Sept. 2, 1969 R. A. RICHARDSON 3,464,320

DECOMPRESSION SYSTEM FOR PRESS BRAKES OR THE LIKE

Filed May 16, 1967 2 Sheets-Sheet 1

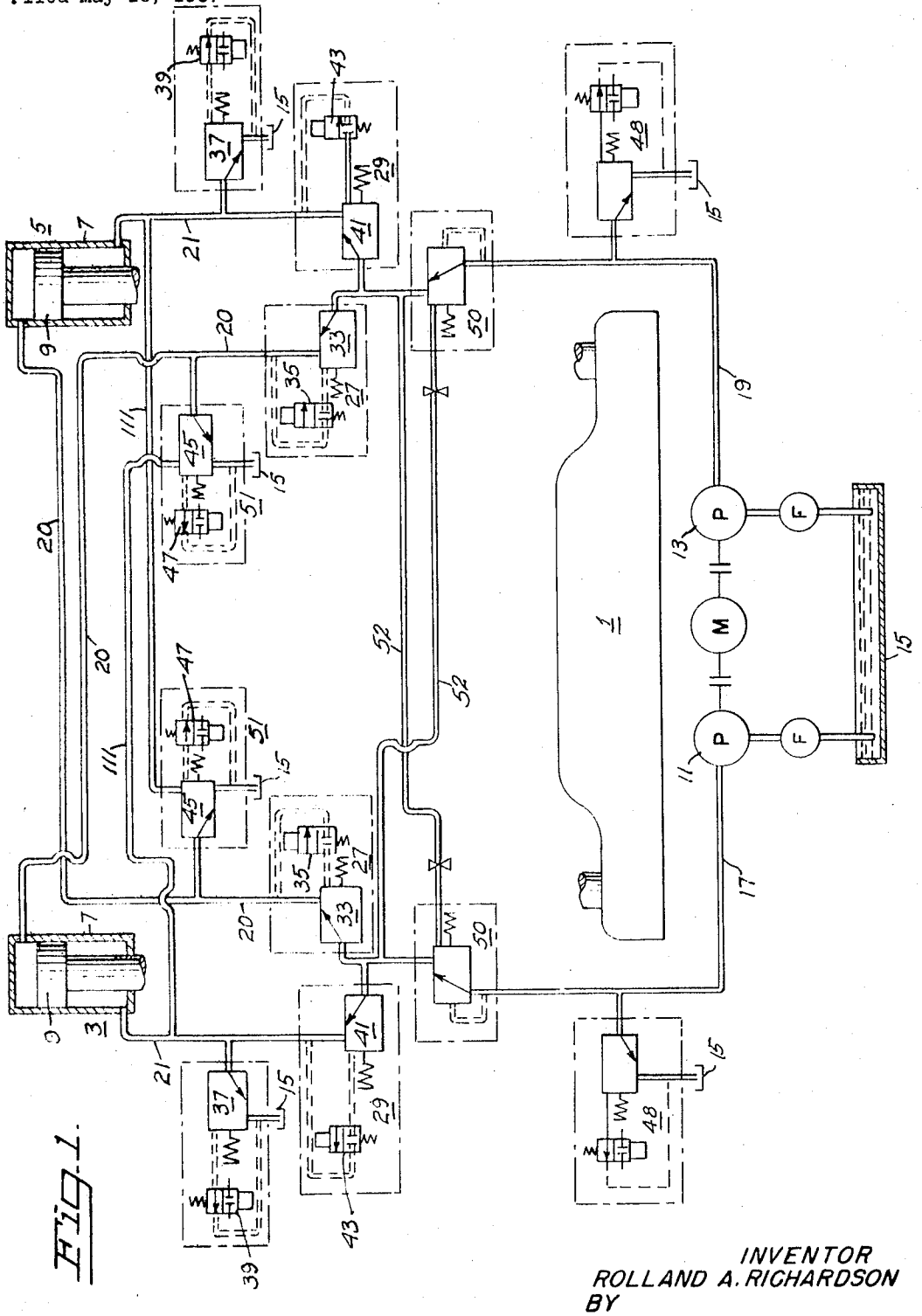

FIG. 1.

