July 10, 1956 J. HILLIER 2,753,761

MICROTOMES

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Fig. 1.

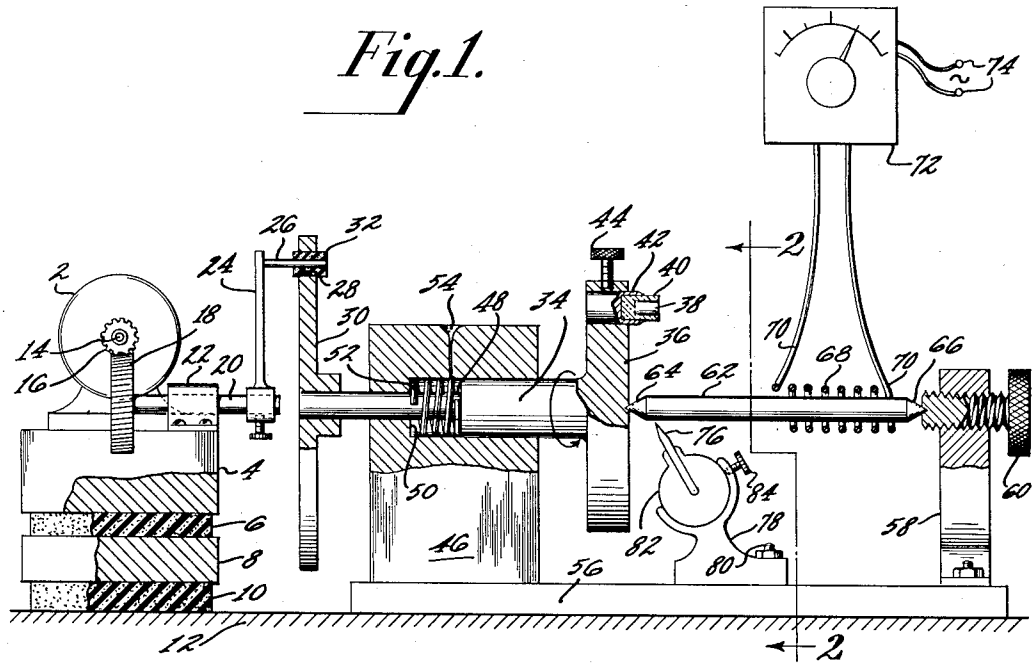
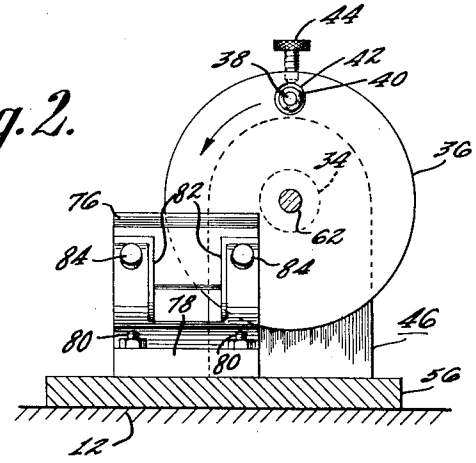


Fig. 2.



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2,753,761

MICROTOMES

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The terminal 15 years of the term of the patent to be granted has been disclaimed.

4 Claims. (Cl. 88—40)

This invention relates to microtomy, and more particularly to means for obtaining ultra thin sections suitable for use as specimens in an electron microscope.

In electron microscopy, difficulty has been experienced in obtaining uniformly thin specimens. In the usual microtome for cutting these specimens, a holder is provided for the sample from which specimen sections are to be cut. The holder is fed into the path of the cutting blade by some means such as a feed screw. In other words, the control of the thickness or uniformity of the specimen is determined by the means pushing the holder toward the blade. It is in the pushing apparatus that much of the irregularity of the motion occurs. This is largely due to the static friction between the several members of the pushing apparatus, and to inaccuracies in the feed screw. A further source of irregularity in the specimens is the irregular vibration of the driving motor which is transmitted to the cutting stage of the apparatus.

It is, accordingly, an object of this invention to provide an improved microtome which overcomes the foregoing objectionable characteristics.

It is another object of this invention to provide an improved microtome as set forth wherein the advancement of the specimen toward the cutting knife is controlled by the relaxation of a restraining force.

