March 5, 1968 J. S. SUTTON 3,371,833

GLASS KNIFE

Filed March 11, 1966

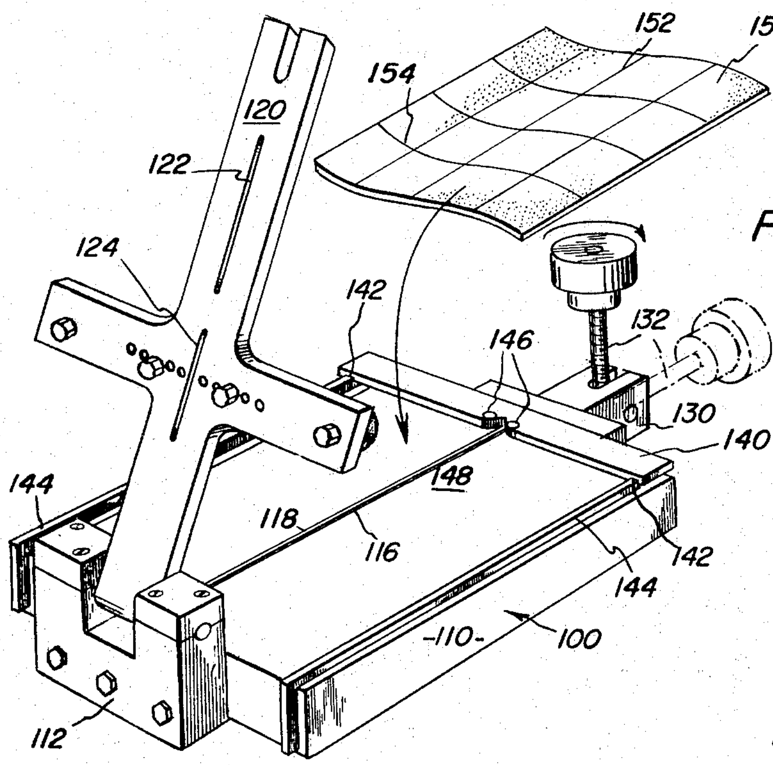


FIG. 1

FIG. 2

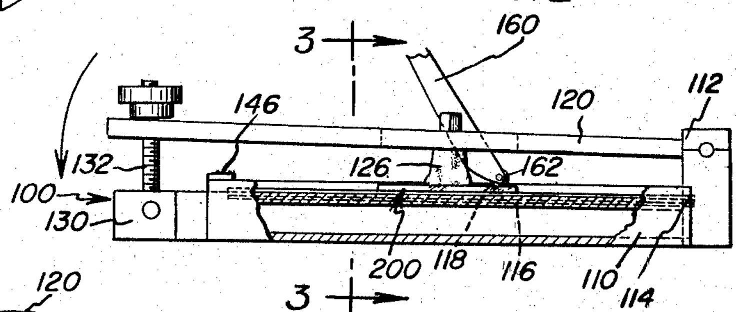


FIG. 3

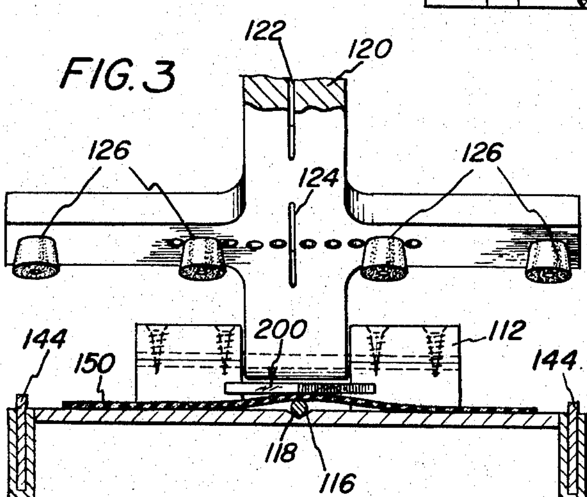
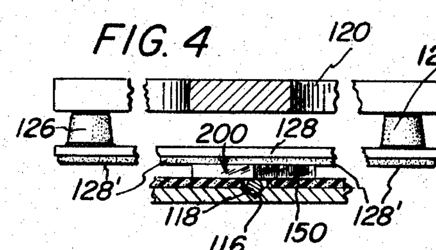


FIG. 4



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United States Patent Office

3,371,833

Patented Mar. 5, 1968

3,371,833

GLASS KNIFE

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Filed Mar. 11, 1966, Ser. No. 533,681
6 Claims. (Cl. 225—2)

ABSTRACT OF THE DISCLOSURE

This is a method and especial apparatus for making glass knives, useful in microscopic biology. Essential elements include a base, a round linear fulcrum set in the base, cushion-like cover for the fulcrum to hold the glass precisely in position and a pressure element which swings onto the glass by means of a micrometric pressure applying screw. The fracture of the glass is accurate and the glass free of defects.