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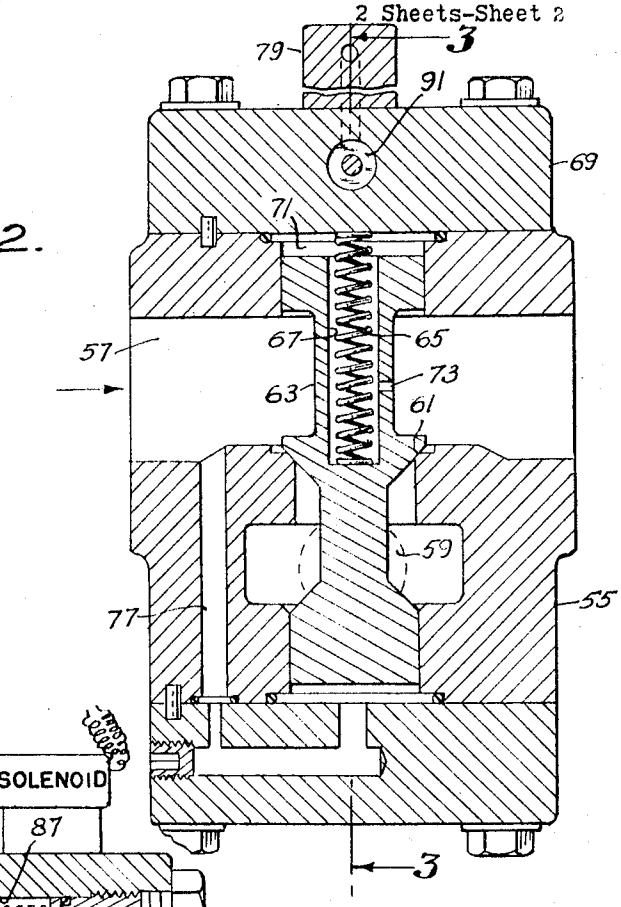
Fig. 2.



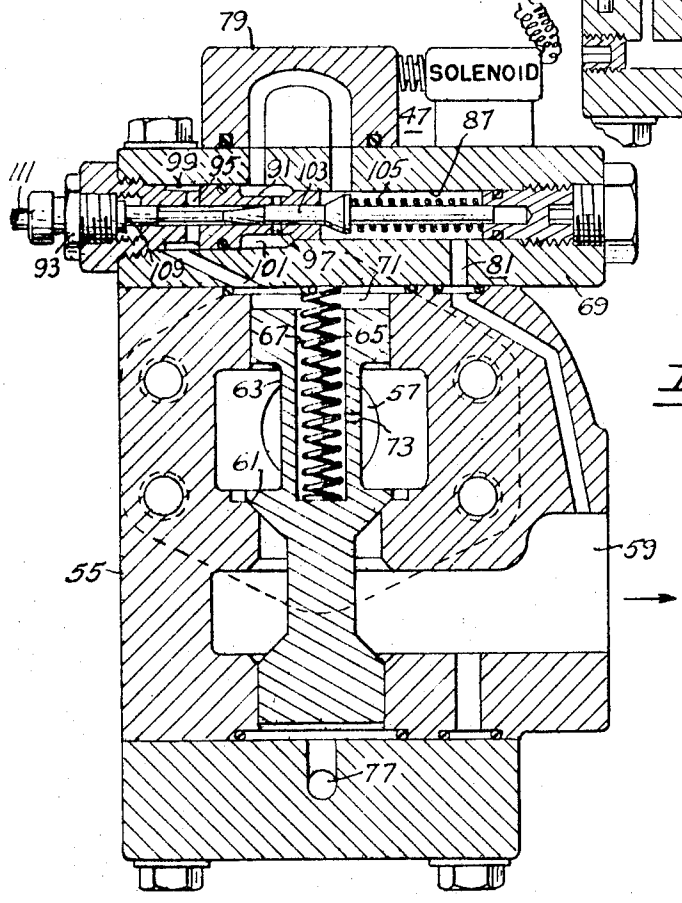


Fig. 3.

