Oct. 22, 1963 P. J. LINDNER 3,107,567

HYDRAULIC BLANKING PRESS

Filed July 15, 1960 2 Sheets-Sheet 1

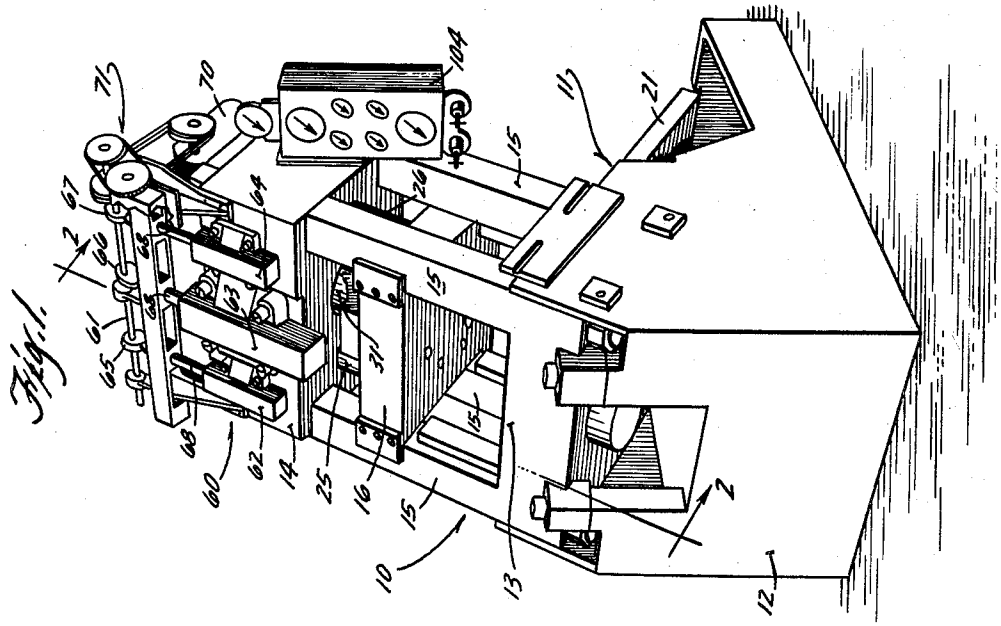

Fig. 1.

