Our invention relates to a die cushion locking and pull down cylinder and more particularly to a control device for regulating the action of the die cushion of a power press.

In one type of operation on a power press such for example as a double action press, the blank holder descends to hold the work against the press bed and then dwells. During the period of dwell of the blank holder, the press inner slide carrying the die moves down to perform a working operation on the blank. In performing a working operation on a blank, the inner slide or ram acts against a cushion pad.

After the forming operation and during the time when the blank holder dwells, the inner slide begins its return. A short time after the inner slide begins its return stroke, the blank holder slide moves up. It will be appreciated that as the inner slide moves up, the cushion pad tends to move the formed blank up with the inner slide and, as the blank holder is still in its dwell, tends to turn the formed part inside out. For this reason it is desirable that some means be provided for holding the die cushion down until after the blank holder begins its return stroke.

In another type of operation on a power press a partially formed part is placed on locating pins or pilots before the stamping operation is performed. In this type of operation the pilots must be exposed to receive the part before the forming operation begins. Then after the forming operation is complete the part must be moved off the pilots or other locating surface in the die.

We have invented a die cushion locking and pull down cylinder adapted to perform both the operations described above in a simple, convenient and expedient manner. Our cylinder is adapted to operate to hold the cushion pad locked after a stamping operation has been performed and, until the blank holder begins its return stroke.

Alternatively where a partially formed part is to be placed on pilot pins or a locating surface before the operation is performed, our cylinder is adapted to operate to pull down the cushion pad to expose the locating surface to permit the part to be placed in the position it is to occupy during the stamping operation. Our cushion locking and pull down cylinder is adapted to perform these operations reliably in a rapid and expedient manner.

One object of our invention is to provide a die cushion locking and pull down cylinder for a power press which is adapted both to lock the die cushion and to pull down the die cushion in two types of operations to be performed on the press.

Another object of our invention is to provide a die cushion locking and pull down cylinder adapted to lock the die cushion in its depressed position in a double action press until after the blank holder begins its return stroke.

A further object of our invention is to provide a die cushion locking and pull down cylinder which performs reliably in a rapid and expedient manner.

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

In general our invention contemplates the provision of a power press die cushion locking and pull down cylinder which, with one ratio of cushion pressure to locking device operating piston pressure, locks the die cushion in its depressed position until the blank holder begins its return stroke in a double action press. With another ratio of cushion pressure to locking assembly operating piston pressure, an auxiliary pull down piston applies pressure to the press cushion locking piston to pull the cushion pad down at the correct point in the press cycle to expose pilots or the like which receive a partially formed part to permit an operation to be performed on the part.

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 view of our die cushion locking and pull down cylinder with some parts shown schematically.

FIGURE 2 is a schematic view of a power press equipped with our pull down and locking cylinder illustrating the relative positions of the parts of the press before a stamping operation is performed.

FIGURE 3 is a schematic view of the press shown in FIGURE 2 illustrating the relative positions of the parts when the inner slide descends to perform the forming operation.

FIGURE 4 is a schematic view of the press shown in FIGURE 2 illustrating the relative positions of the parts as the inner slide begins its return stroke with the cushion pad locked.

FIGURE 5 is a schematic view of the press shown in FIGURE 2 illustrating the relative positions of the parts after the locked die cushion has been released.

FIGURE 6 is a schematic view of a power press equipped with our die cushion locking and pull down cylinder illustrating the relative positions of the parts when the cushion has been pulled down to permit a partially formed work piece to be placed on a locating surface.

FIGURE 7 is a schematic view of the press shown in FIGURE 6 illustrating the relative positions of the parts as the slide descends to perform a blanking operation.

FIGURE 8 is a schematic view of the press shown in FIGURE 6 illustrating the relative positions of the parts when the slide has returned and the cushion has moved the work piece off the locating surface.

FIGURE 9 is a schematic view of a double action press provided with our die cushion locking and pull down cylinder illustrating the relative position of the parts before a forming operation takes place.

FIGURE 10 is a schematic view of the press shown in FIGURE 9 illustrating the relative positions of the parts as the inner slide begins its return stroke with the cushion pad locked.

FIGURE 11 is a schematic view of the press shown in FIGURE 9 illustrating the relative positions of the parts as the inner slide begins its return stroke with the cushion pad locked.

