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Anvil Guide Device for Multiple-Anvil High Pressure Apparatus[i]

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In multiple-anvil high pressure apparatus, typified by the tetrahedral press[iii], the hydraulic rams have usually been valved independently (Fig. 1). The position of each ram, and consequently the position of each anvil, has been indicated by a precision dial gauge. To operate the tetrahedral press it has been customary to individually position the lower triad of anvils so as to form a "nest." The sample tetrahedron, oriented apex down, is placed in the nest, and then the upper, vertical anvil is brought into position against the upward facing base of the tetrahedron. At this point each anvil is individually forced inward by small incremental

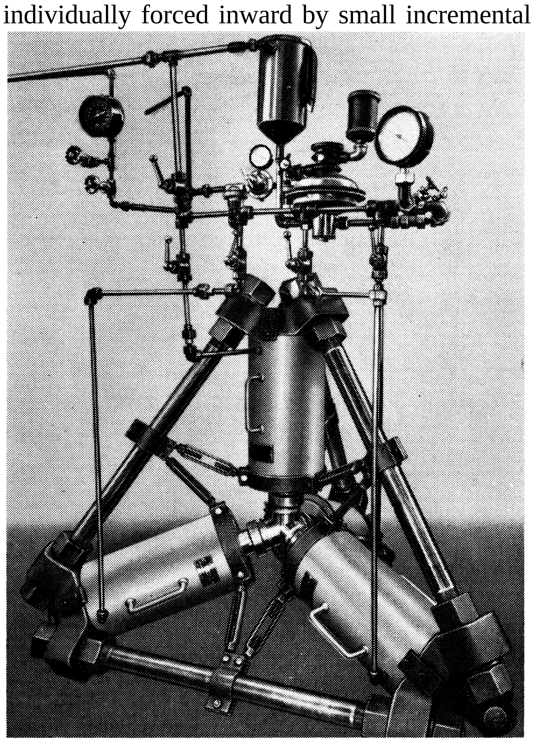

FIG. 1. Original tetrahedral anvil press.

amounts until the anvils have taken a "bite" on the tetrahedron and a good gasket has formed by extrusion of tetrahedron edges between the sloping anvil faces (tetrahedron edge is 25% longer than edge of triangular anvil face). This

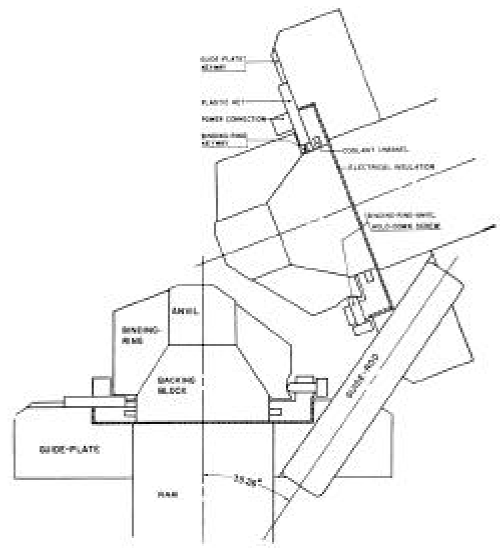

FIG. 2. Plane section through axes of two hydraulic rams of tetrahedral press showing anvil guide device and other design features.

usually requires a total of three incremental adjustments per anvil, performed in systematic order. At this point all valves to the hydraulic rams driving the anvils are opened and hydraulic pressure is then simultaneously applied to every ram. During the course of increasing pressure it is often necessary to stop the flow of oil to individual rams for brief intervals in order to maintain equal advance of the anvils toward the center of gravity of the tetrahedron. Failure to maintain equal anvil advance leads to unsymmetrical gasket formation which can result in a loss of pressure. This can also produce undesirable unbalanced loads on various parts of the press.

While all of the above mentioned operations can be performed in a few minutes time by one who has become skilled in the art, it would be highly desirable to provide a mechanism for automatically advancing all anvils equally. Such a device is described below. This device eliminates human error and tedium, does a better job than can be done by incremental adjustment, saves time, and assures alignment of the press at all times. The device is mechanically simple and trouble free.

