

March 27, 1956

G. G. COCKS ET AL

2,739,507

MICROTOME

Filed Nov. 1, 1951

2 Sheets-Sheet 1

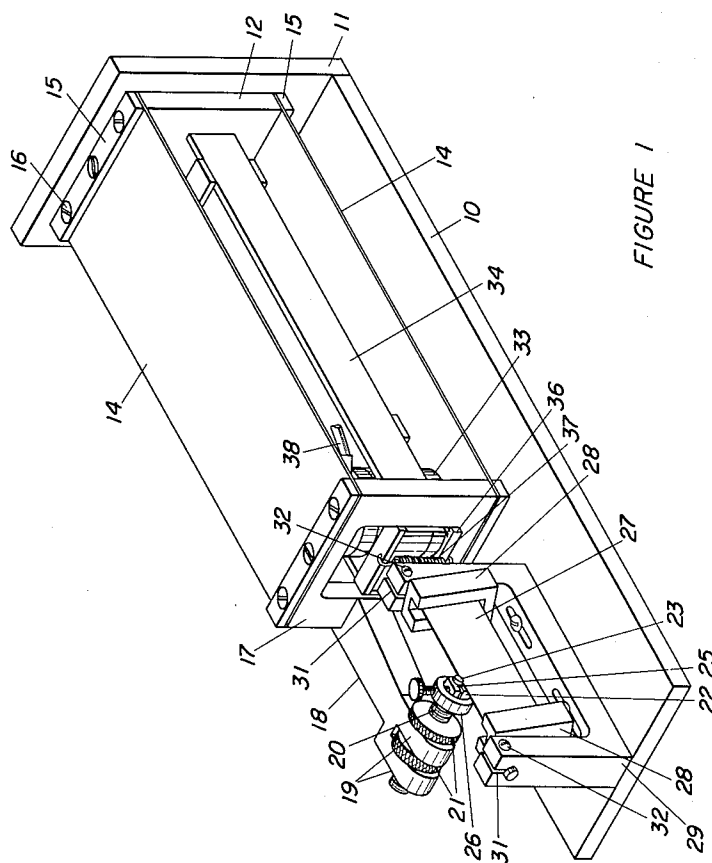


FIGURE 1

INVENTORS.

George G. Cocks

Charles M. Schwartz

BY

Adams, Mac Matthews
Gray & Wilbermuth
AGENTS

March 27, 1956

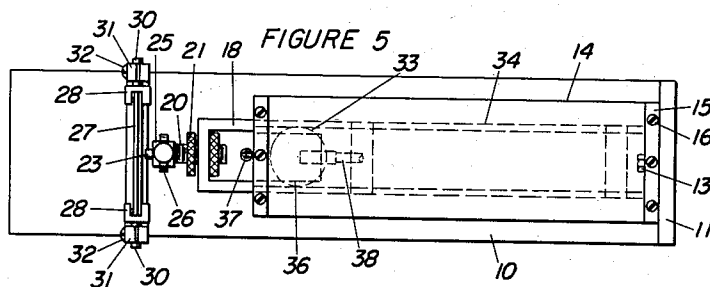
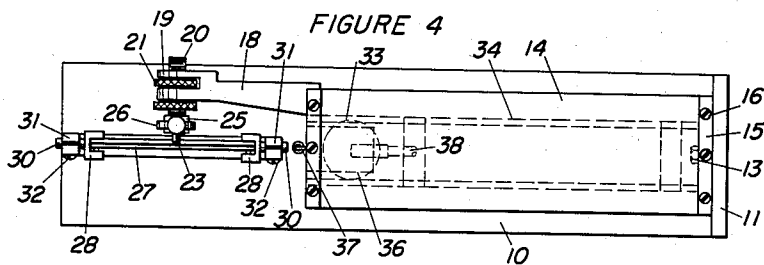
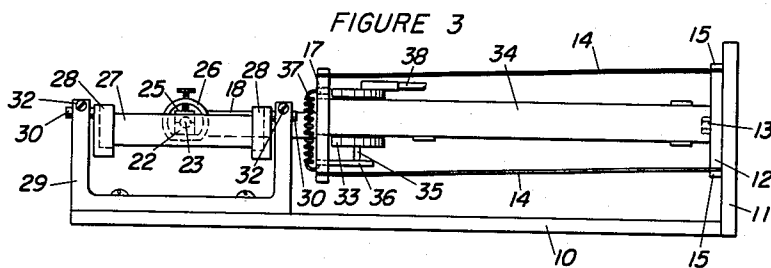
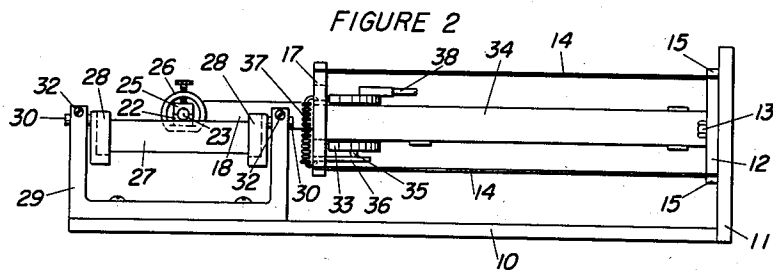
G. G. COCKS ET AL

2,739,507

MICROTOME

Filed Nov. 1, 1951

2 Sheets-Sheet 2



INVENTORS.