Referring now to FIGURE 1 of the drawings the press with which our die cushion locking and pull down cylinder, indicated generally by the reference character 10, is used, includes a piston 12 to which we secure a locking cylinder 14 which receives a locking piston 16. An air control manifold indicated generally by the reference character 18 connects a pipe 20 leading from a suitable source (not shown) of air under pressure to a pipe 22 leading to the interior of the piston 12 which contains a supply of oil the level of which is indicated by the reference character 24. The manifold 18 includes a globe valve 26, a pressure regulator 28, and a pressure gauge 30 connected to the line by a needle valve 32. A check valve 34 connects the regulator valve 28 to the
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surge tank 22. A globe type exhaust valve 36 is connected into the line between the check valve 34 and the pipe. It will be appreciated that pipe 22 is the primary source of fluid under pressure for the cushion and the locking and pull down assembly.

Referring to FIGURES 1 and 2, the piston 12 receives the cushion cylinder 44 which carries the rod 46 and the check valve 34 in a similar manner to the piston 10 of FIGURE 1. The body 74 of the check valve 34 and the cylinder 44 tends to drive the cushion cylinder 44 upwardly as viewed in FIGURE 2. In one form of press with which our device is used the cushion cylinder acts through pressure pins 80 slidably supported in the press frame 52 resiliently to support the cushion pad 54.

In FIGURES 2 to 5 of the drawings we have illustrated a single action press adapted to form a part on which a subsequent operation is to be performed on a press provided with pilot pins or a locating member on which the part is to be placed for a subsequent operation. While in a single action power press adapted to perform the operations illustrated in FIGURES 2 to 5, it is not essential to provide the cushion with a locking cylinder, by way of example, we have shown the cushion as being provided with such a cylinder. As will be explained hereinafter, where a double action press is employed the locking cylinder is essential if proper operation is to be achieved. The press shown in FIGURES 2 to 5 includes an inner slide 56 to which simple harmonic motion is imparted by means of a pitman 58 which drives the slide 56. When the slide moves downwardly, a die 60 carried by the slide acts on a work piece 62 in cooperation with a mating die 64 carried by the press bed to form a part. In the course of this operation the work piece 62 is moved downwardly against the cushion pad to drive the cushion cylinder 44 down, as viewed in FIGURE 2. We provide the piston 16 with a check valve 66 which permits fluid to pass through the piston as it moves downwardly as viewed in FIGURE 1. When the piston moves upwardly as viewed in FIGURE 1, check valve 66 prevents the flow of fluid through the piston 16 and fluid normally is forced through a passage 68 in the cylinder wall past a valve seat 70 and through passages 71 and 72 to the portion of the cylinder 14 below the piston 16.

Our die cushion locking and pull down cylinder includes cylinder 74 which receives an operating piston 76 for reciprocating movement therein. The body 74 includes a portion 78 having a cross sectional area which is reduced with respect to that of the part receiving the piston 76. We close one end of the body 74 by means of a plate 80 secured to the body by any suitable means such as by bolts 82. We secure the other end of the body 74 to the wall of the cylinder 14 by any convenient means such as by bolts 84. A conduit or pipe 86 is adapted to supply fluid such as air under pressure to the interior of the body 74 to drive piston 76 to the left as viewed in FIGURE 1. A manifold indicated generally by the reference character 88 contains a shut off globe valve 99 leading from the source (not shown) of air under pressure, a regulating valve 92, and a check valve 94, connected in series. A needle valve 96 is adapted to connect the pressure line to a gauge 98. A cam operated valve 100 is adapted to be operated alternately to connect valve 94 to the pipe 86 or to connect the pipe 86 to an exhaust pipe 102. We employ any suitable motor such as a relay cylinder 104, actuating follower 106 to operate valve 100 through a linkage 108. We connect an exhaust valve 110 of the globe type to the line between valve 94 and valve 106.

A nut 112 secures an auxiliary pull down piston 114 to the operating piston 76 for movement therewith. A bore 116 formed in the piston 114 receives a spring 118 which acts on a stop 120 carried by one end of a valve stem 122 provided with a head 124 adapted to close on the seat 70 in a manner to be described. In the position of the parts shown in FIGURE 1 stop 120 is moved into engagement with a plug 126 screwed into the end of the piston 114. Piston 114 slidable receives the main pull down piston 128, the head 130 of which has as outside diameter equal to the inside diameter of the portion 134 of the body 74. We provide a suitable seal 132 between piston 128 and body 74 and between piston 114 and piston 128 to prevent communication between the oil and air systems of our device.

