A hydraulic stage: an aid in counting mineral grains

By D. W. Humphries

Dept. of Geology, University of Sheffield

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Summary. A hydraulically operated microscope stage is described and constructional details are given. The stage is foot-operated, which leaves both hands free for continuous focusing of the microscope and the operation of a mechanical counting device. A further advantage of the hydraulic stage is that unmounted grains (or small fossils) can be moved smoothly and without relative movement between individual grains. The rate at which grains (or small fossils) can be counted is thus greatly increased.

THE counting of mineral grains (or small fossils) under the microscope involves three separate processes: the focusing of the microscope on the object, the identification and tabulation of the grain, and the movement of the specimen holder to bring the next grain into the centre of the field of view. The whole cycle is then repeated. For rapid counting of large numbers of grains, it is highly desirable that one hand is continuously used for focusing the microscope, while the other operates a mechanical or electro-mechanical counting device. When the grains are mounted, the electro-mechanical stage of the 'point-counter' type, operated directly from the counting device, is suitable for the movement of the slide. Where the grains are unmounted, however, the jerky movement of this type of stage rapidly piles the grains in a heap.

The hydraulic stage provides a means of moving loose grains across the field of view smoothly and without relative movement between individual grains. Being foot-operated, it leaves the hands free for counting and focusing.

The principle of operation is the transference of oil from the master cylinder in the foot-operated control unit to a slave cylinder in the stage unit and back. The two units are connected by a wire-wound flexible plastic tube. The apparatus is shown in fig. 1 and the details of construction in figs. 2, 3, and 4.

The control unit (fig. 2). A brass cylinder (*a*) closed at its lower end and attached centrally to a steel base plate (*b*) is closed by a piston (*c*)

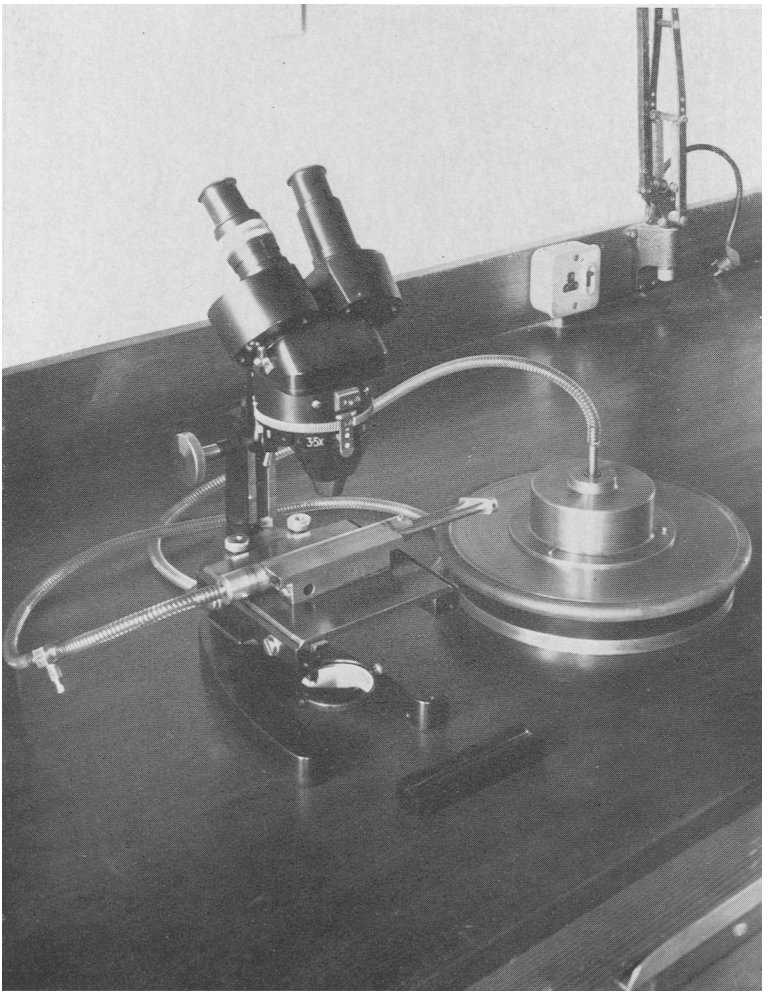


FIG. 1. General view of the hydraulic stage. In normal use the control unit (on the right) is placed on the floor by the operator's foot.

fitted with an oil-resistant hard rubber O-ring seal. The face of the piston is dished to facilitate the removal of air bubbles. The piston rod (*d*) is threaded ($\frac{1}{2}$″ B.S.F.) and has a flat filed down one side. The rod is drilled axially and reduced in diameter at its upper end to allow attachment of the flexible pipe. The piston is retained within the

cylinder by a brass cap (*e*) carrying a small steel plate that bears against the flat on the piston rod and prevents its rotation.