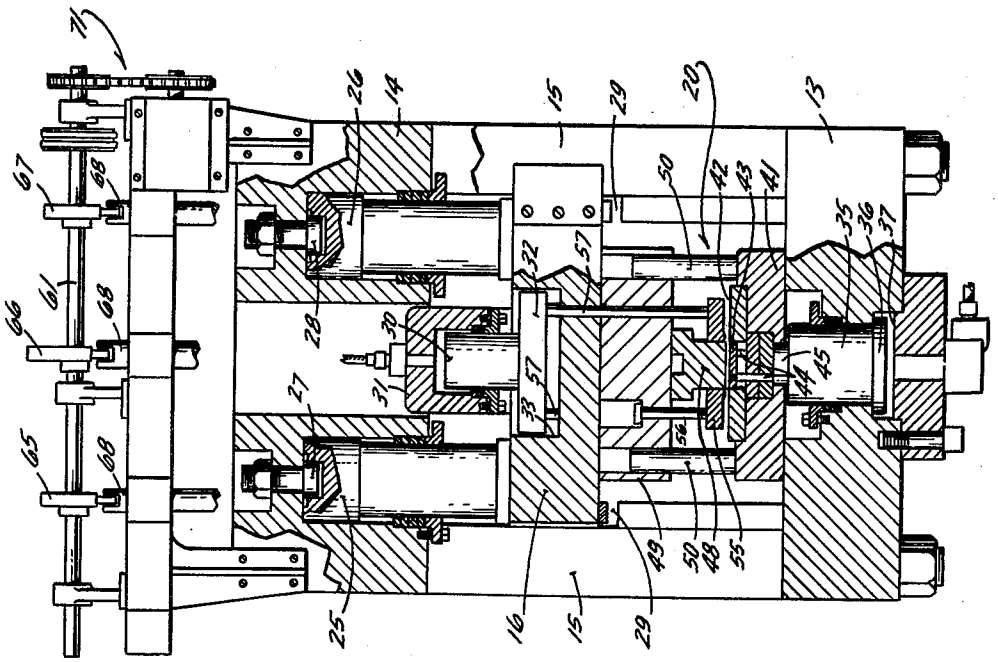

Fig. 2.

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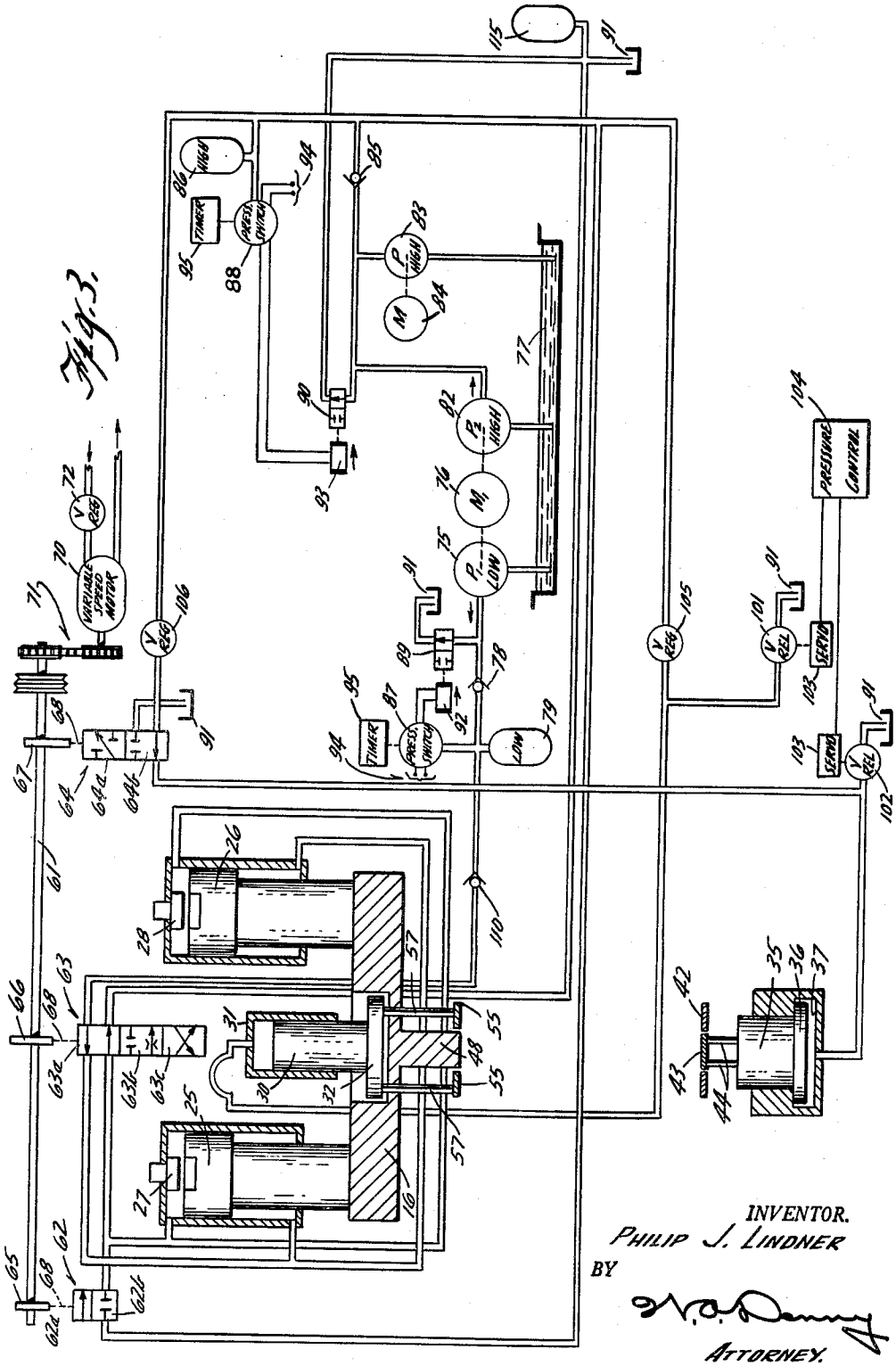

