Retraction system for multi-anvil presses

H. Tracy Hall

Chemistry Department, Brigham Young University, Provo, Utah, 84602
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A hollow guide-pin system is described for retraction of the hydraulic rams of multi-anvil presses that saves weight and machining costs and improves mechanical proportions. The system also unclutters the anvil region, providing more access. The use of inverted rams and right/left-hand thread tie-bars and bases further reduces weight and cost.

The anvils of a conventional multi-anvil press for developing high pressures[1] such as the tetrahedral or hexahedral (cubic) press of the tie-bar design are usually advanced and retracted by means of a double acting (forward and reverse) hydraulic ram. Such a ram is schematically shown in Fig. 1. This figure is a cross-sectional representation of a tetrahedral press taken through the axes of two of the hydraulic rams which lie in the same plane. To advance the anvils, oil under pressure is admitted to the advance oil inlet while oil from the retraction oil inlet flows freely to the oil reservoir. To retract the anvils, oil under pressure is admitted to the retraction oil inlet while oil flows freely to the reservoir from the advance oil inlet.

Note that the guide plate and piston are larger in diameter than the piston rod. Consequently, for assembly, either the piston or the guide plate must be detachable from the piston rod in order that the piston rod may be inserted through the central hole in the cylinder plate. Detachment is usually accomplished by making a threaded hole in the center of the piston and by threading the bottom end of the piston rod to mate with this hole. This two-part threaded structure is mot as strong as a monolithic unit which, of course, cannot be

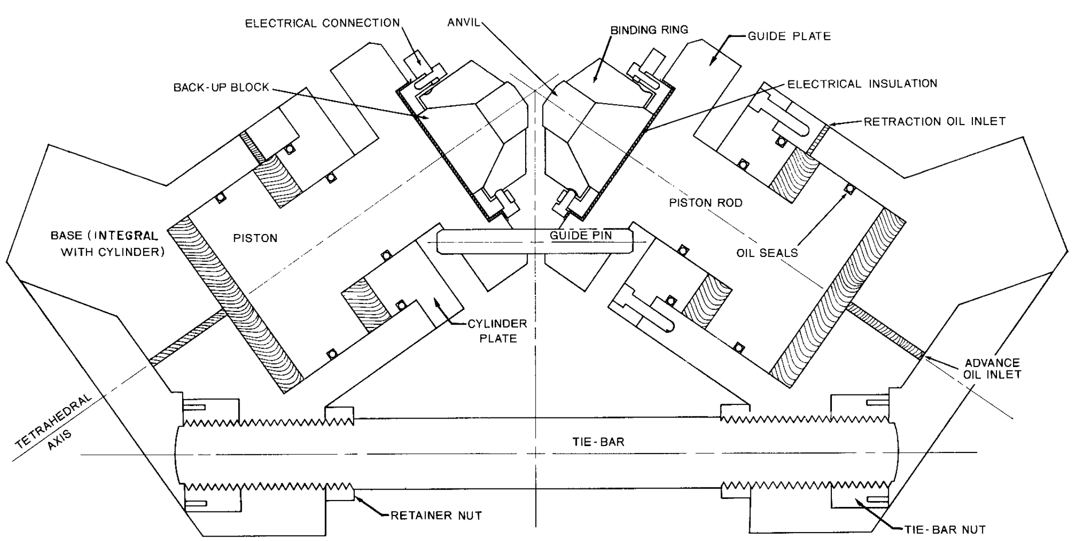

FIG. 1. Plane section through axes of two hydraulic rams of tetrahedral press.

assembled. Consequently these parts must be built more massively. Also, the thread must be made leak-proof to the hydraulic oil and prevented from loosening, by pinning or other means. In addition, the alignment of the piston axis with the cylinder axis is less certain in a two piece, threaded assembly than in a monolithic unit. Again, these engineering problems increase the size and mass of the press. Remember that the ram tonnage (thrust) of common high pressure machines is in the range of 200 tons to 2000 tons. Keeping the size, weight, and consequently the cost down are important problems. Also, it is often difficult to find machine shops with tools large enough to machine, bore, and thread large components for these presses.

The distribution of the mass is another important consideration in the design of this equipment. In past tie-bar designs, the guide