The piston is actuated by a steel disk (*f*) to which is attached a brass cup (*g*) drilled and threaded to fit the thread on the piston rod. This assembly rests on a ball race (*h*) concentric with the cylinder and is held down by a threaded ring (*i*) screwed down over the cylinder.

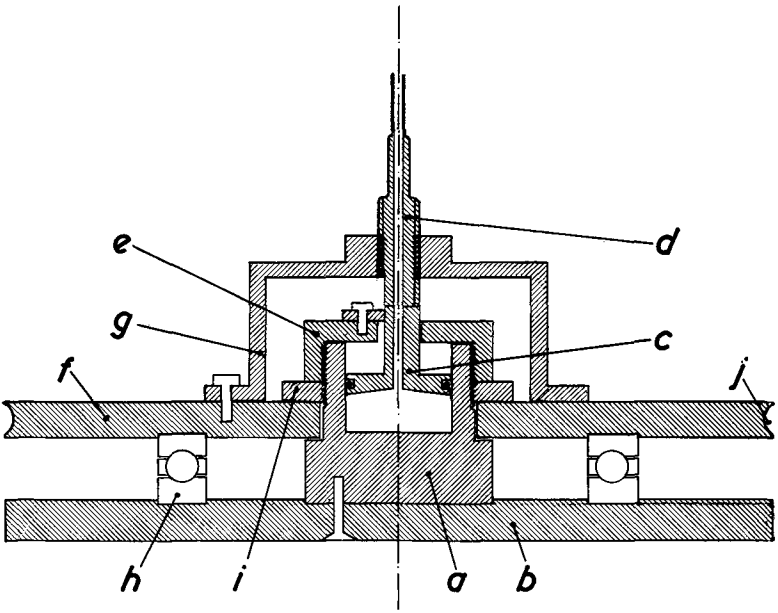


FIG. 2. The control unit. Scale: Approx. $\frac{1}{3}$. This is shown in section. The rubber ring on the foot plate has been omitted. For key to lettering, see text.

A ring made from a length of rubber tubing fits a groove (*j*) in the edge of the disk and prevents the foot slipping when the disk is turned. Since the piston cannot rotate, rotation of the disk causes the piston to rise and fall in the cylinder.

The stage unit (fig. 3). The unit illustrated was made for a stereoscopic microscope with a square stage using reflected light, but could readily be adapted for other stages. The base plate (*a*) of the unit is a piece of stainless steel of the same dimensions as the glass plate of the microscope. On this plate are mounted the slideway (*b*) in which the slide (*c*) carrying the specimen tray runs, and the slave cylinder (*d*). (The slideway and the slide were recovered from the rack and pinion mechanism

of a dismantled microscope.) The slideway is placed in such a position that the specimen tray is carried lengthwise across the field of the microscope.

The cylinder (*d*) consists of a piece of drawn brass tubing which has sufficiently smooth internal finish to need no further turning or polishing. The piston (*e*) is made an easy fit in the tube and carries an O-ring seal.

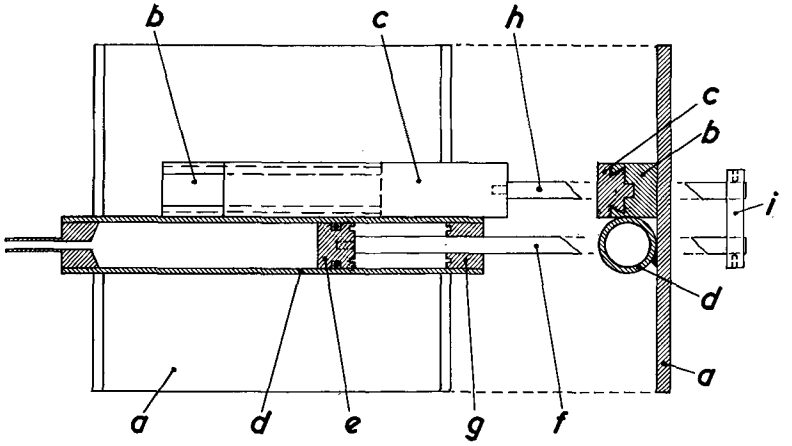


FIG. 3. The stage unit. Scale: Approx. $\frac{1}{3}$. A plan and section are shown. In the plan the slave cylinder (*d*) is sectioned. The compression spring has been omitted, but the retaining recesses in the back of the piston (*e*) and in the piston-rod guide (*g*) indicate its position. In the sectional view, note that the slideway (*b*) is bolted to the base plate (*a*) and the slave cylinder is held in position against it by a fillet of solder. For key to other letters, see text.

