Dec. 6, 1966 F. M. WILLIAMSON 3,290,034

HYDRAULIC CONTROL FOR DIE PADS IN PRESSES

Filed Dec. 31, 1964

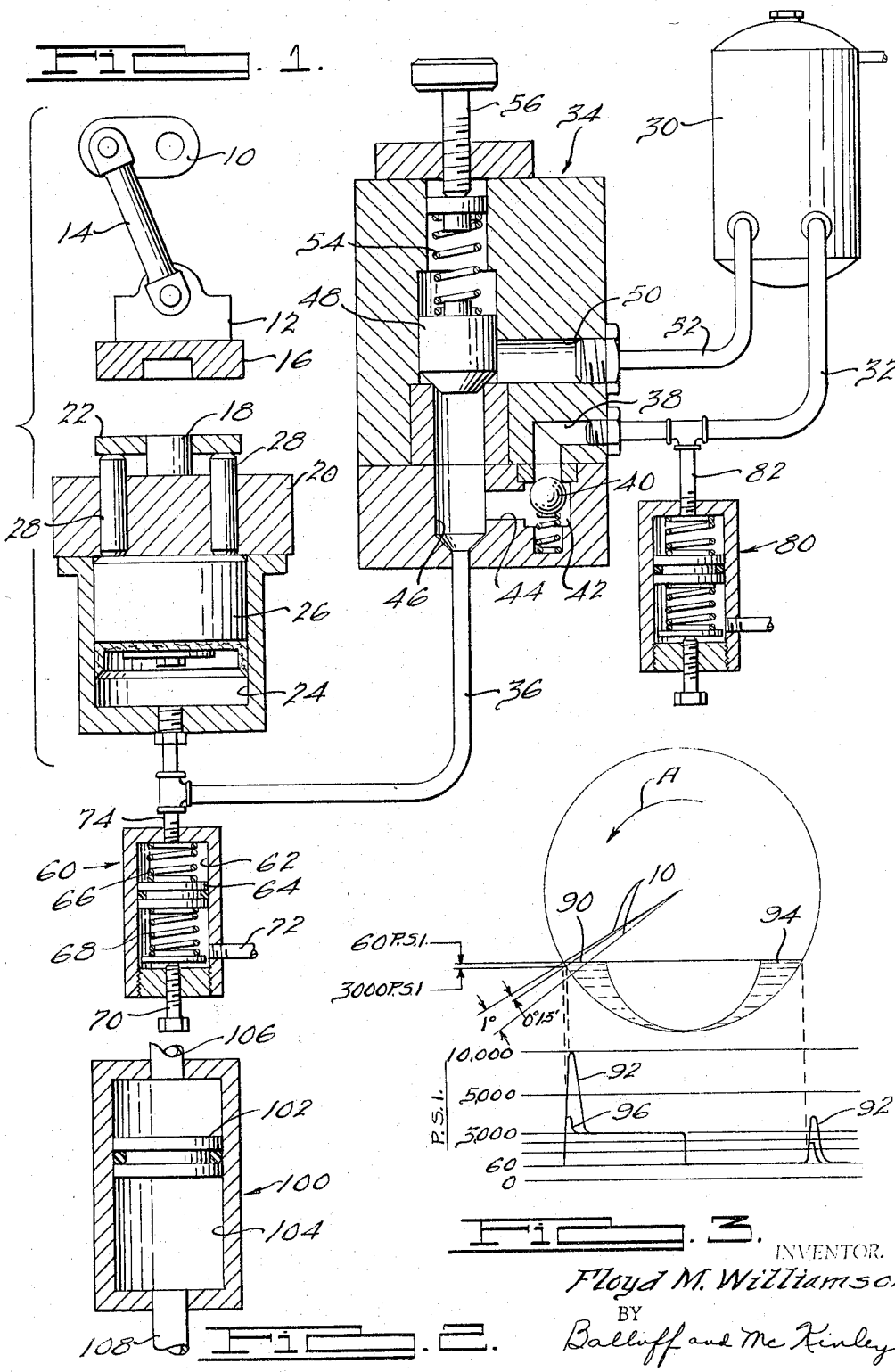


FIG. 1.

FIG. 3.

FIG. 2.

INVENTOR.
Floyd M. Williamson.
BY
Ballluff and McKinley
ATTORNEYS.