From the structure thus far described it will be apparent that when air under pressure is supplied to the body 74 to tend to drive the piston 76 to the left as viewed in FIGURE 1, piston 128 and piston 114 move to the left. The dimensions of the parts are such that head 124 engages in seat 70 before piston 76 engages the right end of piston 128 as viewed in FIGURE 1. As will further be apparent from the description of the parts and the valve action given hereinafter, piston 76 continues to move until it engages the right end of piston 128 and then comes to rest. Before this occurs and after head 124 engages seat 70, piston 114 moves a slight distance further out of telescoped relation with piston 128 and causes a slight increase in pressure of the oil trapped above piston 16. As will be explained hereinafter in another type operation where the cushion pressure is lower than that which exists during the operation just described, after piston 76 moves to the left through a distance sufficient to position head 124 in seat 70, it continues to move and after it engages piston 128 it drives this piston to the left as viewed in FIGURE 1. This continued movement of piston 76 drives piston 128 to the left as viewed in FIGURE 1 to force fluid into the space over the locking piston 16 to move the cushion down. It will be seen that the piston 128 of the die cushion locking and pull down control valve assembly 10 thus supplies fluid under pressure to the upper side of the locking piston 16 as viewed in FIGURE 1.

FIGURES 1 to 5 show the operation of our locking and pull down cylinder for use on a press in which a forming operation is to be performed through the medium of dies 60 and 64 acting on a blanket 62. In the condition of the parts shown in FIGURE 2, the slide 56 is at the top of its stroke and a predetermined pressure within the cushion cylinder 44 and piston 12 engages the cushion pad 54 to the position shown through the medium of the pins 50. As the cycle of press operation continues as shown in FIGURE 5 the slide 56 descends to cause the die 68 to draw the blank 62 down over the die 64 and to push the pad 54 downwardly against the action of the pressure within the cushion. It will be appreciated that this causes a pressure build up within the telescoped cylinder 44 and piston 12. During this operation the condition of the valve 100 is such that line 86 is connected to exhaust pipe 102 and the parts of our die cushion locking and pull down cylinder are in the positions shown in FIGURE 1. When the inner slide 56 reaches bottom dead center and before it begins its return, the valve operating cam 104, which is synchronized with the press drive, acts on its follower 106 to cause linkage 108 to move the valve 100 to the position at which it connects the pipe 86 to the valve 94. At this time air under pressure is applied to the piston 76 to cause the piston to move to the right as viewed in FIGURE 1. In the course of this operation before the piston 76 engages piston 128, head 124 engages seat 70 to block the passage of fluid through passage 72. Thus oil is trapped in the space over the piston 16 and it cannot flow back into the space below the piston as the slide 56 begins its return stroke. The dimensions of the parts shown in FIGURE 1, the head 124 engages seat 78, piston 76 moves through a short distance before it engages piston 128. In the course of
5 this movement piston 114 moves a slight distance further out of telescoped relation with piston 128 to force a small quantity of oil into the space over piston 16 to pull rod 46 and cushion cylinder 44 down slightly. 

8 When piston 76 engages the piston 128, the fluid under pressure acting on piston 76 forces the pistons 76 and 128 to the left as a unit. In this use of our cylinder, however, the cushion pressure is such that with the cushion in its depressed position the pressure exerted on the left face of piston 128 is so great that the pressure applied to the piston 76 is overcome and the parts cannot move further. A short time later the return portion of its stroke as shown in FIGURE 4, cam 104 actuates the valve 100 to connect pipe 86 to the exhaust pipe 102. When this occurs, the cushion cylinder 44 moves upwardly under the influence of the cushion pressure and it drives the locking piston upwardly. As the locking piston moves upwardly, it acts to force oil under pressure into the portion 78 of the housing 74 to move piston 114 to the right as viewed in FIGURE 1. As this piston moves to the right, it moves head 124 out of engagement with the seat 70 to open the passage 72. Thus in this movement of pad 54 upwardly, fluid under pressure is driven out of the space over piston 16 through the passage 68 and through the passage 72 to the space below the piston. Finally the parts return to their initial position shown in FIGURE 5 at which the formed blank 52 has been stripped off the die 64 to a position at which it may be removed in any suitable manner.

