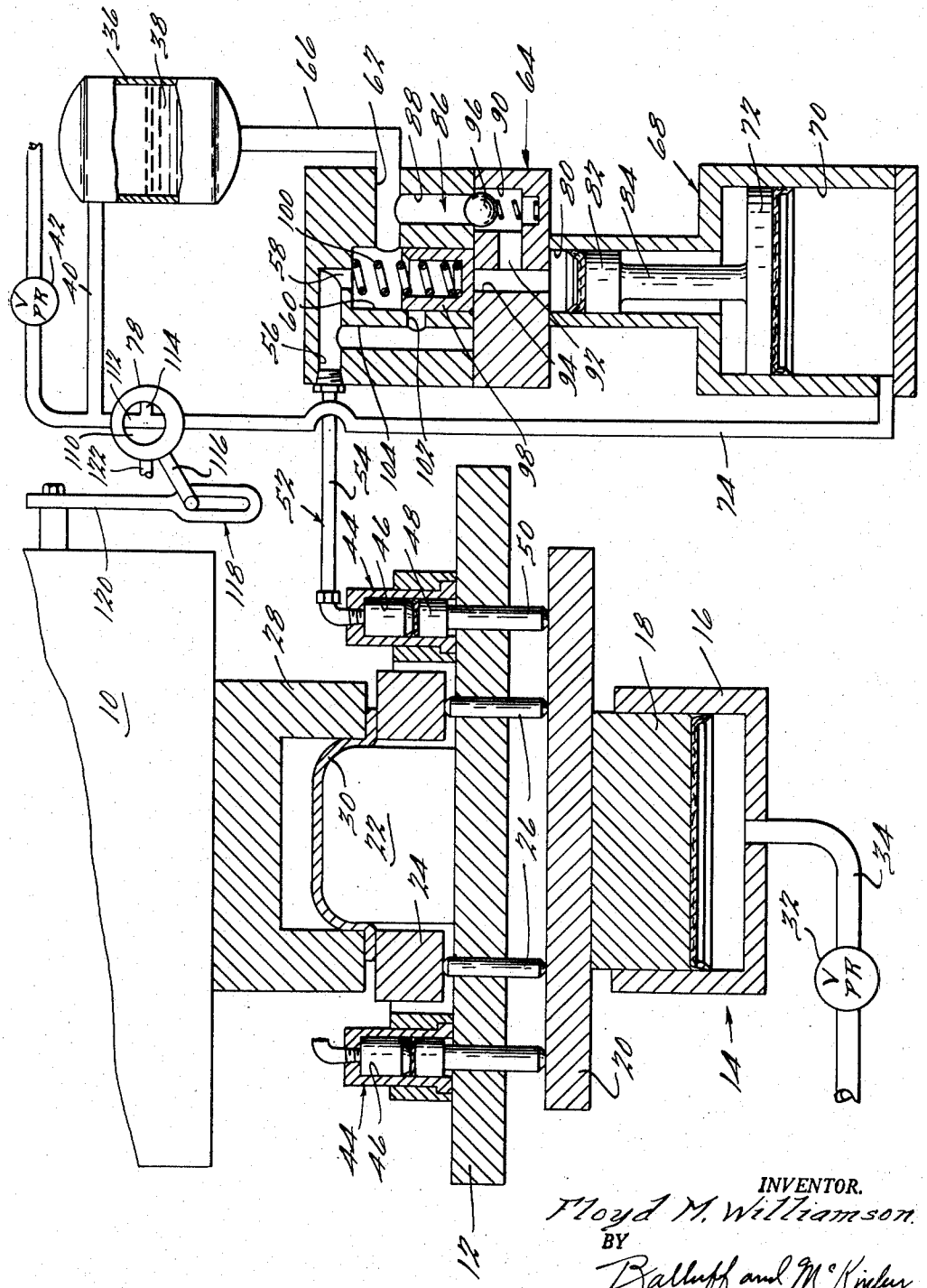
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HYDRAULIC SYSTEM FOR CONTROLLING THE RETURN MOVEMENT OF PRESSURE PADS IN AIR CUSHION PRESSES

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HYDRAULIC SYSTEM FOR CONTROLLING THE RETURN MOVEMENT OF PRESSURE PADS IN AIR CUSHION PRESSES

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This invention relates to hydraulic systems for delaying the return movement of pressure pads in a ram press employing an air cushion.