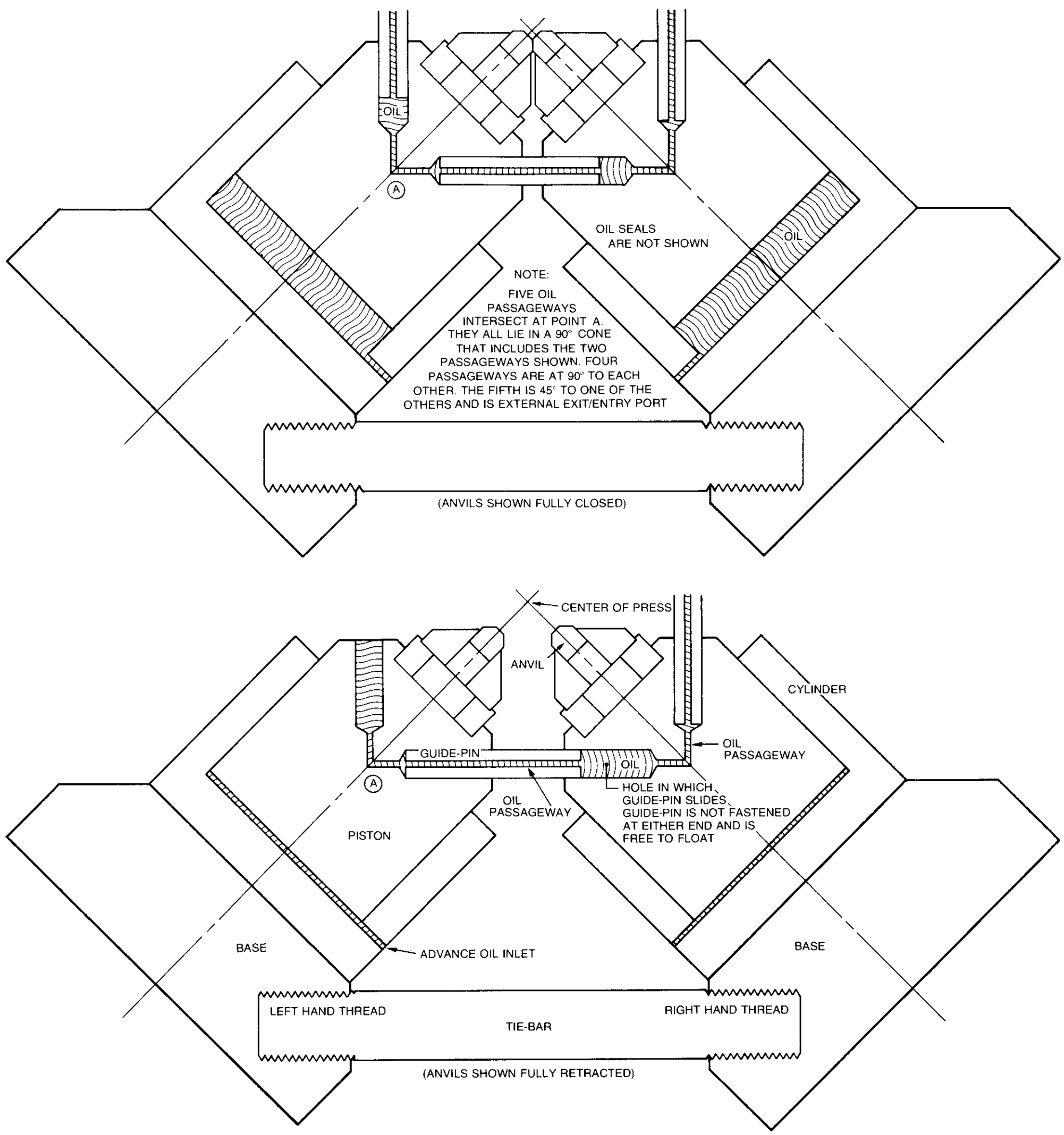

FIG. 2. Closed and retracted plane section through axes of two hydraulic rams of cubic press with anvil guide retraction system (AGRS). Left-/right-hand thread tie bars are also shown.