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3,107,567

HYDRAULIC BLANKING PRESS

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4 Claims. (Cl. 83—124)

This invention relates to hydraulic blanking presses and concerns, more particularly, a control and operating system for such presses.

In recent years, increased attention has been given the use of triple-action presses for blanking or punching operations. A "triple-action" press first clamps the stock rigidly, secondly, squeezes the work piece portion of the stock and thirdly, separates the work piece from the stock. The stock material is thus under compression during the blanking operation and, as a result, the work piece shears cleanly from the stock, eliminating the need for a secondary shaving or trimming operation.

Hydraulic pressure is particularly well suited for triple-action presses since it allows the required critical adjustment of pressures to obtain the proper compression of the material for effective operation. In addition, hydraulic presses have other inherent advantages over mechanical presses such as making die shimming adjustments unnecessary. However, hydraulic triple-action presses have not heretofore been capable of high speed operation and hence their commercial use has been limited.

It is, therefore, the primary aim of the present invention to provide a very high speed, triple-action hydraulic blanking press.

A collateral aim of the invention is to provide such a press having a shock-free driving system despite the high speeds of operation capable of being obtained.

It is also an object of the invention to provide a press as characterized above in which precise adjustments of the pressures developed and of the operating speed and sequence can be made so that the press is exceptionally versatile and flexible in operation and hence well suited for commercial use.

Moreover, it is an object to provide a press of the above type which is simple to adjust and operate.

It is also an object to provide a press as described above which is economical in design so as to be relatively inexpensive to both manufacture and operate.

Other objects and advantages of the invention will become apparent upon reading the following detailed description and upon reference to the drawings in which:

FIGURE 1 is a perspective view of a press embodying the invention;

FIG. 2 is a fragmentary section taken approximately along the line 2—2 of FIG. 1; and

FIG. 3 is a schematic diagram showing the control and operating system embodied in the press appearing in FIG. 1.

While the invention will be described in connection with a preferred embodiment, it will be understood that I do not intend to limit the invention to that embodiment. On the contrary, I intend to cover all alternatives, modifications and equivalents as may be included within the spirit and scope of the invention as defined by the appended claims.

Turning first to FIG. 1, there is shown a hydraulic blanking press **10** embodying the invention and including a frame **11** made up of a base **12**, a table **13** and a head **14** supported above the table by a plurality of posts or columns **15**. A reciprocating platen **16** is mounted on slide portions of the columns **15** for movement perpendicularly with respect to the table **13**. A blanking die set **20** is mounted between the table **13** and the relatively movable platen **16** (see FIG. 2).

As a feature of the invention, the table **13** is sharply inclined with respect to a horizontal plane so as to facilitate stripping and clearing the work pieces from the press following the blanking operation. In the illustrated embodiment, the table **13** inclines rearwardly at approximately a 30° angle and a chute **21** is provided extending from a point adjacent the die set **20** on the table **13** rearwardly of the machine. In this way, once the work piece is cleared from the die set, it falls under the force of gravity onto the chute **21** and is easily discharged from the press.