In such presses it is frequently desirable to delay the return movement of the pressure pad or to stop the pad at some intermediate position in its upward travel to prevent distortion of the workpiece being formed. The invention herein disclosed provides a simple and effective means for carrying out this type of operation.

A principal object of the invention therefore is to provide a hydraulic system for delaying return movement of a pressure pad in a ram press having an air cushion.

Other and further objects of the invention will be apparent from the following description and claims and may be understood by reference to the accompanying drawing which by way of illustration shows a preferred embodiment of the invention and what I now consider to be the best mode of applying the principles thereof. Other embodiments of the invention may be used without departing from the scope of the present invention as set forth in the appended claims. The single figure of the drawing schematically illustrates a ram press with a hydraulic system embodying the invention.

Such a press includes a reciprocable ram **10**, a fixed bolster **12**, and an air cushion **14** comprising an air cylinder **16** and a piston **18** arranged to react upon a pin plate **20** disposed beneath the bolster **12**. A lower die which is mounted on the bolster **12** includes a fixed section **22** surrounded by a pressure pad **24** between which and the pin plate **20** a series of pins **26** are disposed whereby the pad **24** is supported by the pin plate **20**, which in turn is supported by the piston **18** of the air cushion. A die **28** mounted on the ram **10** to move therewith is cooperable with the die sections **22** and **24** for shaping a flat sheet metal blank **30**. When the press is open the pad **24** is positioned so that its upper surface is at the same elevation as the upper flat surface of the section **22**. A suitable adjustable pressure regulating valve **32** is disposed in the air pressure line **34** through which air under pressure is supplied to the cylinder **16** for biasing the piston **18** to its upper position wherein the plate **20** will be positioned against the under side of the bolster **12**. The structure so far described is conventional.

The invention essentially comprises a hydraulic system for controlling the return movement of the pad **24**. This system essentially comprises a tank **36** having hydraulic fluid **38** therein under relatively low pressure, say, for example, 100 pounds per square inch, provided by air under pressure supplied through the air line **40** under the control of a suitable adjustable pressure regulating valve **42**.

One or more hydraulic cylinders **44** are mounted on the bolster **12** around the pressure pad **24**, and each includes a cylinder **46** and a piston **48** having its rod **50** slidably extending through a bore in the bolster **12** and arranged to react on the pin plate **20**. Each cylinder **46** is connected by a fluid pressure line indicated generally

at **52** with the tank **36**, such line including pipe **54**, passages **56**, **58**, cylindrical bore **60**, and passage **62** in the automatic valve unit **64**, and conduit **66** communicating at one end with the passage **62** and at its other end with the interior of the tank **36** at the bottom thereof whereby hydraulic fluid, i.e. oil, under the pressure to which it is subjected in the tank will be supplied to each of the cylinders **46**. The total pressure of the cylinders **46** under only the pressure to which the oil in the tank **36** is subjected is less than the pressure exerted by the air cushion **14** against the pressure pad **24**.

An air pressure operated hydraulic booster **68** is arranged and operable when energized to increase the total pressure developed by the high pressure cylinders **44** to a value in excess of the pressure exerted by the air cushion **14** on the pad **24** whereby the pressure developed by the cylinders **44** is effective to delay the return of the air cushion **14** upon the opening of the press and hence the return of the die pad **24** to its upper position. At times it is necessary to delay the return of the pad **24** or to stop the pad **24** at some position in its upward travel so as to prevent distortion of the workpiece being formed. Thus so delaying the pressure pad will cause the workpiece to cling to the die section **22** upon opening movement of the press.