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DECOMPRESSION SYSTEM FOR PRESS BRAKES OR THE LIKE

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U.S. Cl. 91—420 6 Claims

ABSTRACT OF THE DISCLOSURE

On the return stroke in a hydraulically actuated press brake, discharge from the upper ends of the hydraulic motors is throttled should movement of the pistons exceed the ability of the pumps to normally produce such movement.

The invention relates to hydraulic press brakes or the like, and more particularly, to the hydraulic drive system for such machines, and will be described in connection with the operation of a hydraulic press brake.

In the use of a press brake for rubber pad forming, the ram must penetrate and compress a heavy rubber pad during the forming operation. On the return stroke, the spring back of the rubber can mechanically drive the ram back at a rate faster than normal, and this is particularly likely if the load is off center, as this can cause one end of the ram to initiate a faster return than the other, thus unbalancing or cocking the ram and bringing about an unstable return. This situation can develope also when operating on "springy" steels.

Interpreted in terms of the drive pistons of a hydraulically driven machine, this means that the "guilty" piston is mechanically driven back at a rate faster than can be sustained by the liquid from the pump to the lower end of the associated hydraulic motor cylinder. Thus, under these conditions, a lower than normal hydraulic pressure will exist in the cylinder.

Among the object of my invention are:

(1) To provide a novel and improved hydraulic press brake or the like.

(2) To provide a novel and improved drive system for a hydraulic press brake or the like.

(3) To provide a novel and improved hydraulic drive system for a press brake or the like which can overcome the effects of spring back of a ram during a return stroke, and thereby assure a stable condition during such return stroke of the ram.

Additional objects of my invention will be brought out in the following description of a preferred embodiment of the same, taken in conjunction with the accompanying drawings wherein:

FIGURE 1 is a schematic view of a hydraulic system for a press brake or the like, incorporating the features of the present invention;

FIGURE 2 is a view in section through a valve assembly constituting an important feature of the present invention; and

FIGURE 3 is a view in section taken in the plane 3—3 of FIGURE 2.

Referring to the drawings for details of my invention in its preferred form, I have depicted in outline the ram 1 of a machine, and displaced therefrom on the drawings, a pair of hydraulic motors 3 and 5, each comprising a cylinder 7 and an included drive piston 9, it being understood that each motor will be coupled to a different end of the ram.

These drive motors are supplied with liquid from a pair

of pumps 11 and 13, which in turn, draw liquid from a tank 15, each pump having a discharge line 17, 19 respectively, with a flow connection in the form of a branch line 20, to the upper end of one of the hydraulic motor cylinders 7, and another branch line 21 to the lower end of the other motor cylinder. Expressed in other words, one branch line 20, extends to the drive side of one piston, while the other branch line 21 extends to the lift side of the other piston.

Selectively operable valve means in the form of a solenoid controlled valve 27 in one branch line, and a solenoid control valve 29 in the other branch line, from each pump will cause each pump to supply power to one hydraulic motor for a work stroke and power to the other hydraulic motor for a return or lift stroke. This has the advantage over a system where each pump supplies the power for both the work stroke and the lift stroke, to the same hydraulic motor, for such system necessitates a reversing of the hydraulic lines to each hydraulic motor when changing from a work stroke to a lift stroke, which in turn requires a corresponding reversal of lines in a levelling system, if incorporated in such system.

To control the "down" or work stroke, a normally closed valve 33 under control of a normally closed solenoid pilot valve 35, is connected in each line 20, while a similar valve 37 under control of a normally open solenoid pilot valve 39 is connected from the line 21 to tank. This valve 37 is normally adjusted to open in response to hydraulic pressure above that necessary to support the ram in its idle position, and with the valve 33 open, will permit a work stroke of the ram. Energization of the pilot valve 39 permits of a faster work stroke.

For the return stroke, a normally closed valve 41 controlled by a normally closed solenoid pilot valve 43, is connected in each line 21, while a similar valve 45 controlled by a normally open solenoid pilot valve 47, is connected from each line 20 to tank.