George G. Cocks
Charles M. Schwartz

BY *Adams, Mason, Matthews*
Tracy & Wilbermuth
AGENTS.

1

2,739,507

MICROTOME

George G. Cocks, Worthington, and Charles M. Schwartz, Columbus, Ohio, assignors, by mesne assignments, to The Battelle Development Corporation, Columbus, Ohio, a corporation of Delaware

Application November 1, 1951, Serial No. 254,308

2 Claims. (Cl. 88—40)

This invention relates to cutting instruments. More particularly, it relates to an apparatus which is simple in construction and operation, and which will accurately cut thin slices of material.

In the preparation of specimens for study under a microscope, it is highly important that successive sections cut from the material be uniform in thickness. Such uniformity is of even greater importance when an electron microscope is to be used, since the sections must be approximately 0.1 micron in thickness. In cutting a plurality of such thin sections, the apparatus must be capable of accurately reproducing the required relative motion of the cutting means across the specimen.

It has been customary to use oil- or grease-lubricated bearings or slideways in the movable parts of machines for sectioning. However, when such machines are used for cutting sections in electron microscopy, the uncertainty of the lubricant film thickness and also the dimensional tolerances are limiting factors in determining the accuracy of reproduction of the movements. Difficulty has also been encountered in prior-art machines in coordinating the advancement of the specimen and the cutting stroke, particularly when one, or both, of the operations are performed manually. In addition, the delicate adjustments necessary for accurate sectioning are very sensitive to changes in temperature and are usually disturbed by vibrations.

It is, accordingly, one of the objects of this invention to provide an apparatus for sectioning materials which is simple in construction and operation, and yet is capable of accurately cutting successive sections of uniform thickness.

It is a further object to provide an apparatus for cutting thin sections of material which are suitable for use in microscopy.

Yet another object is to provide an apparatus for sectioning which will be relatively unaffected by vibration or changes in temperature.

Other objects and advantageous features will be apparent from the following detailed description and drawings, in which:

Fig. 1 is a perspective view of the apparatus.

Fig. 2 is a front view, showing the apparatus in an inoperative position prior to the cutting stroke.

Fig. 3 is a view similar to Fig. 2, but showing the apparatus at the end of a cutting stroke.

Fig. 4 is a plan view.

Fig. 5 is a plan view showing a modification of the apparatus.

In general, the apparatus of this invention comprises a material supporting member mounted on one or more cantilever-suspended arms, which, in turn, are fastened to a support extending upwardly from a base. The material supporting member is moved by some suitable means such as the action of a hydraulic piston. Material to be cut is mounted in the supporting member and positioned so as to contact a knife edge when the support is moved by the piston.

2

Referring again to the drawings, Figs. 1, 2, 3, and 4, the apparatus is mounted on a base 10. Extending upwardly from the base 10 is an end plate 11. A cantilever-support plate 12 is rotatably fastened to end plate 11 by means of a nut-and-bolt assembly or other suitable means 13. One or more cantilever strips 14 are connected at one extremity to support plate 12 by means of fastening plates 15 and screws 16. The unsupported ends of the cantilever arms 14 are connected in a similar manner to a frame 17 to which is affixed a specimen support arm 18.

The free end of support arm 18 terminates in two lugs 19, provided with holes through which pass a threaded metal shaft 20, extending at right angles to support arm 18. One or more knurled wheels 21 provide a coarse lateral adjustment of the threaded shaft 20, and also lock it in position. The outwardly extending end of shaft 20 terminates in a chuck plate 22, having a cut-out portion for mounting the material to be cut 23. A fiber insert, not shown, may be used to thermally insulate the chuck plate 22 from the support arm 18. A fastening plate 25, having a corresponding cut-out portion, fits against chuck plate 22, and the assembly is locked together by means of a vise 26, or other suitable means.

A knife 27, which may be glass, steel, or any other suitable material, is rigidly mounted in knife holders 28. The knife holders 28 are rotatably mounted in upstanding arms of support 29 by means of shafts 30, whose axes are aligned with the cutting edge of knife 27, and which pass through split bushings 31. The split bushings are clamped about the shafts 30 by screws 32. By means of this arrangement the knife is rotated about an axis which coincides with the cutting edge itself. It is preferable that the knife be supported so that the cutting plane lies in the central vertical plane of the apparatus. This serves to prevent any twisting or buckling of the cantilever members.

