ends pivoted to opposite sides of the lever. A roller 88 is carried between the lower ends of links 87 and is disposed to ride the edge of cam 89 which is driven from the same shaft 65 which drives the reversing cam 63. During part of the power stroke of the ram the lever 83, links 87, roller 88 and cam 89 are in the position shown in Fig. 1, the slow down valve 72 being open. As the cam 89 is rotated (in the direction indicated by the arrow) from the position shown in Fig. 1 to the position shown in Fig. 2, the roller 88 drops into the cam recess 91, the links 87 being prevented from swinging beyond the vertical position shown in Fig. 2 by engagement of said links with the stop 86. As the cam 89 continues to rotate from the position shown in Fig. 2 to the position shown in Fig. 3 the roller 88 rides on the lift portion 92 of the cam and onto the curved cam surface 93, thus raising lever 83 and link 82 and swinging the bell crank lever 77 in a clockwise direction so that the slow down valve 72 is shifted from the fully open position shown in Figs. 1 and 2 to the partly closed position shown in Fig. 3. The particular instant, in relation to the power stroke of the ram 13, at which the slow down valve 72 is shifted from the position shown in Fig. 2 to the position shown in Fig. 3 may be varied by changing the angular position of the cam 89 as hereinafter explained. The lift portion 70 of the reversing cam 63 is provided with a laterally extending arm 96 compare Figs. 1, 8, 10 and 11. When the lift portion 70 of cam 63 is rotated from the position shown in Fig. 1 to and beyond the valve reversing position shown in Figs. 4 and 7 the arm 96 thereof engages a projection 97 of one of the links 87 (Figs. 7 and 8) so that the links 87 and the roller 88 are swung back to the position shown in Fig. 1 thus permitting lowering or resetting of the lever 83 to return the slow down valve 72 to its normally fully open position. When valve 72 is butted against the left hand end of cylinder 73, as shown in Fig. 1, the lever 83 is prevented from dropping below the position shown in this figure by the link 82.

In Figs. 8 and 9 I have shown what I now consider to be the preferred mechanical assembly of the component parts of the cam mechanism diagrammatically illustrated in Fig. 1. As here shown the central portion of shaft 65 is journalled in a bearing 99 provided in the wall 100 of a casing 101 containing the cams 63 and 89. Shaft 65 is also partly journalled in a bearing 102 provided in a shaft supporting portion 103 of a bracket 104 which is cast integral with or otherwise attached to casing 101. The previously mentioned gears 66 and 67 are arranged between the casing wall 101 and the bracket portion 103,

the gear 66 being keyed to shaft 65 in mesh with the gear 67 which is keyed to a shaft 105 which also carries the gear 68 and which is journalled in suitable bearings 106 and 107.

Cam 63 is clamped in place between the shoulder 65a of shaft 65 and a clamping plate 109 which is jammed against a friction facing 110 secured to said cam. The clamping plate 109 is provided with a hub 111 which is slidably keyed to the shaft 65. The cam 89 is slidably fitted on the hub 11 and is clamped against a friction facing 112 of the clamping plate 109 by means of a clamping nut 113 which is threaded onto the free end of hub 111. A second clamping nut 114 is threaded on the right hand end of shaft 65 as viewed in Fig. 8 and acts against the free end of hub 111 to force the clamping plate 109 against the friction facing 110 of cam 63. A washer 116 is interposed between hub 111 and clamping nut 114 and is provided with a tongue 117 fitted in the hub groove 118.

When it is desired to change the angular displacement of cam 63 this may be conveniently accomplished by loosening the clamping nut 114 sufficiently to permit cam 63 to be turned about shaft 65. When it is desired to change the angular displacement of the cam 89 this is accomplished by loosening the clamping nut 113 sufficiently to permit said cam to be turned about the supporting hub 111. The clamping plate 109 may be graduated as indicated at 119 in Fig. 9 to facilitate duplication of any particular angular setting thereof.

While the cam mechanism illustrated in Figs. 8 to 11 inclusive was developed for and is particularly useful in connection with the purposes of the present invention, it is obvious that such mechanism is capable of general application in connection with hydraulic presses and in various other relations. For example, such mechanism may be used in connection with any form of control valve to prescribe the exact instant at which pressure fluid may be ported, through the valve, to any desired point. There are certain types of presses in which, at a certain stage in the stroke of the down stroking rams, it is desired to impart an up-stroke to auxiliary rams in the press space. The cam mechanism shown in the present application may be used in conjunction with suitable valves to control the exact instant at which pressure fluid is supplied to the auxiliary rams to move them on the up-stroke.

The foregoing are only a few of the many instances which may be cited with reference to the general utilization of the cam mechanism in question.

Having thus described what I now conceive to be the preferred embodiment of this invention it will be understood that various modifications may be resorted to within the scope and spirit of the appended claims.

