The disclosure of the present invention relates to the provision of two groups of cooperative piston cylinder assemblies supplied by two different power sources for a press for compacting fragmentalized metal into highly densed blocks. The operation of the two groups of piston cylinder assemblies with reference to the progressively increased resistance offered during the compacting operation, and hence, the corresponding decrease in speed of the press ram is controlled by a pinion drive transducer in combination with a limit switch-speed switch arrangement.

7 Claims, 2 Drawing Figures
RAMS DOWN ON LOW PRESSURE CYLINDERS 14, 18, 20, AND 22

ZERO SPEED

RAMS DOWN ON HIGH PRESSURE CYLINDERS 18, 20, AND 22

RAM DOWN ON HIGH PRESSURE CYLINDER 14

FIG. 2
HYDRAULIC APPARATUS AND CONTROL FOR A PRESS

Hydraulic presses are presently employed in performing work where the press ram or rams have a relatively long working stroke or strokes and wherein the speed of the ram or rams during the stroke is substantially reduced due to the increased resistance offered by the workpiece, for example, due to the increased density of the workpiece due to its being compressed by the ram or rams. In such applications, there is a great need and interest in conserving the power and time to perform the total pressing operation.

It is therefore the object of the present invention to provide a multi-piston cylinder assembly arrangement for a press, in combination with a control means for conserving the power required to operate the piston cylinder assemblies with reference to a change in speed of the press and the time necessary to perform the total pressing operation in terms of an increase in the resistance offered by a workpiece during the pressing operation.

More particularly, the present invention provides a single group or multi-group of piston cylinder assemblies associated with a working ram of a press and a control means for said piston cylinder assemblies including means sensitive to a change in the speed of the ram and a means for changing the working force of a piston cylinder assembly or a number of the piston cylinder assemblies of a single group or two or more groups of cylinder assemblies with reference to the detected change in the speed of the ram.

It is still further object of the present invention to provide for a working ram of a press a main piston cylinder assembly and one or more auxiliary piston cylinder assemblies in combination with a low pressure system for said main and auxiliary piston cylinder assemblies, a high pressure system for said main and auxiliary piston cylinder assemblies, a speed measuring means associated with said ram to measure its speed during its working stroke, a cylinder selector means associated with the speed measuring means arranged to first effect a connecting of the low pressure system to one or more of said piston cylinder assemblies, and then to effect a connecting of the high pressure system to one or more of said piston cylinder assemblies.

Another object of the present invention the low pressure system takes the form of a prefilled pressure system, the speed measuring means includes a transducer and the cylinder selector means includes a limit switch-speed switch arrangement.

These objects, as well as other novel features and advantages of the present invention, will be better appreciated when the following description of one embodiment thereof is read along with the accompanying drawings of which:

FIG. 1 is a schematic elevational view, partly in section, of a hydraulic press, and particularly, of the piston cylinder assembly arrangement and hydraulic systems thereof constructed in accordance with the present invention.

FIG. 2 is an electrical diagram of part of the speed and power control system for the piston cylinder assembly arrangement shown in FIG. 1.

In referring to FIG. 1 there is shown the upper portion of a piston cylinder arrangement of a compacting press of which the main crosshead 10 is fragmentally shown connected to the upper portion of a vertically arranged ram 12 of the press. Other components of the press have not been shown since they may follow well-known designs and a description thereof is not required to understand the present invention. The piston cylinder assembly arrangement of the press is shown since it forms an important part of the invention. It consists first of a centrally located main piston cylinder assembly 14, the ram 16 of which engages the top of the crosshead 10. Outward of the main cylinder assembly 14 there are three equally spaced similar auxiliary piston cylinder assemblies 18, 20, and 22, their rams 24 also engaging the top surface of the crosshead 10. Lastly, intermediate the main and auxiliary cylinders there are located a pair of pull back piston cylinder assemblies 25 and 26 for the crosshead 10.