A relief valve assembly 48 in shunt to each pump, functions in response to an overload on the pump, to connect the overloaded pump to tank, and thus by-pass the overload and protect the pump.

In each pump discharge line, is a blocking valve assembly 50, which is so designed as to normally open in accordance with the work load on the pump which is feeding liquid therethrough. The resistance to opening of such valve may be controlled in part by a flow connection from the discharge line of the other pump, at a point down stream of the blocking valve in that line, whereby the flow connection will transmit the load pressure from the one discharge line to the control element in the blocking valve in the other discharge line. With such an arrangement, each blocking valve will respond to the load condition at the far end of the ram, to so adjust the loading on its associated pump as to maintain substantially equal loading on the pumps, despite any unbalancing of the work load on the hydraulic motors.

A system of the character described may be found in my copending application for Ram Attitude Control System, Ser. No. 543,864 filed Apr. 20, 1966, now Patent 3,349,669 of Oct. 31, 1967, in which reference is made to an earlier patent of mine for Precision Control System for Press Brakes or the Like, No. 2,906,096 of Sept. 29, 1959.

To incorporate the present invention into a system such as disclosed in either of the aforementioned application or patent, the valve 45 and pilot valve 47 become part of a modified valve assembly 51 which remains part of the stroke reversing means controlling each hydraulic motor.

Structurally, such valve assembly may include a valve housing 55 having an offset main flow passageway there-

through, the input end **57** for flow connection to a pump discharge line **20**, while the discharge end **59** is connected to tank **15**. At an intermediate point in the main flow passageway, is a valve seat **61** against which a spool shaped main valve **63** is normally seated by a biasing spring **65** housed in a recess **67** in the valve and bearing against a head section **69** to create a small chamber **71**, adjacent that end of the valve. A small opening **73** through the wall of the recess, permits liquid communication with the inlet **57** of the main passageway, whereby hydraulic pressure may accumulate in the spring recess and the small chamber above to assist the spring in maintaining closing pressure on the main valve.

An auxiliary passageway **77** from the input end of the main flow passageway to the opposite end of the spool shaped main valve, will bring pump pressure to bear against this end of the valve in opposition to the pressure build-up in the spring recess due to the combined liquid pressure and that of the main valve biasing spring. The normal differential pressure will be in the direction of seating the main valve. Any release of the hydraulic pressure assisting the spring will reverse the differential pressure on the main valve, which will then be in the direction of opening such valve.

Slidably mounted on the head section is the valve **79** of the pilot valve assembly **47**. Release of hydraulic pressure from the chamber **71** is normally provided by this solenoid actuated valve assembly **47**, which is adapted to open or close a by-pass passageway **81** about the main valve, from the chamber, such by-pass passageway including the opening **73**, chamber **71**, the solenoid valve **79**, and a return passageway in the main valve housing **55** which terminates at the discharge end **59** of the main valve passageway.

In accordance with the present invention, this by-pass passageway, in part, passes from the chamber **71** through the head section **69** and the pilot valve, then back through the head section and main valve casing to the outlet end of the main valve passageway.

This head section is provided with a longitudinal bore **87** intercepting the bypass passageway. In this bore is disposed a monitoring valve assembly for adjustably interrupting the by-pass passageway, whereby to independently control flow through the by-pass passageway, when the solenoid controlled valve is in its depicted position to complete the by-pass passageway.

The monitoring valve assembly includes a valve sleeve **91** installed at one end of the bore with its exposed end recessed to receive a tube fitting **93**. At spaced longitudinal points, the sleeve has passages **95**, **97** diametrically therethrough, each connecting with an annular chamber **99**, **101** respectively about the sleeve, both annular chambers being thus flow connected by way of the diametrical passages and the longitudinal passageway of the sleeve.

One of these diametrical passages **97** is adapted to be blocked off by a spool valve **103**, normally biased to its blocking position by a biasing spring **105**.

The monitor spool valve tapers at its free end to a stem of smaller diameter than the sleeve passageway, and terminates beyond the remaining diametrical passage **95** in a piston **109** slidably fitting the sleeve passage and of a length to abut the inner end of the tube fitting **93**. Any pressure exerted through the tube fitting against the piston, if of sufficient magnitude to overcome the pressure of the biasing spring **105**, will cause the monitor valve to shift to a position where it will adjustably unblock the diametrical passage **97** in varying degrees in accordance with the pressure applied against the piston.