What I claim is:

1. Cam mechanism comprising a cam shaft having an abutment thereon, a cam rotatably mounted on said shaft adjacent said abutment, a clamping plate slidably keyed to said shaft and adapted to be forced against the side of said cam remote from said abutment, a second cam rotatably mounted on a hub extension of said clamping plate and adapted to be clamped against the side of the clamping plate remote from the first mentioned cam member, a second clamping plate slidably keyed to said hub and adapted to be clamped against the side of the second cam member which is remote from the first mentioned clamping plate, a clamping nut having threaded engagement with said hub and adapted to be screwed into clamping engagement with said second clamping plate and a second clamping nut having threaded engagement with said shaft and adapted to be screwed against said hub to clamp said first mentioned cam in place between said shaft abutment and said first mentioned clamping plate.

2. Cam mechanism as set forth in claim 1 including a separately formed friction facing interposed between each cam and the adjacent side of the first mentioned clamping plate, each friction facing being non-rotatably secured to one of the opposing surfaces between which it is interposed.

3. Cam mechanism comprising a cam shaft, means for rotating said shaft, a cam mounted on said shaft to rotate therewith, a cam-operated lever having a portion thereof opposed to the periphery of said cam, a roller riding the periphery of said cam, swingable roller-carrying means securing said roller to said lever, means associated with said lever to limit swinging movement thereof toward the periphery of said cam, the contour of said cam and the relative arrangement of the cam, lever and roller carrying means being such that the roller carrying means is held in an inclined position relative to the lever when the roller is riding a predetermined portion of the cam but swings to a position normal to the lever when another portion of the cam which is of minimum radius is rotated into contact with the roller, a stop arranged to arrest further swinging movement of said roller carrying means after the latter has swung from its inclined to its normal position with reference to said lever, said cam being so contoured that, following movement of the roller carrying means to a position normal to said lever, portions of the cam of gradually increasing radius from the minimum to the maximum are rotated into contact with the roller to effect outward movement of the roller carrying means and lever with reference to the axis of the cam shaft, the direction of rotation of the cam being such that the cam tends to maintain the roller carrying means against said stop when said roller carrying means is in a position normal to said lever and means functioning, at a predetermined instant subsequent to the aforesaid outward movement of said lever, to swing said roller carrying means back to an inclined position with reference to said lever to permit the latter to move inwardly to its original position, said cam mechanism being further characterized in that the roller rides on and is supported by said cam in both positions of said roller carrying means.

4. Cam mechanism as set forth in claim 3 in which the said means for swinging the roller carrying means back to an inclined position with reference to said lever is secured to the cam shaft to rotate therewith.

5. Cam mechanism as set forth in claim 3 in which the means for swinging the roller carrying means back to an inclined position with reference to said lever comprises a member secured to said cam shaft to rotate therewith, said member and said cam being adjustable about said shaft to various positions of angular displacement.

6. Cam mechanism as set forth in claim 3 in which the means for swinging the roller carrying means back to an inclined position with reference to said lever comprises a disk member secured to said cam shaft to rotate therewith, said disk

member being provided with a lateral projection adapted, when moving through a predetermined portion of its circular path of travel, to engage and swing said roller carrying means to said inclined position.

7. Cam mechanism comprising a rotary cam shaft, means for rotating said shaft, a first cam mounted on said shaft to rotate therewith, a second cam mounted on said shaft to rotate therewith in side by side relation with the first cam, a first pivotally mounted lever having a portion thereof opposed to the periphery of the first cam, a second pivotally mounted lever having a portion thereof opposed to the periphery of the second cam, a roller riding the periphery of the first cam, swingable roller carrying means securing said roller to the first lever, means for limiting swinging movement of the first lever in the direction of the periphery of the first cam, said roller carrying means being held in an inclined position relative to the first lever when the roller is riding a predetermined portion of the first cam but being swingable to a position normal to said first lever when another portion of the first cam, which is of minimum radius, is rotated into contact with said roller, a stop arranged to arrest further swinging movement of said roller carrying means after the latter has swung to a position normal to the first lever, said first cam being contoured so that, following movement of said roller carrying means to a position normal to said first lever, portions of the cam of gradually increasing radius from the minimum to the maximum are rotated into contact with said roller to move the first lever outwardly with reference to the cam shaft, the direction of rotation of the cams being such that the first cam tends, by its engagement with said roller, to hold the roller carrying means against said stop when said roller carrying means is in a position normal to the first lever, a roller carried by the second lever and disposed in riding engagement with the periphery of the second cam and means carried by the second cam adapted to engage and swing said roller carrying means back to its inclined position with reference to the first lever at a predetermined instance subsequent to the aforesaid outward movement of the first lever with reference to said cam shaft, said cam mechanism being further characterized in that the first mentioned roller rides on and is supported by the first cam in both positions of said roller carrying means.

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