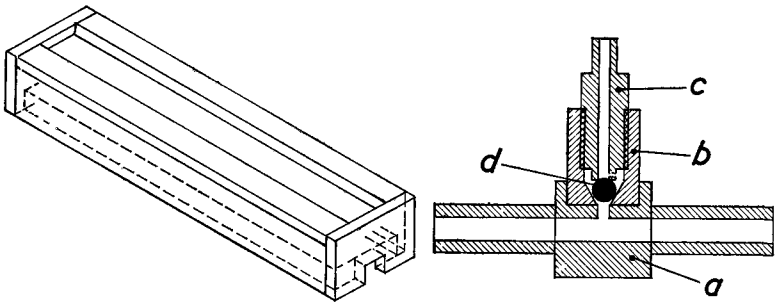
The piston rod (*f*) slides in a guide (*g*) held in position by three set-screws. This rod is connected to a rod (*h*) screwed into the end of the slide by a small link-piece (*i*) held in place by grub-screws. To assist the return of the piston a light compression spring is inserted between the head of the piston and the piston-rod guide.

Specimen tray (fig. 4). This is made of 'Perspex' and is made a press fit over the slide. A black tray is used for counting quartz grains, but when measurement by eyepiece graticule is required, a blue or grey tray is preferable.

Dimensions. The only dimensions of importance are the diameter and strokes of the pistons, since the volumes of the two cylinders must be the same. In the present apparatus the diameter and stroke of the master cylinder are $1\frac{1}{4}$ in. and $\frac{3}{4}$ in. respectively. The slave cylinder has

a bore of $\frac{5}{8}$ in. and a stroke of 3 in. Other dimensions are indicated in figs. 2 to 4 which are drawn to scale.

Filling and operation. The oil used is a light hydraulic oil (Shell Tellus 27). Any oil of low viscosity and good lubricating properties would be suitable, provided oil-resistant O-ring seals and connecting pipe are used. Motor-car brake fluid was used initially since it has a very low viscosity. Unfortunately, it is not a good lubricant and the slightly heavier hydraulic oil is preferred.



FIGS. 4 and 5: FIG. 4 (left): Specimen tray. Scale: Approx. $\frac{2}{3}$. FIG. 5 (right): Bleed valve. Scale: Approx. $\frac{2}{3}$. The connecting tubes and base of the valve (*a*) are turned from a single piece of $\frac{1}{2}$ in. square bar. The valve (*b*) itself is soldered into a recess bored in one face of the block. The screw (*c*) retaining the steel ball (*d*) has flats filed on it to fit a small spanner.

To fill the apparatus the control unit is partially dismantled and the piston removed. The cylinder is filled with oil and the piston inserted until the O-ring seal is just below the edge of the cylinder. The unit is then reassembled. The tube connecting the control and stage units consists of 6 ft of single wire-wound polythene tubing and has a bleed valve (fig. 5) inserted about 6 in. from the stage unit end. The tube is attached to the stage unit with the valve closed. With the piston removed from the stage unit, the cylinder and tube are filled with oil, care being taken that no air bubbles are trapped in the tube. The control unit is adjusted until oil is just overflowing from the hole in the piston rod and the connecting tube is attached. The control unit is then turned until the master cylinder is filled with oil. The slave cylinder is filled and the piston inserted. This inevitably traps some air, but by inverting the cylinder and opening the bleed valve this air can be flushed out, and at the same time the piston can be set to the end of its stroke. Finally, the bleed valve is closed, the spring replaced in the

slave cylinder, and the stage unit reassembled. By this procedure all air should be removed from the system.

In operation the stage unit is placed on the stage of the microscope and the control unit is placed on the floor convenient to the operator's foot.

It will be noted that no provision has been made for moving the specimen tray perpendicular to its length. This could readily be provided either by attaching the whole stage unit to a second plate with a rack and pinion or screw-thread movement, or by fitting a square mechanical stage to a large plate attached to the slide. Provision of this extra movement has not been found necessary since sufficient grains for accurate counting can be accommodated in the tray described.

While this apparatus has been designed for use with reflected light slight modification would enable it to be used with transmitted light. The slideway and the supporting plate would have to be pierced, the slide slotted lengthwise, and a transparent tray used.

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