The initial spacing of the material 23 over the knife 27 is made by means of knurled wheels 21. In the embodiment shown in the drawings a fine feed adjustment can be accomplished thermally by first cooling the chuck plate 22 below room temperature. As sections are cut from material 23, the chuck plate 22 is allowed to warm to room temperature. The expansion of the chuck plate 22 slowly moves the material 23 across the plane of the cutting edge of knife 27.

The movement of the material 23 against the cutting edge is accomplished by a hydraulic piston 33, held by a supporting assembly 34 which is fastened to the cantilever support plate 12. A plunger 35 actuated by piston 33 moves against a plate 36, which is integral with frame 17, and forces the material 23 in contact with the knife 27.

In order to minimize twisting or buckling of the cantilever members, it is desirable to have the driving force located as near to the cutting plane as possible.

A spring 37 connects the piston supporting assembly 34 and frame 17 at plate 36 for the purpose of returning the cantilever arm 14 to the starting position at the end of the cutting stroke. An oil tube 38 is connected to piston 33, and to an oil reservoir, not shown, to provide driving means. A suitable valve, also not shown, may be used to admit air to the reservoir and also to provide a release of air pressure when it is desired to return the cantilever arms 14 to their starting position.

The length or tension of spring 37 may also be so adjusted that the cantilever arms 14 have a zero deflection when the cutting stroke is half completed. In such an arrangement the upward deflection of the cantilever arms 14 at the inoperative position is approximately equal to the downward deflection at the end of the cutting stroke. This results in a reduction of the elastic deformation of the cantilever systems and reduces the maximum stress

3

in the cantilever arms for a given motion of the specimen.

The cutting machine shown in Figures 1, 2, 3, and 4 is operated in the following manner: The material to be cut 23 is mounted between the chuck plate 22 and fastening plate 25, and locked in place by vise 26. The material 23 is initially moved to a position where it extends over the knife 27, and locked in position by the knurled knobs 21. The chuck plate 22 is then cooled by using Dry Ice or other suitable substance. Air is admitted to the reservoir which results in a downward stroke of the material 23. A release of the air pressure permits the cantilever arms 14 to return the material 23 to its position above the knife 27.

Since the chuck plate 22 expands continually as it is heated to room temperature, the use of identical temperature intervals between the cutting strokes will result in material cuts of the same thickness. It is possible to connect a thermocouple to the chuck plates 22 to determine the desired temperature interval, or a calibration table can be prepared to show the proper time interval between the cuts for any desired thickness. Other methods may be used for advancing the material during cutting. It may also be desirable to maintain the material in fixed position and provide for movement of the cutting edge.

Fig. 5 is a modification of the cutting machine in which the knife 27 is mounted on the base 10 at right angles to the cantilever arms 14. In this arrangement the material 23 is mounted in line with the cantilever arms. Some modification will be necessary in the mounting of the threaded shaft 20 in the support arm 18. It may also be desirable in this embodiment to construct the support arm 18 or the entire machine of Invar or some other similar material in order to minimize expansion during temperature changes. In this modification, cantilever support plate 12 may be rotated about nut-and-bolt assembly 13, so that the material 23 contacts knife 27 with a slicing cut instead of a chopping cut.

From the foregoing description it can be seen that this cutting machine is adapted to a wide range of section sizes and yet will reproduce the sizes accurately. No oil or grease lubrication is needed, and the mechanism is not sensitive to outside influences of vibration or temperature change.

4

While several specific forms have been given as illustrative of the machine, it is to be understood that the invention is not to be limited thereby, but only by the scope of the following claims.

What is claimed is:

1. A microtome capable of cutting uniform sections approximately 0.1 micron thick, comprising: a flat base; a support member rigidly connected to said base adjacent one end thereof and extending upwardly therefrom; a plurality of spaced resilient cantilever arms, each comprising a flat spring rigidly attached at one end to said support member and extending therefrom over, and substantially parallel to, said base; a rigid spacer member fixedly connected to the opposite end of said flat springs for maintaining them in spaced parallel relation to each other; a fixed member rigidly connected to, and extending from, said spacer member; material-holding means mounted on said extending member; means for elastically deforming said cantilever arms to provide movement of said material-holding means toward and away from said base; and cutting means mounted on said base adjacent the end of the base opposite said support member in a position to cut the material in said material-holding means during said movement thereof.

2. A microtome according to claim 1, in which said deforming means comprises a piston held by supporting means rigidly mounted with respect to said base, and a plunger actuated by said piston positioned to move said spacer member in a direction substantially perpendicular to said base.

References Cited in the file of this patent

UNITED STATES PATENTS

775,556	Dieckmann	Nov. 22, 1904
1,765,283	Patterson et al.	June 17, 1930
1,998,428	Huettnner	Apr. 16, 1935
2,312,010	Akker	Feb. 23, 1943
2,439,671	Ott	Apr. 13, 1948

FOREIGN PATENTS

8,258	Great Britain	of 1899
666,552	Germany	Oct. 22, 1938