25 Referring now to FIGURES 6 to 8 of the drawings, in another use of our die cushion locking and pull down cylinder the manifold 18 is set to provide a cushion pressure which is relatively low as compared with that which existed in the type operation described above. The parts with which our assembly is used in this type operation includes an inner slide 136 carrying a punch 138 and a stripper plate 140 normally moved to a position substantially flush with the end of the punch by compression springs 142 and 144. The press frame 146 carries a pilot member 148 formed with a slug opening 150. The cushion pad 54 in this form of press is similar to that of the form of press shown in FIGURES 2 to 5 and is actuated upon by pressure pins 56 actuated by the cylinder 44. When the slide 136 is actuated at the 350 degree position in the up stroke of the press, the cam 104 actuates the overtravel 106 to cause valve 100 to connect pipe 86 to the valve 94 to apply pressure to the piston 76 in a direction tending to move the piston to the left as viewed in FIGURE 1. When this occurs as in the type operation described above, the piston 128 forces oil through passage 72 to the right to the left first to engage head 124 with seat 70 to block the passage 72. Upon continued movement of piston 76 to the left, it engages piston 128 to tend to move this piston to the left. In this type of operation the cushion pressure is such that the pressure exerted on piston 128 by piston 76 overcomes the cushion pressure to drive piston 128 to the left. In the course of its movement to the left piston 128 forces oil through the passage 68 into the space over piston 16 to move the piston downwardly thus to pull the pad 54 downwardly to the position as shown in FIGURE 6. As it moves downwardly, pad 54 exposes the locating member 148 to permit a partially formed part 152 in which a hole is to be punched for example, to be placed over the locating surface. 

As slide 136 moves downwardly to the position shown in FIGURE 7, punch 154 moves through the work to punch a slug 154 out of the member 152. In the course of this operation the stripper plate 140 engages the work to compress springs 142 and 144. After the punching operation the slide 136 begins the return portion of its stroke. During this movement of the slide, plate 140 holds the part 152 against the locating member to permit the punch to be stripped from the work. At an appropriate point in the cycle of press operation, cam 104 causes

valve 100 to connect pipe 86 to exhaust pipe 102 and the pad 54 begins to move upwardly to strip the finished work piece off the locating member 148. As the part moves upwardly so does the piston 16. In the course of this operation, fluid is forced out of the space over the piston 16 through the passage 68 and into the interior of the portion 78 of the housing 74. This fluid under pressure moves piston 128 to the right until it engages piston 76 to move this piston to the right toward its initial position. When the parts approach their initial positions, head 124 moves out of engagement with seat 70 to permit fluid to flow from the space over the piston 16 through the space 72 to the space below piston 16. After this the return of the parts is provided by the fluid pressure coming from the supply line.

As is pointed out hereinafter in operation of the single action press shown in FIGURES 2 to 5 which is to perform a forming operation which results in the part 62 or 152 on which subsequent operations are to be performed as illustrated in FIGURES 6 to 8, it is not essential that a locking cylinder be employed. Referring now to FIGURES 9 to 12, we have illustrated a double action press in which a locking cylinder is required if parts are to be formed properly. The press shown in these figures includes an inner slide 154 carrying a punch 156 for movement therewith and a blankholder slide 158 carrying a blankholder ring 160 for movement therewith. In a manner known to the art slide 154 and 158 are driven in timed relation to each other to cause the blankholder ring 160 first to move down into engagement with a work piece 166 to clamp the work piece between the ring 160 and a stationary bottom die 162 carried by the press bed 52. After the blankholder ring 160 engages the work 166, slide 156 moves down into the work against the action of a pressure pad 164 supported by the pressure 165. When the part has thus been formed, the slides 154 and 158 occupy the positions shown in FIGURE 10. When the slide 154 is at this bottom dead center position and before it begins its return stroke, cam 104 acts on follower 106 to move valve 100 to the position at which it connects pipe 86 to the valve 94 to supply air under pressure to piston 76 to move the piston to the left as viewed in FIGURE 1. Before the piston 76 engages piston 128, head 124 engages seat 70 to block the flow of fluid through passage 72 to trap oil in the space over piston 16. This locks cylinder 44 in the position to which it has been moved under the action of the slide 154 and punch 156. It is to be noted that in this use of our cylinder the cushion pressure is such that with the cushion in its depressed position the pressure exerted on the left face of piston 128 is such that the pressure applied to the piston 76 does not cause any further movement of the parts.

After the blankholder slide 158 has moved the ring 160 by an amount equal to the height of the part drawn from the work 166 as shown in FIGURE 3, then valve 100 moves to a position at which pipe 86 is connected to the exhaust to permit the cushion to move upwardly to return the pad 164 to its initial position to move the formed part out of the die 162 as shown in FIGURE 12 of the drawings. It will readily be seen that this action of locking the pressure pad 164 until the blankholder slide begins its return stroke locks the die cushion from turning the formed part inside out as the inner slide begins its return while the blankholder slide is still in its dwell.