United States Patent Office 3,290,034 Patented Dec. 6, 1966

3,290,034

HYDRAULIC CONTROL FOR DIE PADS IN PRESSES

Floyd M. Williamson, Detroit, Mich., assignor to Di-Dro Engineering Company, Detroit, Mich., a corporation of Michigan

Filed Dec. 31, 1964, Ser. No. 422,783
5 Claims. (Cl. 267—1)

This invention relates to hydraulic cushions for movable die members in a crank type press and has particular reference to a hydraulic control system for such a press having provisions for substantially reducing or eliminating the shock which normally occurs in the hydraulic fluid connections at the moment of impact of the ram of the press against the movable die member or die pad and the shock which occurs upon abrupt stoppage of the flow of hydraulic fluid during the return stroke of the ram.

In a crank type press the ram reaches its highest velocity during its working stroke at some point after the crank has moved 90° past top dead center, and the ram velocity decelerates thereafter to a dwell at the bottom of its working stroke and accelerates from the bottom of the stroke on its return movement. In crank type presses employing a hydraulic cushion in which a reciprocating piston reacts against a movable die pad to hold the same in its extended position and to provide a predetermined resistance to retraction of the die pad under impact of the ram, the die pad and the piston which reacts against it are put in motion during the working stroke of the ram with an impact at high speed which means that all of the hydraulic fluid in the hydraulic cushion cylinder and the lines leading back to the supply tank will be put in motion at maximum velocity which causes an extreme back pressure on the system until the velocity of the hydraulic fluid increases or picks up momentum. The shock in the hydraulic fluid flow connections caused by this impact and initial high back pressure causes the joints and couplings to loosen and ultimately leak. The invention therefore contemplates the provision of a shock absorber or dampener connected directly to the hydraulic cushion cylinder to substantially reduce the effects of the impact of the ram on the die pad and the shock in the connections resulting therefrom.

As the ram begins its return stroke its velocity increases from zero to a maximum as the hydraulic cushion cylinder is refilled with oil to return the die pad to its extended position. This means that the velocity and volume of flow of hydraulic fluid are at their maximum on the return stroke at the moment the cylinder becomes completely filled and flow is abruptly stopped. The momentum of the flowing oil at the instant of abrupt stoppage of flow when flow velocity is at its maximum likewise causes considerable shock in the supply lines and fluid flow connections which ultimately leads to their deterioration. The invention therefore also provides a shock absorber or dampener in the supply line leading from the supply tank back to the hydraulic cushion cylinder for reducing the effects of abrupt stoppage of the flow of oil when its velocity and momentum are high.

A principal object of the present invention is to provide a means for reducing the shocks which normally occur in hydraulic fluid flow connections between the supply tank and hydraulic cushion cylinder in a crank type press having movable die pads provided with hydraulic cushions.

Another object of the invention is to provide a hydraulic shock absorber or dampener in a hydraulic control system of the kind described for reducing the effects of ram impact and the attempt to instantaneously put a large volume of hydraulic fluid in motion at high velocity.

A further object of the invention is to provide a hydraulic control system of the type described including provisions for reducing shocks in the system resulting from abrupt stoppage of hydraulic fluid flow when its velocity and momentum are at a maximum.

Another object of the invention is to provide a new and improved hydraulic cushion for crank type presses including hydraulic shock absorbing means which renders the control system more suitable for use at high press speeds and in systems having relatively large volume hydraulic cushions.

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 drawings which by way of illustration show preferred embodiments 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.

In the drawings:

FIG. 1 is a schematic illustration of a hydraulic control system for crank type presses embodying the present invention;

FIG. 2 is a fragmentary sectional view of a modified form of shock absorbing device which may be employed; and

FIG. 3 is a diagram which relates crank movement to hydraulic fluid flow velocity, displacement, and pressure.

A hydraulic control system embodying the present invention is adapted for use on a crank type press which includes a crank **10** and a reciprocating ram **12** connected to the crank **10** by a pitman **14**. A die **16** movable with the ram **12** is adapted to engage a workpiece resting upon a fixed die member **18** mounted on a bolster **20** and a movable die pad **22** which is backed up by a hydraulic cushion which includes a cylinder **24** having a piston **26** reciprocable therein and reacting against the die pad **22** by means of plungers or rods **28**.