The present invention relates to the controllable breaking of crystalline mass in one specific embodiment of which the breaking is used in the production of biological instrumentation, for example defect-free knife edges. In this concept, the same instrument is used for the gradual reduction of rectangular masses of glass, for example, to strips, rhomboids and squares, the instrument executing all breaks, including the final one producing the knife edge.

The most effective use of the present invention lies in the production of glass knives used specifically in ultramicrotomy in which ultrathin sections of embedded tissue are acquired for use in electron microscopy. The art of glass knife breaking is well known, but the production of a clean, accurate, defect-free fracture, both reductional and diagonal, on a controlled, reproducible basis has as yet to be developed. Pliers have been used to effect the purpose. Corresponding concavo-convex jaws here break along an index reference. The more common instruments resemble nut crackers in which a pointed fulcrum rests along the line of desired break, with opposed pressure points on either side of a score line, carefully aligned with the pointed fulcrum. It is desired in this art, that the cutting edge be at right angles to the major surfaces of the crystalline mass or glass. In practice, a square or rhomboid piece of glass is first developed for breaking. This can be attained through continuous and comparatively inaccurate reduction in size by conventional means to an appropriate size, as for example, two by two inches. In the present system one instrument can be used for the reduction in size, per se, and using the same instrument, as proposed, the most effective knives can be made.

With the objective of presenting a new method of glass knife preparation for ultra-thin-section microtomy in which the knives produced are free of strain and score marks, and include an accurate edge which is at substantially right angles, end to end with the surface of the glass broken, the following is submitted.

The invention is most clearly understood from reference to the accompanying drawings in which:

FIG. 1 comprises a view in perspective of invention showing the pressure element raised;

FIG. 2 is a view in side elevation showing the pressure element depressed;

FIG. 3 is an exploded view in section taken along the lines 3—3 of FIG. 2 illustrating the operative relationship of the pressure element, the crystalline mass in which is being broken and supporting fulcrum; and

FIG. 4 shows a pressure element modification.

In FIG. 1, the instrument 100 comprises a base 110 which is generally of rectangular configuration having at one end a pressure hinge 112, in turn adapted to receive a pressure element 120 hereinafter described in greater detail. At the near end opposite the hinge, there is provided a seat for pressure element clamping means, this seat 130 being in extension of the base 110. Intermediate the respective ends of the base 110 is a centrally disposed rod seat or groove 116 into which is placed a fulcrum rod 118, the same protruding at least its radius above the groove, providing thereby a breaking fulcrum which is substantially coextensive with the length of the base 110. Groove 116 is preferably V-shaped to accommodate fulcra of varying diameter. To prevent displacement of the rod in a transverse direction, it is seated at 114 adjacent the hinge abutment 112.

The diameter of the linear fulcrum is best varied with the size of the rectangular mass of glass to be fractured. In its present embodiment three diameters best effect the intended purpose: 0.0090, 0.1040, and 0.121 inch. In general, the larger the rectangular mass the larger diameter the fulcrum employed, e.g. (10" x 20" rectangle—0.0121 inch fulcrum) and vice versa. The principle embodied herein is that the fracture of the frangible crystalline mass is accomplished with minimal force along the linear axis of the fulcrum, thereby keeping stress marks and deflects to a minimum in the fracture plane. The velocity of the fracture can be finely controlled by the micrometric pressure applicator mechanism hereinafter disclosed.

In the embodiment shown, the pressure element is pressure or friction hinged for arcuate movement manually upwardly and downwardly. The pressure element comprises joined longitudinal and transverse cross-arms, the longitudinal arm of which includes plural slots for viewing and/or scoring, slots 122 and 124. Within the transverse cross-arm there are provided plural bores to seat the compressible pressure foci contacts 126 appropriately for applying pressure on opposite sides equi-distant from the fulcrum shown. In this instance, for adjustable contacts are illustrated, two on either side of the longitudinally extending cross-arm. These contacts comprise, preferentially, compressible silicone rubber pressure applicator feet, each adapted to deformably engage and dampen break the crystalline mass upon application of pressure by turning the clamp 132 once its shank is positioned in the clamp groove of extension 130 provided at the near end of the pressure element. The instrument shown is adapted to break all types of glass used currently in electron microscopy. The rounded fulcrum and compressible pressure foci effect the necessary alignments, provided accurate coordination of the piece of glass is effected along the fulcrum. In practice, one can obtain at least 75% yield of knives with at least an average of greater than 50% of the knife edges being useful in ultrathin sectioning of embedded tissue. Obviously, the contacts 126 may be independent of the pressure element; for example, if such contacts or pads were simply carefully placed upon the glass equi-distant from the fulcrum and in the path of the pressure element, satisfactory results could be achieved. The coordinates of the pad 150 are useful, in this connection. Squaring bar guide 140 rests in slidable relation to the base upon bilateral grooves 142 which, in turn, are adapted to the tracks 144. The guide provides accurate placement and vertical perpendicularly to the glass mass to be divided, irrespective of its overall size. Metal disc plugs 146 are situated each at the tip of the arms of the V-groove for accurate engagement and alignment of the apex of glass square or rhomboid.