For driving the platen **16**, a pair of double-acting main rams **25** and **26** are mounted in the press frame head **14** and are rigidly secured to the platen. The rams **25, 26** cooperate with hydraulic ram cushions **27, 28**, respectively, at their upper ends which limit upward travel of the platen **16** without shock. Sets of cooperating stops **29** limit downward movement of the platen.

The platen **16** carries a single-acting clamping ram **30** mounted within a housing **31** secured to the upper surface of the platen between the main rams **25, 26**. Upward movement of the ram **30** is limited by its fit within the housing **31**. Downward movement of the clamping ram is limited by engagement between a head **32** carried by the ram and the bottom of a recess **33** formed in the upper surface of the platen and within which the head **32** reciprocates.

Mounted within the press table **13** is a single-acting cushion ram **35** having a head portion **36** which reciprocates within a chamber **37**. The movement of the cushion ram **35** is limited by the confines of the chamber **37** within which the ram head **36** moves.

Hydraulic connections, shown in more detail in FIG. 3, are provided for hydraulically driving the clamping ram **30** in a downward direction, the cushion ram **35** in an upward direction, and the double-acting main rams **25, 26** in either an upward or a downward direction.

Turning now with more particularity to the die set **20**, the die set includes a base **41** fixed to the table **13** and carrying a die **42** having a central die opening. The die **42** surrounds a relatively movable die cushion **43** which fits closely within the die opening. A plurality of rods **44**, together with a block **45**, provide a direct thrust connection between the cushion **43** and the cushion ram **35**. When the cushion ram **35** is in its upward limit position, the upper surface of the cushion **43** is flush with the upper surface of the die **42**.

Operatively disposed above the die **42** is a punch **48** mounted on a block **49** which is guided for reciprocating movement relative to the die base **41** by a plurality of pins **50**. A thrust connection between the punch **48** and the platen **16** is provided by abutment of the platen with the upper surface of the block **49**.

For clamping the material during the blanking operation, a clamping plate **55** closely surrounds the punch **48** and is relatively movable with respect thereto. The clamping plate is suspended by headed pins **56** from the block **49**. A direct thrust connection between the clamping ram **30** and the clamping plate **55** is provided by a plurality of rods **57** slidably fitted both through the block **49** and the platen **16** so as to abut the head **32** carried by the clamping ram.

In accordance with the invention, operation of the press **10** is controlled by directing hydraulic fluid from both high and low pressure sources to the rams **25, 26, 30** and **35** through a bank **60** of cam controlled valves (see FIG. 1) operated in proper sequence by a plurality of cams phased on a single cam shaft **61**. The valve bank **60** is mounted on the press frame head **14** so that the valves are closely coupled to the main rams **25, 26** and the clamping ram **30** of the press and, in this way, ram reaction time is minimized and rapid op-

eration of the press is greatly facilitated. As will be explained below, the cushion ram 35 remains charged during most of the operating cycle and hence its relatively greater distance from the valve bank 60 has virtually no delaying effect on the operating speed of the press.

In the preferred embodiment, the valve bank 60 includes three valves 62, 63 and 64. With more specific reference to FIG. 3, the valve 62 is a two-position, two-connection shut-off valve having positions 62*a* and 62*b*. The valve 63 is a three-position, four-connection directional valve having positions 63*a*, 63*b* and 63*c*. The valve 64 is a two-position, three-connection directional valve having positions 64*a* and 64*b*.

The valves 62, 63, 64 are operated by cams 65, 66 and 67, respectively, through cam follower and push rod assemblies 68 (see FIGS. 1 and 2). It can be readily seen that the shape of the cams 65, 66, 67, and their angular phasing on the common cam shaft 41, dictates the proper sequence of operation for the press 10 and that the timing of the several rams which operate the press can be precisely and easily adjusted by simply adjusting the angular positions of the cams. The positive mechanical connections between the cam shaft 61 and the several valves in the valve bank 60 assures that a proper sequence of operation, once obtained, is maintained throughout the operating run of the press.