The anvil guide device for the tetrahedral press consists of two types of components, a guide rod and a guide plate (Fig. 2). Six guide rods and four guide plates are required. A guide plate is fastened to the moving end of each hydraulic ram. The anvil, with its binding ring, backing block, and other appurtenances, is mounted centrally on the surface of the guide plate. Symmetrically disposed, at 120º angles, around the outer portion of the guide plate, are three guide holes. The axes of these holes make angles of 35.26º with respect to the ram axis. When assembled the guide rods are positioned within the guide holes, all guide plates being interconnected by the guide rods. One end of each guide rod is fastened securely by a set screw, or other means, in one guide hole. The other end of the guide rod is free to slide. (Alternatively the guide rod can be allowed to "float," being free to slide at both ends. In this instance some restraint is imposed on the rod's movement to insure that sufficient rod bearing surface is present within the guide holes at all times. "Stops" for the rod ends or a narrow collar around the rod midway between the ends could provide this restraint.)

The axes of the guide rods form a regular tetrahedron. Hydraulic oil for advancing the rams is simultaneously applied from one valve to all four rams. All rams, being interconnected by the guide rods and plates, are forced to move synchronously together. Consequently, the anvils move simultaneously and symmetrically toward the center of the press. As the rams move inwardly, the regular tetrahedron defined by the guide rod axes decreases in size. Retraction of the rams, of course, reverses the above processes.

Use of the anvil guide device requires a different procedure than the usual "nest insertion" for placement of the tetrahedron sample holder. One technique is to simply hold the tetrahedron in place on the face of one of the lower anvils with a small piece of adhesive tape. Exact placement is not essential because the tetrahedron will orient itself as the anvils close on it. More elaborately, a spring steel finger assembly, somewhat like the mechanism of a screw-holding screwdriver, that slips over the anvil-binding ring assembly can be used. Three flat, thin steel springs hold the tetrahedron on an anvil face until the anvils are almost closed, at which point the springs are retracted. A third method mounts the tetrahedron on a thin rod attached at an apex. The tetrahedron is held in proper position in the center of the press by this rod while the anvils come together. A variation of the third method consists of a thin rod with three fingers at the top, spaced 120º apart, that form a nest for the tetrahedron. The three tetrahedron edges radiating from an apex rest in narrow V-ways on the fingers. The fingers are sufficiently thin to fit in the spaces between the anvils at closure. After the anvils have closed on the tetrahedron, the rod, with its fingers, is withdrawn.

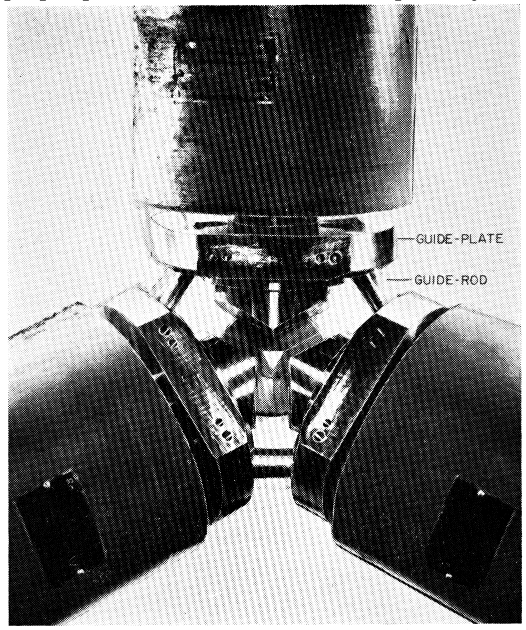

FIG. 3. Photograph of anvil guide device installed on original tetrahedral press.

Use of the anvil guide device eliminates the need for the turnbuckles (visible in Fig. 1) used on the original tetrahedral press to affect alignment. A view of the anvil guide device installed on this press is shown in Fig. 3.

The anvil guide device described above for the tetrahedral press can be adapted for use with other types of multiple anvil presses. For example, a cubic press utilizing six anvils would require six guide plates and 12 guide rods. The guide plates fastened to each of the six hydraulic rams would have four guide holes spaced around the periphery at 90º angles to each other. The axes of these holes would be at 45º angles with respect to the ram axes.

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[ii] Alfred P. Sloan Foundation Research Fellow.

[iii] H. T. Hall, Rev. Sci. Instr. 29, 267 (1958).