The main piston cylinder assembly 14 and the three auxiliary piston cylinder assemblies 18, 20 and 22 may be considered in function and operation as separate groups of cylinders in which the two groups are associated in common with two different hydraulic power systems, one being a low pressure or prefill system and the other a substantially higher pressure system. The main piston cylinder assembly 14 has associated with it a prefill valve 30 whereas the auxiliary piston cylinder assemblies are associated with their own prefill valve 32. Both of these valves 30 and 32 are connected to a prefill system by standards 34 and 36, respectively. The standards communicate with an anti-surge device 38 which in turn receives water under a prefill pressure from a prefill vessel, not shown, all in accordance with well-known practice.

The prefill valves 30 and 32, which are similar in construction, operate in accordance with well-known valve technology, have center spools 40 actuated by operating stems 42 and high pressure orifices 44 for allowing water under the high pressure to pass into cylinder orifices 46 when the spools 40 are moved to the left as one views FIG. 1. To the high pressure orifice 44 of the valve 30 there is connected piping 48 of the high pressure system, which includes a main control directional valve 50. The high pressure water for the valve 32 is received by piping 52 from an auxiliary control directional valve 54. A third directional control valve 56 is shown, this valve by piping 58 communicates with the pull back cylinders 26. The directional valves 50, 54 and 56, according to well-known practice receive the high pressure fluid from an accumulator and pump arrangement, such as several direct flow type pumps, not shown. It may be well to note that the pumps and accumulator will have a working pressure capacity of order of 4,500 psi, whereas the prefill supply system has a working pressure of 300 psi. It will be appreciated that while they have not been referred to specifically, the two hydraulic systems will include valves, strainers, gauges, etc., that customarily are employed in heavy industrial hydraulic applications.

Turning now to the electrical control provided for the coordinated operation of the prefill and high pressure systems, it will be noted in FIG. 1 that connected to the crosshead 10 of the press there is a vertical downwardly extending rack 59 which is engaged by a pinion 60 of a transducer 62. Also associated with the crosshead 10 are three vertically spaced-apart limit switches, LS-1, LS-2, and LS-3, having their rollers arranged to be contacted sequentially by a cam attached to the adjacent side of the crosshead 10. Referring now to FIG. 2, the electrical circuitry of the control includes
two power lines 64 and 69 connected together by a switch 68 in a line 70 which line also includes a relay 1CR. On the right side of the switch 68 a line 72 is connected to the line 70 which allows current to pass through three secondary lines 74, 76 and 78 arranged in parallel. The line 74 includes the limit switch LS-1, a zero speed switch contact 80 and a relay 4CR. Line 76 includes the limit switch LS-2, a contact of the relay 4CR and a relay 2CR which is connected inside the line 76 on the opposite sides of the contact 4CR. Lastly, line 78 includes the limit switch LS-3, a second contact of the relay 4CR and a relay 3CR which is connected into the line 78 on opposite sides of the second contact 4CR. Also shown in FIG. 2 is a speed measuring instrument for establishing the setting for the zero speed switch 80 at which setting the relay 4CR will be operated.

The operation of the above described piston cylinder arrangement will now be briefly outlined. Let it be assumed that the piston cylinder assemblies 14, 18, 20 and 22 are in the position shown in FIG. 1 which is the position they assume at the top of the working stroke of the press and that the spools 40 of the prefill valves 30 and 32 are positioned to be closed to the high pressure system and opened to the prefill system. In this event the switch 68 is operated to activate the relay 1CR. Prior to this, the speed switch 80 will have been set by the instrument 82 to a predetermined speed setting in order to conserve power and time during the downward travel or working travel of the crosshead 10 of the press. On the operation of the relay 1CR water under the prefill pressure is admitted to all four piston cylinder assemblies 14, 18, 20 and 22 to cause the crosshead 10 and ram 12 to descend on the workpiece. The descending crosshead 10 will without too much delay engage and trip the limit switch LS-1 to activate the relay 4CR.

As the crosshead continues to descend the limit switch LS-2 is tripped and should the speed of the crosshead have fallen below the speed setting of the speed switch 80 as measured by the instrument 82 the contact in line 76 of the relay 4CR will close activating the relay 2CR. This will cause the spool 40 of the prefill valve 32 to shift to open this valve to the high pressure system and admit high pressure fluid to the auxiliary piston cylinder assemblies 18, 20 and 22 while the main piston cylinder assembly 14 is still under the prefill pressure. The contact of the relay 4CR in line 76 will remain closed until the speed of the ram has been increased to above the speed setting of the speed switch 80 after which it will be opened and the current in line 76 will pass through the contact 2CR which was closed on operation of the relay 2CR.