For driving the cam shaft 61, a variable speed motor 70 is mechanically coupled to the cam shaft through connections 71. A regulator valve 72 controls the input of hydraulic fluid under pressure to the motor 70 and thus dictates the speed at which the motor is driven. Since the operating speed of the press 10 is dictated by the rotational speed of the cam shaft 61, the press speed can be selected by simply adjusting the speed of the motor 70. Alternatively the speed of the cam shaft 61 could be varied by means of a mechanical speed reducer.

To provide a low-pressure, high-volume source of hydraulic fluid, a pump 75 is coupled to a motor 76 and connected by a hydraulic fluid reservoir 77. The pump 75, when driven by the motor 76, delivers fluid under pressure from the reservoir 77 through a check valve 78 to a low-pressure accumulator 79.

To provide a high-pressure source of hydraulic fluid, a pair of pumps 82 and 83 are each connected to the reservoir 77 and are driven by the motor 76 and a second motor 84, respectively. The pumps 82, 83, when driven by their respective motors, deliver fluid under high pressure from the reservoir 77 through a check valve 85 to a high-pressure accumulator 86.

For regulating the pressure build-up in each of the accumulators 79 and 86, the accumulators are associated with pressure responsive switches 87 and 88, respectively, which control solenoid operated shut-off valves 89 and 90. The valves 89 and 90 are normally open and connect the pumps 75, 82 and 83 to a sump 91 for the hydraulic system of the press. When solenoids 92 and 93 are energized from a source of electric current 94, the valves 89 and 90 are shifted to their closed positions whereupon the hydraulic pumps are able to charge their respective accumulators 79 and 86. When a predetermined pressure is reached, the pressure responsive switches 87 and 88 start timers 95 and if the predetermined pressure is maintained for a short interval, for example ten seconds, the switches 87, 88 are effective to break the solenoid circuits and thus deenergize the solenoids 82 and 83. As a result of this arrangement, the pumps 75, 82, 83 are able to build up and maintain desired pressure levels in the accumulators 79, 86 for operation of the press rams. However, in the event that the press remains idle, the output of the pumps is discharged, at no pressure, directly to the system sump 91 and, of course, eventually to the reservoir 77.

In order to accurately control the compression forces exerted on the stock during the blanking operation, both

the clamping ram 30 and the cushioning ram 35 are associated with relief valves 101 and 102, respectively, which are capable of being accurately set by servos 103 from a pressure control station 104. In a practical case, the servos 103 can be air-operated with the air pressures being adjusted and visually indicated at the station 104 so as to provide a particularly convenient way of setting and reading the hydraulic pressures exerted on the rams 30 and 35 (see also FIG. 1).

To supply controlled amounts of hydraulic fluid to the rams 30, 35, pressure regulation valves 105 and 106, respectively, are provided in hydraulic lines between the high-pressure accumulator 86 and the respective rams. The regulator valves 105, 106 are set to deliver fluid at a pressure slightly lower than the relief pressure at which the valves 101, 102 are set. Therefore the relief valves 101 and 102 control the compressive forces exerted on the work during operation of the press, in the manner made plain below, and the valves 105, 106 control the supply of fluid to the ram circuits.

The remaining connections of the press control circuit can be best described by briefly reviewing a complete cycle of press operation. To begin operation of the press, the motors 76 and 84 are started and the solenoids 92 and 93 energized so as to drive the pumps 75, 82, 83 and charge the low-pressure accumulator 79 and the high-pressure accumulator 86. Initially, valve 62 is in its closed 62*b* position. Valve 63 is in its 63*a* position so as to direct fluid from the low-pressure accumulator 79 through a check valve 110 and to the underside of the double-acting main rams 25, 26. This elevates the platen 16 to its starting position.