A flow connection **111** to the tube fitting end of the monitor valve assembly, from the lower end of the cylinder **7**, whose discharge, the main valve **63** is to control, will place the monitor valve in pressure sensing relationship to the instantaneous pressure prevailing in the lower portion of the cylinder during a return stroke.

With conditions normal in the lower portion of the hydraulic motor cylinders, a hydraulic pressure will prevail beneath the pistons, of a magnitude sufficient to overcome the resistance of the biasing spring **105** in the monitor valve assembly, and permit the monitor valve **103** to open, thereby enabling the solenoid controlled valve **79** to function effectively in relieving the hydraulic pressure on the upper end of the main valve, causing the main valve to open to permit full discharge flow from the upper end of the associated cylinder during the return stroke.

On the other hand, should the return movement of a piston be at a rate in excess of that capable of being handled by the pump, a reduced pressure will develop in the lower end of the cylinder of a value insufficient to overcome the resistance of the biasing spring, whereby the monitor valve under the circumstances will move toward its blocking position, thus rendering the solenoid control valve more or less ineffective to open the main valve, whereby continued return movement of the piston will be stifled in accordance with the inability of the liquid in the upper end of the cylinder to escape. Such slow down of the piston will permit the pump to build up pressure in the cylinder and unblock the relief passage **81** through the solenoid controlled valve and enable the main valve to open.

From the foregoing description of my invention in its preferred form, it will be apparent that the same is subject to alteration and modification without departing from the underlying principles involved, and I accordingly do not desire to be limited in my protection to the specific details illustrated and described except as may be necessitated by the appended claims.

I claim:

1. A hydraulic press brake or the like comprising a ram having a substantial horizontal dimension, a hydraulic system for driving said ram, said hydraulic system including a plurality of spaced apart hydraulic motors, each including a cylinder and associated piston therein coupled to said ram, pump means, a flow connection from the pressure side of said pump means to the upper end of each of said cylinders with a flow connection from the lower end of each of said cylinders to the intake side of said pump means, whereby liquid will enter the cylinders at their upper ends and discharge from their lower ends to produce a work stroke of said ram, means for reversing the flow to said cylinders to cause liquid to enter the lower ends thereof and discharge from their upper ends to produce a return stroke of said ram, said flow reversing means including a valve assembly for each of said hydraulic motors, and means, during a return stroke of each piston, for variably throttling discharge flow from its associated cylinder through its associated valve assembly when return movement of a piston exceeds that producible by normal pump feed of liquid to its associated cylinder, said variable throttling at each cylinder being in accordance with such excessive return movement of the piston in such cylinder to maintain the prevailing attitude of said ram during a return stroke and prevent cocking thereof.

2. A hydraulic press brake or the like as recited in claim **1**, characterized by each said throttling means being responsive to a deficiency of liquid pressure on the intake side of a particular piston.

3. A hydraulic press brake or the like as recited in claim **1**, characterized by each said valve assembly having a main flow passageway included in a flow connection from a cylinder upper end to the intake side of a pump means, a main valve in said passageway and adapted in its seating position, to close said main passageway, means normally seating said valve, and means for unseating said main valve to initiate a return stroke.

4. A hydraulic press brake or the like as recited in claim **3**, characterized by each of said throttling means rendering said main valve unseating means substantially impotent in response to and during a deficiency of liquid

pressure on the intake side of the piston controlled by such throttling means.

5. A hydraulic press brake or the like as recited in claim 4, characterized by each of said main valve unseating means as including a pilot valve in pressure relieving relationship to the main valve.

6. A hydraulic press brake or the like as recited in claim 5, characterized by each of said throttling means as including a monitoring valve intercepting the pressure relieving relationship between said pilot valve and said main valve, said monitoring valve being in pressure sensing relationship to the prevailing pressure in the lower end of the cylinder whose piston is being controlled thereby.

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