The booster **68** includes an air cylinder **70** having a piston **72** reciprocable therein, the cylinder **70** being connected by air pressure line **74** to the line **40** through which air pressure is supplied to the tank **36**. A rotary valve **78** controls the supply of air under pressure through the line **74** to the cylinder **70** and the porting of the cylinder **70** to atmosphere. The booster includes a hydraulic booster cylinder **80** having a piston **82** reciprocable therein, the piston **82** being connected by stem **84** to the piston **72** so as to move therewith. The piston **72** has an effective area substantially greater (say, for example, ten times) than the piston **82**. The cylinder **80** is connected by a hydraulic fluid line indicated generally at **86** with the oil under pressure in the tank **36**, such line including the conduit **66** and in the valve **64** the passages **62**, **88**, **90**, **92** and **94**, the latter of which communicates with the end of the cylinder **80**. A check valve **96** in the line **86** permits flow of hydraulic fluid from the tank **36** under the pressure therein into the cylinder **80** but prevents return flow.

The passage **94** communicates with one end of the bore **60**. A valve **98** slidable in the bore **60** is biased by a spring **100** to a position to close the end of the passage **94** opposite the cylinder **80**. The bore **60** communicates through a port **102** with a passage **104** which communicates with the passage **56**. Thus when the valve member **98** in response to the discharge of fluid from the cylinder **80** moves against the force of the spring **100** sufficiently to uncover the port **102**, fluid will flow from the cylinder **80** through the passage **94**, the bore **60**, the port **102**, the passage **104**, the passage **56**, and the conduit **54** toward the cylinders **46** thereby to transmit the pressure of the fluid in the cylinder **80** to the hydraulic fluid in the cylinders **46**.

When the booster **68** is not energized, the air piston **72** will normally be at or adjacent the bottom of the cylinder **70**. However, when the valve **78** is positioned so as to supply air under pressure through the line **74** to the cylinder **70**, the piston **72** will be effective to advance the piston **82** in the cylinder **80** whereby the fluid discharged from the cylinder **80** moves the valve member **98** upwardly sufficient to cause the same to close the end of the passage **62**, thereby shutting off the communication between the tank **36** and the cylinders **46**, and then upon further upward movement of the valve member **98** to uncover the port **102** for the purpose of transmitting the pressure thus developed by the piston **82** to the cylinders

46. As previously noted, the pressure developed in the cylinders 46 is in excess of the upward thrust of the air cushion 14.

The valve 78 includes a rotary body 110 having passages 112 and 114 therein, the body 110 having fixed to it an arm 116 having a pin and slot connection 118 with a link 120 which is fixed to the ram 10 for movement therewith. Upon the closing of the press the mechanical linkage between the ram 10 and the valve body 110 will rotate the latter so that the passage 112 will establish communication between the air pressure lines 40 and 74, thus admitting air under pressure to the cylinder 70 to advance the piston 72 thereof. Since the cylinders 46 and 80 were previously in communication with the tank 36, the cylinders 46 and 80 will be charged with hydraulic fluid under the pressure to which they are subjected by the air pressure in the tank 36. Thus when the press closes, that is, with the parts of the press arranged as shown in the drawing, the air pressure operated hydraulic booster 68 will be energized so as to shift the valve member 98 to shut off the communication between the cylinders 46 and the tank 36 and then to open the communication between the cylinder 80 and the cylinders 46, thus increasing the pressure in the cylinders 46 to a value sufficient to counteract the air cushion 14, thus delaying return movement of the pad 24.