The valve 64 is initially in its 64*b* position so as to direct fluid from the high-pressure accumulator 86 to the cushion ram 35, thereby holding the cushion 43 in its elevated position flush with the die 42. It will also be seen that the regulator valve 105 is in direct communication with the clamping ram 30 so that the clamping plate 55 is held, by high pressure fluid, in its lowermost limit position.

To begin operation of the press, the variable speed motor 70 is energized so as to start rotation of the cam shaft 61. The cam 66 first comes into play by shifting the valve 63 to its position 63*c* so that fluid from the low-pressure accumulator 79 is directed to the top of the main rams 25, 26 and the fluid from beneath these rams is vented to the sump 91. This drives the platen 16 downwardly at high speed.

As downward movement of the platen causes the punch 48 to approach the die 42, further movement of the cam shaft 61 causes the cam 65 to shift the valve 62 to its 62*a* position, whereupon fluid under high pressure from the accumulator 86 is directed above the rams 25, 26. The low-pressure line from the accumulator 79 through the valve 63 remains open but backflow through this line is prevented by the check valve 110. It is important to note that fluid is not being drained from the accumulator 79 during this time interval, and hence the pump 75 has an opportunity to recharge the accumulator for subsequent operation of the press.

The downward pressure of the punch 48 is opposed by the cushion 43 through the stock material, thus compressing the work piece, and the surrounding portions of the stock material are compressed between the clamping plate 55 and the die 42. Thus, both the work piece being blanked and the surrounding stock material are subjected to compressive forces as is the operating mode of a triple-action press. It can be seen that the compressive force exerted on the work piece itself is controlled by the relief valve 102, while the compressive force exerted on the surrounding blank material is dictated by the setting of the relief valve 101. In this way, the press can be set for proper blanking action with different materials of varying size by simply setting the valves 101, 102 from the station 104.

As soon as fluid from the high-pressure accumulator is admitted to the top of the rams **25**, **26**, the greater force exerted by these rams lowers the cushion **43** against the resistance of the cushion ram **35** and drives the punch **48** into the stock thus shearing the work piece from the surrounding stock. Throughout the shearing operation, the exact desired compression forces are exerted on both the work piece and the surrounding stock since the relief valves **101**, **102** maintain their predetermined pressures on the stock and work piece upon upward movement of the clamping ram **30** as the plate **55** is arrested by the die **42** and downward movement of the cushion ram **35** under the force of the punch **48**.

Following the actual blanking operation, the continuously rotating cam shaft **61** causes all three of the cams **65**, **66**, **67** to shift their respective valves. The valve **62** is shifted to its **62***b* position thereby cutting off the flow of high-pressure fluid to the main rams **25**, **26**. The valve **63** is shifted to its **63***b* position thereby decompressing the high-pressure fluid charging the main rams. The valve **64** is shifted to its **64***a* position so as to decompress the ram **35** by discharging the ram directly to the sump **91**. It is important to note that in this interval of press operation, there is no flow of fluid from the high-pressure accumulator **86**, and thus the pumps **82**, **83** have an opportunity to recharge this accumulator. Also during this period, the low-pressure accumulator **79** continues to be recharged.

Further rotation of the cam shaft **61** causes the cam **66** to shift the valve **63** back to its initial **63***a* position thereby directing low-pressure fluid to the underside of the rams **25**, **26** so as to reelevate the platen **16**. Since the clamping plate **55** and the clamping ram **30** are carried by the platen **16**, upward movement of the platen draws first the punch **48** and then the clamping plate from the work. The clamping ram **30** automatically returns to its initial down position as the platen **16** is elevated since the regulator valve **105** is set for a slightly lower pressure than the relief valve **101** and more fluid is supplied to the clamping ram circuit as soon as the upward stock compressing force on the plate **55** is relieved.