The cylinder **24** is supplied with hydraulic fluid under relatively low pressure, for example, 60 lbs. per square inch, from a supply tank **30**. A hydraulic fluid flow connection **32** leads from the supply tank **30** to a valve indicated generally at **34**, and a line **36** leads from the valve **34** to the lower end of the hydraulic cushion cylinder **24**. The line **32** communicates with a passage **38** in the valve **34** which has a ball check valve **40** therein disposed within a chamber **42** which communicates through passages **44** and **46** with the line **36**. Hydraulic fluid from the tank **30** flows through line **32** past check valve **40** to line **36** into cylinder **24** to move the piston **26** and the die pad **22** to its extended position as illustrated in FIG. 1.

The valve **34** includes a pressure relief valve **48** which is adapted to close communication between the passage **46** and a cross passage **50** which communicates with a line **52** leading back to the supply tank **30**. As the ram **16** engages the die pad **22**, the piston **26** is retracted into cylinder **24**, forcing hydraulic fluid from the cylinder through the line **36** into the valve **34**. The check valve **40** prevents return flow through the line **32**, and the hydraulic fluid displaced from the cylinder **24** is returned to the tank **30** through passage **46** past the pressure relief valve **48** into cross passage **50** and line **52**. The pressure relief valve **48** is held against its seat by a spring **54** which is backed up by an adjustment screw **56** so that the valve **48** will open at a predetermined relatively high pressure, such as 3000 lbs. per square inch, thereby providing a predetermined resistance to movement of the die pad **22**.

A hydraulic shock absorber or dampener **60** includes a cylinder **62** having a piston **64** reciprocable therein and urged toward a neutral position by springs **66** and **68**, the latter spring being adjustable by means of a screw **70**.

In addition, the lower end of the cylinder **62** is communicated by means of a line **72** with atmosphere or with air under a suitable pressure. The cylinder **62** communicates directly with the hydraulic cushion cylinder **24** through a connection **74**. The resistance to movement of the piston **64** in the shock absorbing device afforded by the spring **68** is less than the resistance provided by the pressure relief valve **48** so that upon impact of the ram, hydraulic fluid from the hydraulic cushion cylinder **24** can flow into the cylinder **62** prior to opening of the pressure relief valve **48** to prevent the extreme back pressure built up by ram impact and the attempt to put a large volume of oil into motion instantaneously at high velocity. The hydraulic dampener thus substantially reduces the shocks that would otherwise occur in the hydraulic connections resulting from ram impact.

A similar hydraulic shock absorber **80** is provided in the supply line **32** leading from the tank **30** and is connected into the line **32** by a connection **82**. As described above, the return flow of oil from the tank **30** to the hydraulic cushion cylinder **24** increases in velocity and momentum as the piston **26** approaches its extended position due to the fact that the ram accelerates from its bottom dead center position on its return stroke and the returning oil achieves considerable momentum which causes severe shocks in the hydraulic connection when the return flow is abruptly shut off as the piston **26** reaches its fully extended position. The hydraulic shock absorber **80** which is connected into the line **32** between the supply tank and the check valve **40** will absorb the shocks in the system which would otherwise occur when the accelerating oil flow is abruptly cut off. The construction of the shock absorber **80** may be the same as the shock absorber **60** although the force of the springs therein may be differently adjusted in accordance with the lower pressures that exist in the supply line **30**.

FIG. 3 is a diagrammatic illustration of the effects of ram impact during the working stroke of the press and the momentum built up in the supply lines during return movement of the ram in existing press control systems employing hydraulic cushions. In the diagram the crank rotation is indicated by the arrow A and the shaded area represents the flow pattern of the oil as it is displaced from and returned to the hydraulic cushion cylinder **24** during a cycle of operation. The line **90** indicates the point during the working stroke of the ram when impact occurs. Just prior to impact the pressure in the cylinder **24** which reacts against the die pad **22** is 60 p.s.i. The lower portion of the diagram illustrates the pressures that exist during a cycle of operation. With a press operating at 60 strokes per minutes and having a relatively large volume hydraulic cushion, the pad pressure will rise from 60 lbs. per square inch at impact to about 3000 lbs. per square inch after the crank **10** has traveled 0°15′ past the point of impact. As shown by the curve **92**, the impact of the ram and the attempt to place a large volume of oil in motion substantially instantaneously cause the pressure to rise to about 10,000 lbs. per square inch as the crank **10** approaches 1° of travel beyond impact. Thereafter the pressure drops rapidly until it levels off at 3000 lbs. per square inch, or whatever value the pressure relief valve **48** is set for, until bottom dead center is reached, when the pressure again drops to the pressure existing in the supply tank **30** or 60 lbs. per square inch.