As the crosshead continues to descend under the re-established optimum rate of speed and power the increased resistance offered by the workpiece due, for example, to its increased density, will again reduce the speed of the ram 12 and when its speed falls below the setting of the speed switch 80 and the crosshead has been lowered to trip the limit switch LS-3 the contact of the relay 4CR in line 78 is closed to activate relay 3CR. This will cause the spool 40 of the prefill valve 30 to shift to close off the prefill system from the main piston cylinder assembly 14 and open this piston cylinder assembly to the high pressure system so that all four piston cylinder assemblies will be under the maximum available pressure. Once the predetermined speed has been again re-established the contact 4CR in line 78 will open and the current in line 78 will pass through the contact 3CR which was closed on operation of the relay 3CR. The limit switches LS-1, LS-2 and LS-3 are strategically spaced so as to conserve the available power and time, in which once the limit switch LS-3 has been tripped, the ram 12 will be approaching the conclusion of its downward stroke.

In accordance with the provisions of the patent statute, we have explained the principles and operation of our invention and have illustrated and described what we consider to represent the best embodiment thereof. We claim:

1. In a press having at least a first piston cylinder assembly and a group of second piston cylinder assemblies for causing a ram of the press to pass through its working stroke, a first and a second power source for said piston cylinder assemblies, means sensitive to a change in the speed of said ram during its working stroke, means for connecting one of said power sources to at least said first piston cylinder assembly to commence the working stroke, and means for selectively connecting said other power source to at least one of said second piston cylinder assemblies with reference to a detected change in the speed of said ram to control the speed of said ram during its working stroke.

2. In a press having a ram, a first piston cylinder assembly and at least one second piston cylinder assembly for causing said ram to pass through its working stroke, a low pressure system for said first and second piston cylinder assemblies, a high pressure system for said first and second piston cylinder assemblies, a speed measuring means associated with said ram to measure its speed during its working stroke, and a piston cylinder assembly selector means associated with said speed measuring means arranged to first effect a connecting of said low pressure system to at least one of said piston cylinder assemblies, and then to effect a connecting of said high pressure system to at least said other piston cylinder assembly thereby to control the speed of said ram and offset a reduction in the speed of the ram due to increased resistance during its working stroke.

3. In a press having a ram, a first piston cylinder assembly and several second piston cylinder assemblies for causing said ram to pass through its working stroke, a low pressure system for said first and second piston cylinder assemblies, a high pressure system for said first and second piston cylinder assemblies, a speed measuring means associated with said ram to measure its speed during its working stroke, and a piston cylinder assembly selector means associated with said speed measuring means including means for first effecting a connecting of said low pressure system to all of said piston cylinder assemblies and means for then effecting a connecting of said high pressure system to at least some of said piston cylinder assemblies.

4. In a press according to claim 3 wherein said low pressure system takes the form of a prefill pressure sys-
5. In a press according to claim 4 wherein said transducer means includes a rack displacable by said ram of said press, a pinion arranged to mesh with said rack and connected to said transducer means.

6. In a press according to claim 4 wherein said selector means includes a series of limit switches arranged in a spaced linear relationship with respect to the direction of travel of said ram adapted to be sequentially engaged by said ram during its working stroke, said speed switch being associated with said limit switch adapted to be first engaged by said ram during its working stroke so that when engaged said speed switch is operative.

7. In a press according to claim 4 wherein said first piston cylinder assembly comprises a main piston cylinder assembly and said second piston cylinder assembly comprising one or more auxiliary piston cylinder assemblies, means for associating a first limit switch in a manner to effect operation of said main and auxiliary piston cylinder assemblies by said low pressure, means for associating a second limit switch with said high pressure system in a manner to effect operation of said auxiliary piston cylinder assemblies by said high pressure, and means for associating a third limit switch with said high pressure system in a manner to effect said operation of a main piston cylinder assembly by said high pressure.