As a final step upon completion of one full revolution of the cam shaft **61**, the cam **67** returns the valve **64** to its initial **64***b* position thereby directing fluid from the high-pressure accumulator **86** to the cushion ram **35**. This elevates the cushion **43** to the level of the die **42** and thus positively ejects the work piece from the die. It will be noted that the return of the valve **64** to its **64***b* position is slightly delayed with respect to the return of the valve **63** to its **63***a* position so as to avoid pushing the work piece back into the surrounding stock material.

It will be appreciated that the above-described sequence of operations occurs very quickly and, indeed, a practical press embodying the invention can function at approximately 125 cycles per minute. The operating speed of the press is, of course, dictated by the cam shaft driving speed of the motor **70** and the single cam shaft, with its positive mechanical connections to the control valves **62**, **63** and **64**, provides precise timing of the press operating sequence at whatever speed the press is operated.

Those skilled in the art will also understand that the cam shaft **61** can be used to operate, and thus properly time, a stock feeding device of any desired type as well as control a work piece clearing unit such as an air blast ejector.

In addition to the high speed effect of the rapid and precise sequencing afforded by the cam control of the operating valves, the high speed of the press **10** also results from positioning the valve bank **60** close to the main rams **25**, **26**, and from using low-pressure, high-volume fluid to move the main rams while calling upon high-pressure fluid only to perform the actual punching operation. In addition, the fact that the accumulators **79**, **86** are given time for recharging in the press operating cycle, and that the operating rams are charged at all times, materially contributes to the high speed of the press. High press speed also results from carrying the clamping ram **30** on the platen **16** which is actuated by the fast moving main rams **25**, **26**.

Shock free operation, in spite of high cycling speeds, results from using low fluid pressures for rapid positioning and high pressures for actual metal working. In addition, giving the accumulators time to recharge contributes to smooth power flow. To further minimize hydraulic shock, an accumulator **115** is associated with the sump discharge outlet of the high pressure lines.

While the press **10** has been described in use with a blanking die set **20**, it will, of course, be appreciated that the invention can be employed with equal effectiveness in a press performing similar operations such as draw forming or severing.

I claim as my invention:

1. In a hydraulic press having a fixed die surrounding a shiftable die cushion and a movable punch surrounded by a relatively shiftable clamping plate, the combination comprising, a cushion ram for holding said cushion, a double-acting main ram for driving said punch toward said fixed die, a clamping ram carried by said main ram for urging said clamping plate towards said fixed die, a low-pressure, high-volume source of fluid under pressure, a high-pressure source of fluid under pressure, means including a pressure regulator for directing fluid from said high-pressure source to said clamping ram at a preset pressure, means including a pressure regulator and a first valve having a first position for directing fluid from said high-pressure source to said cushion ram at a predetermined pressure, means including a second valve having a first position for thereafter directing fluid from said low-pressure source to said main ram to rapidly drive said punch and said clamping plate toward said die, means including a third valve for directing fluid from said high-pressure source to said main ram as said punch reaches said die so as to drive the punch through the stock against the resistance of said cushion ram, said first and second valves having a second position for subsequently exhausting high-pressure fluid from said main ram and said cushion ram following movement of said punch into said die, said second valve having a third position for directing fluid from said low-pressure source to said main ram to rapidly drive the punch away from the die following said exhausting of high-pressure fluid, and means for subsequently operating said valves to the siad respective positions including means for thereafter shifting said first valve to said first position for redirecting fluid from said high-pressure source to said cushion ram so as to eject a blank in said die.