To most effectively accomplish the controlled break, a cushioning blanket 150 is interposed between the substantially rigid fulcrum member, in this instance, rod 118, and the crystalline mass per se. The desired amount of dampening by the base rubber pad may be increased or decreased by varying its thickness accordingly. In this instance, the cushion member 150 contains longitudinal and transverse coordinates 152 and 154, each being adapted to alignment respectively with the fulcrum member and the ends of the device. These coordinates likewise are adapted to accurate alignment with apex of the squaring guide apex 148 appearing centrally of the guide 140. In practice, a square or rhomboid segment of glass 200 is aligned, with opposing corners overlying the longitudinally disposed fulcrum, the position of which is represented by the longitudinal central coordinate 152 of the pad 150. The near corner of the glass is positioned in the squaring guide 140 which has been adjusted into position. In this manner, careful alignment and accurate positioning of the glass can be effected without displacement, immediately prior to, during and after the breaking process. A scoring is made by application of the knife 160 which is guided by the channel 122 in cutting wheel alignment with the fulcrum 118. Cutter wheel 162 thus may score accurately. Upon application of the clamp, a slow, even break can be accomplished with the broken segments retained in situ on the blanket pending release of the clamp and pressure element.

The FIG. 4 modification of pressure element comprises an integral flexible bar 128 fixed to the applicators 126 by epoxy glue, a suitable pad 128′ being interposed between bar and the mass 200 to be broken upon fulcrum 118. In this adaptation, one can obtain a yield up to 90% and more than 75% of the edges on the glass knives may be used for ultra-thin sectioning. Fortuitously, knives thus produced have desired curvilinear edges. This device may be used with or without pad 150.

Effective methods of employing combinations of the linear fulcrum and dampened pressure foci in the final diagonal break to produce a knife edge include:

(A) Combining the bare fulcrum 118 and pressure element modification 128 shown in FIG. 4 with pad 150 bisected vertically, one-half covering the base 110 bilaterally to fulcrum 118, to dampen fracture. This is a preferred system.

(B) With padded fulcrum, three different methods are available involving dampening rubber strips placed across the fulcrum 118:

(a) Strip width coextensive with diagonally opposed corners lying along line of intended fracture.

(b) Strip width exceeding slightly the diagonal length of square or rhomboid to be fractured.

(c) Strip width less than diagonal length in such manner that opposing corners along line of intended fracture overlap rubber pad edge affording precision visual alignment with linear axis of fulcrum.

(d) Two rubber strips placed over fulcrum such that opposing corners overlap upper and lower strip edges leaving zone of bare fulcrum between. Accurate precise alignment with fulcrum available.

The versatility of the instrument lies in the preferential number of principal combinations with fulcrum size, dampened pressure foci and visual and manual control of fracturing velocity. The flawless edges of the glass masses obtained reflect perfect optical images within. Furthermore, these reflected images insure critical alignment of the glass piece upon the fulcrum and finer control over the breaking velocity through earliest visual perception of the developing fracture at which point pressure application is stopped.

With these and other objectives in view, it will be ap-

parent that the invention in its broadest aspects is represented by the appended claims, and that various modifications to the construction can be effected without avoidance thereof. For example, the fulcrum may be integral; various combinations of fulcrum, micrometric pressure application and dampening effect may be selectively undertaken to accomplish similar defect free breaks.

In the claims:

1. In the controllable linear fracturing of crystalline mass, the system of:

(A) fixing a round linear fulcrum against displacement;

(B) cushioning the fulcrum to secure the mass in situ resting the mass on the cushioned linear fulcrum which said cushion and fulcrum are set coordinately with the line of intended fracture of the mass;

(C) scoring the mass parallel to the linear fulcrum;

(D) simultaneously progressively applying minimal fracturing pressure to the mass on opposite sides of the linear fulcrum, whereby to obtain an accurate linear fracture of the mass which is free of stress marks and defects.

2. The system of claim 1 further including micrometrically progressively applying minimal fracturing pressure to the mass to obtain an accurate linear fracture thereof.

3. A device for fracturing crystalline mass comprising:

(A) a base;

(B) linear fulcrum means set in the base, said fulcrum means including cushion covering to support the crystalline mass, the fulcrum and covering being coordinately set with the line of intended fracture of the mass;

(C) a pressure element in hinged connection with the base, overlying the fulcrum;

(D) pressure application means mounted on the base and engaging the pressure element to controllably apply the pressure element to the mass to fracture same linearly along the line defined by the fulcrum.

4. The device according to claim 3 in which the fulcrum is curvilinear and at least coextensive with the length of the mass.

5. The device according to claim 3 wherein the pressure element is laterally flexible.

6. A device for fracturing crystalline mass comprising:

(A) a base;

(B) linear fulcrum means set in the base, said fulcrum means being cushion covered to support the mass;

(C) a pressure element in hinged connection with the base, overlying the fulcrum;

(D) micrometric pressure application means mounted on the base and engaging the pressure element to controllably apply the pressure element to the mass to fracture same linearly along the line defined by the fulcrum.

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