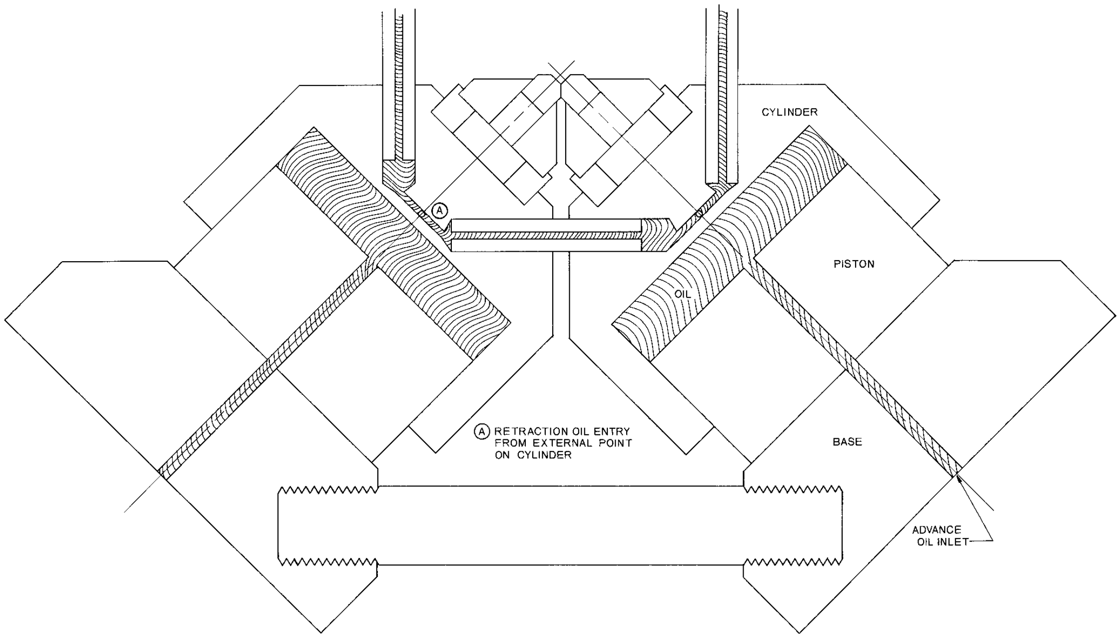

FIG. 3. Inverted ram with Anvil Guide Retraction System.

plate has been less massive than desired. This is also true for the piston rod.

The object of the present design is not only to reduce the mass and overall size of the press but also to achieve a better balance of mass between the guide plate, piston rod, and piston. This decreases the amount of machining to be done. The new retraction system is described below (see Fig. 2).

The usual hydraulic ram retraction system is eliminated, and the piston rod is eliminated. The piston, piston rod, and guide plate become one monolithic unit. The guide pins are provided with a central hole through which oil may pass. An oil seal is made between each pin and the guide pin hole in the top end of each monolithic piston. Also, an oil hole proceeds from the end of the guide pin holes to a central point (an apex) in each piston where they interconnect. Oil from a pressure source is admitted from outside the press through a hole which connects to one of these apices. This oil will cause retraction of all pistons of the press. Oil will flow from the apex when the hydraulic rams are advanced. If desired, oil may be connected to more than one apex.

When the anvil guide retraction system (AGRS) (which the new system is called) is not being used to retract the press, cooling oil may be admitted to one apex and exit at another apex to carry away excess heat from the anvils. Since oil is free to flow through all the hollow guide pins into the top of each piston, this provides an uncluttered way of providing cooling to the anvil region. Previously, each anvil had an external cooling jacket interconnected externally with flexible tubes to the other anvils. For cubic presses seven such flexible leads are required to interconnect the six anvils. In addition, six pipes or flexible pressure hoses are brought to each retraction oil inlet in a conventional cubic press, and this adds to the clutter. With AGRS only two flexible leads are required. Access to the anvil region of multi-anvil presses is inherently limited. The AGRS significantly improves access to this area.

It has been difficult for many of my colleagues to see how this system of hollow guide pins and interconnected guide pin holes works in retracting the pistons. In fact, I have encountered much skepticism concerning it. I think this is so because there is not a cylinder with a visible solid bottom nor is there a piston with a visible solid bottom, as in the usual case of a simple hydraulic ram. One does not readily discern what the oil (under pressure) can push against. However, if one looks at the system as a chemist and invokes Le Chatelier's principle, the fact that retraction does occur should become clear. Le Chatelier's principle requires that any system under stress moves in a direction that will reduce the stress. Therefore, pressurized oil admitted to this system will reduce that pressure by increasing its volume by forcing the pistons to retract. The volume available for oil is thus increase in the guide-pin/guide-pin hole system as the pistons retract.

The value of AGRS has been proven on both tetrahedral and cubic presses that have been built during the past few years.

Another design change that also has merit is the inversion of the ram; i.e., the piston is fixed to the base and the cylinder (sleeve plus integral cylinder head) advances and retracts (Fig. 3).

Inversion of the ram allows the tie bar ends to be placed closer together at each piston base (because the piston diameter is smaller than the outside diameter of the cylinder). Therefore, the base can be decrease in diameter, reducing weight without sacrificing strength.

A further feature that has been used to reduce the diameter of the base is to use left- and right-hand threads on opposite ends of each tie-bar and to thread them into corresponding holes in the bases. This necessitates the starting of twelve tie bars into 24 holes (in the case of a cubic press) within ± ¼ turn of each other. And after starting, the tie-bars must be must be rotated one by one in sequence approximately ¼ turn at a time until the threads are fully engaged. Although this procedure may seem onerous, in practice it has not been so. Right-/left-hand thread tie bars have been successfully used on a number of tetrahedral and cubic presses. Figures 2 and 3 show this arrangement.

Older designs (Fig. 1) used right-hand threads on both ends of the tie bars, a plain hole with counterbore on the bottom side of the base, and a nut threaded onto each end of the tie bar, said nut abutting the bottom of the counterbore. A nut was also required on the front side of the base to fully secure the tie bars to the base. The counterbore and nut require a larger diameter base than the right-/left-hand threaded tie bar base system.

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[1] H. T. Hall, Rev. Sci. Instrum. **29**, 267 (1958); **33**, 1278 (1962); Rev. Phys. Chem. Jap. **37**, 63 (1967); U. S. Patents 2,918,699; 3,159,876; 3,182,353.