2. In a hydraulic press having a fixed die surrounding a shiftable die cushion and a movable punch surrounded by a relatively shiftable clamping plate, the combination comprising, a cushion ram for holding said cushion, a double-acting main ram for driving said punch toward said fixed die, a clamping ram carried by said main ram for urging said clamping plate towards said fixed die, a low-pressure, high-volume source of fluid under pressure including a first pump and a first accumulator, a high-pressure source of fluid under pressure including a second pump and a second accumulator, means for directing fluid from said high-pressure source to said clamping ram at a preset pressure, means including a first valve having a first position for directing fluid from said high-pressure source to said cushion ram at a second preset pressure, means including a second valve having a first position for thereafter directing fluid from said low-pressure source to said main ram to rapidly drive said punch and said clamping plate toward said die, means including a third valve having a first position for directing fluid from said high-pressure source to said main ram as said punch reaches said stock so as to drive the punch into the stock against the resistance of said cushion ram, one way valve

means responsive to said high pressure in said main cylinder for shutting off flow from said low-pressure source and thus permit said first pump to charge said first accumulator, said first and second valves each having a second position for exhausting high-pressure fluid from said main ram and said cushion ram following movement of said punch into said stock, said second valve having a third position for directing fluid from said low-pressure source to said main ram to rapidly drive the punch away from the die following said exhausting of high-pressure fluid, said third valve having a second position effective to shut off flow from said high-pressure source to said main ram and thus permit said second pump to charge said second accumulator, and means for thereafter shifting said first valve to said first position for redirecting fluid from said high-pressure source to said cushion ram so as to eject a blank away from said die.

3. In a hydraulic press having a fixed die surrounding a shiftable die cushion and a movable punch surrounded by a relatively shiftable clamping plate, the combination comprising, a cushion ram for holding said cushion level with said die, a double-acting main ram for driving said punch toward said fixed die, a clamping ram carried by said main ram for urging said clamping plate towards said fixed die, a low-pressure, high-volume source of fluid under pressure, a high-pressure source of fluid under pressure, means for directing fluid from said high-pressure source to said clamping ram at a predetermined pressure, means including a first valve element for directing fluid from said high pressure source to said cushion ram, means including a second valve element for thereafter directing fluid from said low-pressure source to said main ram to rapidly drive said punch and said clamping plate toward said die, means including a third valve element for directing fluid from said high-pressure source to said main ram as said punch reaches the stock so as to drive the punch into the stock against the resistance of said cushion ram, means including fourth and fifth valve elements for exhausting high-pressure fluid from said main ram and said cushion ram following movement of said punch into the stock, means including a sixth valve element for directing fluid from said low-pressure source to said main ram to rapidly drive the punch away from the die following said exhausting of high-pressure fluid, cam follower means associated with each of said valve elements and a plurality of cams on a driven cam shaft coacting therewith for exactly timing and operating said valve elements in numerical sequence and subsequently operating said first valve element a second time for redirecting fluid from said high pressure source to said cushion ram so as to eject a blank from said die.

4. In a hydraulic press having a fixed die surrounding a shiftable die cushion and a movable punch surrounded by a relatively shiftable clamping plate, the combination comprising a cushion ram for holding said cushion level with said die, a double-acting main ram for driving said punch toward said fixed die, a clamping ram carried by said main ram for urging said clamping plate towards said fixed die, a low-pressure, high-volume source of fluid under pressure, conduit means for directing fluid from under pressure, a high-pressure source of fluid said high-pressure source to said clamping ram, first flow control means for directing fluid from said high-pressure source to said cushion ram, second flow control, means for thereafter directing fluid from said low-pressure source to said main ram to rapidly drive said punch and said clamping plate toward said die, third flow control means for directing fluid from said high-pressure source to said main ram as said punch reaches the stock so as to drive the punch into the stock against the resistance of said cushion ram, fourth flow control means for exhausting high-pressure fluid from said main ram and said cushion ram following movement of said punch into the stock, fifth flow control means for directing fluid from said low-pressure source to said main ram to rapidly drive the punch away from the die following said exhausting of high-pressure fluid, cam means for sequentially operating said flow control means in numerical order and thereafter again operating said first flow control means for redirecting fluid from said high-pressure source to said cushion ram so as to eject the blank from said die, and means for exactly controlling the fluid pressures acting on said clamping and cushion rams so as to regulate the compression forces exerted on stock material being blanked in said press.

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