As the ram begins its return movement, oil flows through the supply line **32** past check valve **40** into the hydraulic cushion cylinder **24** under a pressure of 60 lbs. per square inch. During this time, however, the volume of oil flow per degree of travel of the crank is rapidly increasing due to the accelerated motion of the ram, and when the cylinder **24** is completely filled there is an abrupt cutoff of oil flow as indicated at **94** in the diagram of FIG. 3. However, as shown by the right-hand portion of the curve **92**, the pressure rises very rapidly after the

abrupt cutoff of oil flow due to the momentum of the large volume of oil that is flowing through the supply line at the moment of cutoff. The excessive pressure rises indicated by the curve **92** of FIG. 3 at and shortly after the moment of impact of the ram and after the abrupt cutoff of oil flow when the hydraulic cushion cylinder is completely filled will cause excessive shock and vibrations in the fluid flow connections in a hydraulic control system of this type which is not provided with the hydraulic shock absorbers of the present invention. The elimination of such excessive pressures during the working stroke of the ram improves the performance of the entire control system and insures that the pressure relief valve will open at the pressure for which it is set to obtain efficient die action. At the same time the life of the hydraulic connections and fittings is greatly extended due to the substantial reduction in shock and vibration provided by the shock absorbing devices.

The shock absorbers are particularly suitable in presses of the type described when the hydraulic cushion is of relatively large volume so that a large volume of oil must be moved through the connections in a very short time. However, the same pressure increases exist in small capacity hydraulic cushions, although to a lesser extent as indicated by the curve **96** in FIG. 3.

In FIG. 2 there is illustrated a modified shock absorbing device **100** in which a piston **102** is reciprocable within a cylinder **104**, one end of which is connected by a line **106** into the hydraulic fluid flow connection and the other end of which is connected by a line **108** to a source of air or other fluid under pressure. In either form of the invention the pressure exerted on the piston to resist movement thereof is controlled and set at a desired value to achieve the desired reduction in pressure in the hydraulic control system at ram impact and upon stoppage of the return flow.

While I have illustrated and described preferred embodiments of my invention, it is understood that these are 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 crank type press having a ram and a movable die and in which the die is contacted by the ram during that portion of its stroke in which its velocity is relatively high and is decelerating, and a hydraulic cushion for the die including a hydraulic cylinder having a piston therein reacting against said die, a tank of hydraulic fluid under relatively low pressure, a hydraulic connection between said tank and said cylinder for supplying hydraulic fluid under tank pressure to said cylinder to bias said die to its extended position, means preventing return flow through said connection, a second hydraulic connection between said tank and cylinder through which hydraulic fluid flows from said cylinder to said tank as said die is retracted upon closing of the press, a pressure relief valve in said second connection to provide a predetermined resistance to displacement of hydraulic fluid from said cylinder upon closing of the press, a hydraulic shock absorber communicating directly with said cylinder to allow displacement of hydraulic fluid from said cylinder into said shock absorber prior to opening of said pressure relief valve to reduce shock in said connection caused by the impact of the ram on the die at said high velocity, and a hydraulic shock absorber in said first connection into which hydraulic fluid flowing from said tank to said cylinder upon opening of the press may be discharged to reduce the shock in said connections caused by the momentum of the hydraulic fluid flowing through said first connection and the abrupt stoppage of flow of fluid when said die reaches its fully extended position.