As the ram moves upwardly, that is, as it retracts, the pin and slot connection 118 will shift the valve body 110 through 90° in a clockwise direction so that the passages 112 and 114 will port the air pressure line 74 to atmosphere through the atmospheric vent 122, thus dissipating the pressure in the cylinder 70. The pressure exerted on the pistons 48 by the air cushion 14, through the piston 18, the pin plate 20 and the piston rods 50, will displace hydraulic fluid from the cylinders 46 through the conduit 54, the passage 56, the passage 104, the port 102, the bore 60, and the passage 94 to the cylinder 80. Since both sides of the valve member 98 will be exposed to the same pressure, the spring 100 will be free to shift the valve member 98 so as to close the port 102 and to expose the end of the passage 62, thereby permitting the return of fluid from the cylinders 46 through the fluid pressure line 52 to the tank 36. As soon as the pressure in the air cylinder 70 is dissipated, hydraulic fluid will flow from the tank 36 through the line 86 into the cylinder 80. Since return of the valve member 98 to its lowermost position will leave the cylinders 46 in communication with the oil in the tank 36, the cylinders 46 will always be charged with hydraulic fluid under the pressure of the hydraulic fluid in the tank 36. The circulation of oil obtained by reason of the operation of the booster 68 will serve to dissipate heat from the oil.

Thus the system provides an effective means for delaying the return movement of the pad 24 under the influence of the air cushion 14. It is contemplated that the mechanical connection between the ram 10 and the valve body 110 may be temporarily broken so as to permit manual control of the valve 110 whereby the return of the pad 24 can be manually controlled for checking purposes.

While I have illustrated and described a preferred embodiment of my invention, it is understood that this is capable of modification and I therefore do not wish to be limited to the precise details set forth but desire to avail myself of such changes and alterations as fall within the purview of the following claims.

I claim:

1. In a ram press having a fixed bolster, a movable pressure pad arranged to be moved toward the bolster by the press ram upon the closing of the press and an air cushion reacting on said pad to resist such movement and to move such pad away from the bolster upon opening of the press: a hydraulic system for delaying return movement of such pad comprising a tank having hydraulic fluid under pressure therein, a hydraulic booster cylinder, a fluid pressure line between said tank and cylinder through which hydraulic fluid from the tank is supplied to said cylinder, a check valve in said line to prevent return flow of fluid therethrough, an air cylinder having a piston therein, a piston in said hydraulic cylinder connected to said air piston so as to move therewith, a high pressure hydraulic cylinder and piston associated with the bolster of the press and arranged so as to counteract said air cushion, a hydraulic line between said tank and said high pressure hydraulic cylinder, a hydraulic fluid line between said booster hydraulic cylinder and said high pressure hydraulic cylinder, valve means in said last-mentioned line permitting fluid flow therein from said booster hydraulic cylinder to said high pressure hydraulic cylinder, said valve means including a valve actuated by the discharge of hydraulic fluid from said booster hydraulic cylinder to close the hydraulic fluid line between said tank and said high pressure hydraulic cylinder whereby such discharge of hydraulic fluid increases the pressure of the hydraulic fluid in the high pressure hydraulic cylinder to a value sufficient to counteract said air cushion, an air pressure line connected to said air cylinder having a valve therein operated upon closing of the press to open such line to the flow of air under pressure to the booster air cylinder for causing the piston thereof to actuate the piston of said hydraulic booster cylinder to discharge hydraulic fluid therefrom, said last-mentioned valve in another position thereof being adapted to port the line leading to said booster air cylinder to atmosphere upon the opening movement of the press.