It will be seen that we have accomplished the objects of our invention. We have provided a die cushion locking and pull down assembly which operates in a rapid and expeditious manner to lock the die cushion of a power press in its depressed position. The cylinder operates also to pull down a die cushion pad to expose locating surfaces in the die when an operation is to be performed on a partially completed part. Our cylinder accomplishes both types of operations in a rapid and expeditious manner.
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. In a power press having a locking device comprising a locking cylinder and a locking piston and a passage providing communication between the opposite sides of the piston, a locking and pull down assembly including in combination a normally open valve adapted to be actuated to block said passage to trap fluid between said locking piston and said locking cylinder on one side of said piston, an operating cylinder, means providing communication between said operating cylinder and said locking cylinder on said one side of the locking piston, a pull down piston having a certain dimension in cross-section, means mounting said pull down piston for movement within said operating cylinder, a valve operating piston having a dimension corresponding to said certain dimension which is appreciably less than said certain dimension, means mounting said valve operating piston for movement with respect to said pull down piston, means responsive to movement of said valve operating piston for closing said valve, means responsive to movement of said pull down piston for supplying fluid under pressure to said locking cylinder on said one side of the locking piston, means for supplying fluid under pressure to said locking and pull down assembly, first means responsive to a first predetermined pressure of fluid supplied to said locking and pull down assembly for moving said operating piston to close said valve and second means including said first means responsive to a second predetermined pressure of fluid supplied to said assembly for moving said operating piston to close said valve and for moving said pull down piston to supply fluid under pressure to said locking cylinder on said one side of said locking piston.

2. A power press having a locking device comprising a locking cylinder and a locking piston and a passage providing communication between the opposite sides of the piston, a locking and pull down assembly including in combination a normally open valve adapted to be actuated to block said passage to trap fluid between said locking piston and said locking cylinder on one side of said piston, an operating cylinder, means providing communication between said operating cylinder and said locking cylinder on said one side of the locking piston, a pull down piston having a certain dimension in cross-section, means mounting said pull down piston for movement within said operating cylinder, a valve operating piston having a dimension corresponding to said certain dimension which is appreciably less than said certain dimension, means mounting said valve operating piston for movement with respect to said pull down piston, means responsive to movement of said valve operating piston for closing said valve, means responsive to movement of said pull down piston for supplying fluid under pressure to said locking cylinder on said one side of the locking piston, means for supplying fluid under pressure to said locking and pull down assembly, first means responsive to a first predetermined pressure of fluid supplied to said locking and pull down assembly for moving said operating piston to close said valve and second means including said first means responsive to a second predetermined pressure of fluid supplied to said assembly for moving said operating piston to close said valve and for moving said pull down piston to supply fluid under pressure to said locking cylinder on said one side of said locking piston.

3. In a power press having a locking device comprising a locking cylinder and a locking piston and a passage providing communication between the opposite sides of the piston, a locking and pull down assembly including in combination a normally open valve adapted to be actuated to block said passage to trap fluid between said locking piston and said locking cylinder on one side of said piston, an operating cylinder, means providing communication between said operating cylinder and said locking cylinder on said one side of the locking piston, a pull down piston having a certain dimension in cross-section, means mounting said pull down piston for movement within said operating cylinder, a valve operating piston having a dimension corresponding to said certain dimension which is appreciably less than said certain dimension, means mounting said valve operating piston for movement with respect to said pull down piston, means responsive to movement of said valve operating piston for closing said valve, means responsive to movement of said pull down piston for supplying fluid under pressure to said locking cylinder on said one side of the locking piston, means for supplying fluid under pressure to said locking and pull down assembly, first means responsive to a first predetermined pressure of fluid supplied to said locking and pull down assembly for moving said operating piston to close said valve and second means including said first means responsive to a second predetermined pressure of fluid supplied to said assembly for moving said operating piston to close said valve and for moving said pull down piston to supply fluid under pressure to said locking cylinder on said one side of said locking piston.
down piston, means mounting said pull down piston for movement within said operating cylinder, a valve operating piston, means mounting said valve operating piston for movement with respect to said pull down piston, means responsive to movement of said operating piston for closing said valve, means responsive to movement of said pull down piston for supplying fluid under pressure to said locking cylinder on said one side of the locking piston, means adapted to be operated selectively to move said operating piston to close said valve and to move both said operating piston to close said valve and said pull down piston to supply fluid under pressure to said locking cylinder on said one side of the locking cylinder.

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