2. In a crank type press having a ram and a movable die and in which the die is contacted by the ram during that portion of its stroke in which its velocity is relatively

high and is decelerating, and a hydraulic cushion for the die including a hydraulic cylinder having a piston therein reacting against said die, a tank of hydraulic fluid under relatively low pressure, a hydraulic connection between said tank and said cylinder for supplying hydraulic fluid under tank pressure to said cylinder to bias said die to its extended position, means preventing return flow through said connection, a second hydraulic connection between said tank and cylinder through which hydraulic fluid flows from said cylinder to said tank as said die is retracted upon closing of the press, a pressure relief valve in said second connection to provide a predetermined resistance to displacement of hydraulic fluid from said cylinder upon closing of the press, a hydraulic shock absorber comprising a chamber communicating directly with said cylinder, a piston reciprocable in said chamber, and means yieldably resisting movement of said piston in said chamber to allow displacement of hydraulic fluid from said cylinder directly into said chamber prior to opening of said pressure relief valve to reduce shock in said connections caused by the impact of the ram on the die at said high velocity.

3. In a crank type press having a ram, a movable die and a hydraulic cushion for the die including a hydraulic cylinder having a piston therein reacting against said die, a tank of hydraulic fluid under relatively low pressure, a hydraulic connection between said tank and said cylinder for supplying hydraulic fluid under tank pressure to said cylinder to bias said die to its extended position, means preventing return flow through said connection, a second hydraulic connection between said tank and cylinder through which hydraulic fluid flows from said cylinder to said tank as said die is retracted upon closing of the press, a pressure relief valve in said second connection to provide a predetermined resistance to displacement of hydraulic fluid from said cylinder upon closing of the press, a hydraulic shock absorber in said first connection comprising a chamber and a piston reciprocable therein and means resisting displacement of said piston whereby hydraulic fluid flowing from said tank to said cylinder upon opening of the press may be discharged into said chamber to reduce the shock in said connections caused by the momentum of the hydraulic fluid flowing through said first connection and the abrupt stoppage of flow of fluid when said die reaches its fully extended position.

4. In a crank type press having a ram and a movable die and in which the die is contacted by the ram during that portion of its stroke in which its velocity is relatively high and is decelerating, and a hydraulic cushion for the die including a hydraulic cylinder having a piston therein reacting against said die, a tank of hydraulic fluid under relatively low pressure, a hydraulic connection between said tank and said cylinder for supplying hydraulic fluid under tank pressure to said cylinder to bias said die to its

extended position, means preventing return flow through said connection, a second hydraulic connection between said tank and cylinder through which hydraulic fluid flows from said cylinder to said tank as said die is retracted upon closing of the press, a pressure relief valve in said second connection to provide a predetermined resistance to displacement of hydraulic fluid from said cylinder upon closing of the press, a hydraulic shock absorber comprising a chamber communicating directly with said cylinder, a piston reciprocable in said chamber and means yieldably resisting movement of said piston in said chamber to allow displacement of hydraulic fluid from said cylinder directly into said chamber prior to opening of said pressure relief valve to reduce shock in said connection caused by the impact of the ram on the die at said high velocity, a hydraulic shock absorber in said first connection comprising a second chamber and a piston reciprocable therein and means resisting displacement of said piston whereby hydraulic fluid flowing from said tank to said cylinder upon opening of the press is discharged into said second chamber to reduce the shock in said connections caused by the momentum of the hydraulic fluid flowing through said first connection and the abrupt stoppage of flow of fluid when said die reaches its fully extended position.

5. In a crank type press having a ram and in which the die is contacted by the ram during that portion of its stroke when its velocity is relatively high and is decelerating, and a movable die and a hydraulic cushion for the die including a hydraulic cylinder having a piston therein reacting against said die, a tank of hydraulic fluid under relatively low pressure, a hydraulic connection between said tank and said cylinder for supplying hydraulic fluid under tank pressure to said cylinder to bias said die to its extended position, means preventing return flow through said connection, a second hydraulic connection between said tank and cylinder through which hydraulic fluid flows from said cylinder to said tank as said die is retracted upon closing of the press, a pressure relief valve in said second connection to provide a predetermined resistance to displacement of hydraulic fluid from said cylinder upon closing of the press, and hydraulic shock absorbing means communicating directly with said cylinder and into which hydraulic fluid flows from said cylinder prior to opening of said pressure relief valve to reduce shock in said connections caused by the impact of the ram on said die at said high velocity, and to reduce the shock in said connections caused by the momentum of the hydraulic fluid and the abrupt stoppage of fluid flow when said die reaches its fully extended position.

No references cited.

ARTHUR L. LA POINT, *Primary Examiner.*

R. M. WOHLFARTH, *Assistant Examiner.*