2. In a ram press having a fixed bolster, a movable pressure pad arranged to be moved toward the bolster by the press ram upon the closing of the press and an air cushion reacting on said pad to resist such movement and to move such pad away from the bolster upon opening of the press: a hydraulic system for controlling the return movement of such pad comprising a tank having hydraulic fluid therein, a hydraulic booster cylinder, a fluid pressure line between said tank and cylinder through which hydraulic fluid from the tank is supplied to said cylinder, a check valve in said line to prevent return flow of fluid therethrough, an air cylinder having a piston therein, a piston in said hydraulic cylinder smaller than said air piston and connected thereto so as to move therewith, a source of air pressure connected to said tank above the hydraulic fluid therein, a high pressure hydraulic cylinder and piston associated with the bolster of the press and arranged when actuated so as to counteract said air cushion, a hydraulic line between said tank and said high pressure hydraulic cylinder through which hydraulic fluid is supplied to such cylinder from said tank, a hydraulic fluid line between said booster hydraulic cylinder and said high pressure hydraulic cylinder, valve means in said last-mentioned line permitting fluid flow therein to said high pressure hydraulic cylinder, said valve means including a valve adapted by the discharge of hydraulic fluid from said booster hydraulic cylinder in response to actuation of the air piston in the booster cylinder to close the hydraulic fluid line between said tank and said high pressure hydraulic cylinder whereby such discharge of hydraulic fluid increases the pressure of the hydraulic fluid in the high pressure hydraulic cylinder to a value sufficient to counteract said air cushion, an air pressure line between said source and said air cylinder having a valve therein adapted in one position thereof to open such line to the flow of air under pressure to the booster air cylinder and a connection between said last-mentioned valve and a part of the press movable with the ram for operating said valve, said last-mentioned valve in another position thereof being adapted to port the line leading to said booster air cylinder to atmosphere upon the opening movement of the press.

3. In a ram press having a fixed bolster, a movable pressure pad arranged to be moved toward the bolster by the press ram upon the closing of the press and an air cushion reacting on said pad to resist such movement

and to move such pad away from the bolster upon opening of the press: a hydraulic system for controlling the return movement of such pad comprising a tank separate from the air cushion and having hydraulic fluid under pressure therein, a series of high pressure hydraulic cylinders and pistons mounted on the top side of the bolster of the press and disposed around the pressure pad and arranged to react when energized on said air cushion for counteracting the same, a hydraulic line between said tank and said high pressure hydraulic cylinders through which hydraulic fluid is supplied to said cylinders from said tank, a normally open valve in said line, an air pressure operated booster connected with said line between said valve and said high pressure hydraulic cylinders and operable when energized to react on the hydraulic fluid therein for closing said valve and increasing the pressure of the hydraulic fluid in the high pressure hydraulic cylinders to a value sufficient to counteract said air cushion, an air pressure line connected to said booster for energizing the same and a control valve therefor adapted upon closing of the press to open such line to the flow of air under pressure to the booster and to port said line to atmosphere upon opening of the press.

4. In a ram press having a fixed bolster, a movable pressure pad arranged to be moved toward the bolster by the press ram upon the closing of the press and an air cushion reacting on said pad to resist such movement and to move such pad away from the bolster upon opening of the press: a hydraulic system for controlling the return movement of such pad comprising a tank having hydraulic fluid therein, an air pressure operated hydraulic booster including a cylinder, a fluid pressure line between said tank and cylinder through which hydraulic fluid from the tank is supplied to said cylinder, means to prevent return flow through said line, a source of air pressure connected to said tank above the hydraulic fluid therein, a high pressure hydraulic cylinder and piston associated with the bolster of the press and operable so as to counteract said air cushion, a hydraulic line between said tank and said high pressure hydraulic cylinder, a hydraulic fluid line between said booster hydraulic cylinder and said high pressure hydraulic cylinder, valve means in said last-mentioned line permitting fluid flow therein from said booster hydraulic cylinder to said high pressure hydraulic cylinder, said valve means including a valve actuated by the discharge of the hydraulic fluid from said booster hydraulic cylinder to close the hydraulic fluid line between said tank and said high pressure hydraulic cylinder whereby such discharge of hydraulic fluid increases the pressure of the hydraulic fluid in the high pressure hydraulic cylinder to a value sufficient to counteract said air cushion, and a valve associated with said booster and controlled by opening and closing movement of the press for controlling the operation of said booster.

5. Apparatus according to claim 4 wherein said valve actuated by the discharge of hydraulic fluid from said booster hydraulic cylinder forms a check valve to prevent return flow of hydraulic fluid in said last-mentioned line from said high pressure hydraulic cylinder to said booster hydraulic cylinder.

6. Apparatus according to claim 4 wherein said means to prevent return flow through said fluid pressure line between said tank and booster cylinder includes a check valve in said fluid pressure line.

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