A further object of this invention is to provide a microtome as set forth which is further characterized in that the vibrations of the drive motor are prevented from influencing the severing of the specimen.

In accomplishing these and other objects, there has been provided, in accordance with the invention, a microtome in which the specimen is mounted near the periphery of a massive fly wheel. The wheel rotates fairly slowly, moving the specimen past a stationary knife. The whole fly wheel is spring biased in a direction towards the knife. The advancement of the specimen bearing fly wheel is controlled by the thermal expansion or contraction of a needle thrust bearing. The temperature of the thrust bearing is controlled electrically. The vibrations of the drive motor are isolated from the cutting stage by special, relatively high frequency, mechanical filters.

A better understanding of this invention may be had from the following detailed description when read in connection with the accompanying drawing in which:

Fig. 1 is an elevational view, partly broken away, of a microtome embodying the present invention; and

Fig. 2 is a view taken along the line 2—2 of Fig. 1 and looking in the direction of the arrows.

Referring now to the drawings in more detail, there is shown a motor 2 which is mounted on a heavy base 4. The base 4 may be made of lead, for example, and should be sufficiently massive to weigh several times as much as the motor 2. Below the lead base 4 there is a pad 6 of resilient material such as sponge or foam rubber. Under the pad 6 there is another block 8 of heavy material such as lead, followed by a second pad 10 of resilient material, which, in turn, rests upon a support or table 12.

The motor 2 has a shaft 14 to which is affixed a worm gear 16. The worm gear 16 cooperatively engages a complementary gear 18 which is fixed to the end of a shaft 20. Suitable means, such as bearing 22, are provided for supporting the shaft 20. A crank arm 24 is secured to the end of the shaft 20. The free end of the crank arm 24 carries a driving pin 26.

The driving pin 26 is inserted through a hole 28 in a driving wheel 30. The hole 28 is considerably larger than the pin 26. This permits the placing of a pad 32 of vibration damping material in the hole surrounding the driving pin. The driving wheel 30 is secured to one end of a shaft or spindle 34. The other end of the spindle carries a main or specimen carrying wheel 36.

The specimen 38 is mounted in an embedment 40 of a suitable plastic which, in turn, is held in a cylindrical holder 42. The holder 42 is carried by the specimen wheel in any suitable manner, such as by clamping the holder in an opening in the wheel 36 as by a thumb screw 44. The spindle 34, together with the two wheels associated therewith are supported by a heavy bearing member 46. It will be noted from the drawing that the spindle has a step 48 thereon and that the bearing is counterbored to form a shoulder 50. A spring 52 is positioned in the bore of the bearing between the shoulder 50 of the bore and the step 48 of the spindle. An opening 54 is provided in the bearing which may serve both as an oil hole and an air passage. The bearing member 46 is secured to one end of a sub-base member 56.

A rigid post member 58 is secured to the other end of the sub-base member 56. Through the post member 58 there is carried an adjusting screw 60. Supported between the end of the adjusting screw 60 and the axis of the main wheel 36 is a thermally activated variable thrust bearing 62 having needle ends 64 and 66. An electric heating coil 68 is mounted on the thrust bearing 62 in such a way that the thrust bearing may be heated thereby. The heating coil 68 may be connected, by means of suitable leads 70, through a suitable control means 72, to a source of electrical energy 74.

There is provided a knife 76 which may be mounted in a more or less conventional mounting. The knife mounting may comprise a bracket 78 which is adjustably secured to the sub-base 56 as by bolts 80. The bracket may be moved in a direction to move the knife toward or away from the main or specimen wheel 36 to a rough approximation of the desired position. Then it may be secured in that position by tightening the bolts 80. The blade or knife 76, itself, is carried by a pair of cylindrical knife holders 82 which are, in turn, adjustably supported in the bracket 78 and secured therein as by thumb screws 84.

In operation the motor 2 drives the worm gear 16 which, in turn, drives the complementary gear 18 and hence the shaft 20. The crank arm 24 turns with the shaft 20, carrying the pin 26. Since there is no need for high speed rotation of the specimen wheel 36, the arm 24 may be driven very slowly, and the system need not be dynamically balanced.

The driving pin 26 fits into the hole 28 in the driving wheel 30 in driving relation thereto. Although the system need not be dynamically balanced, higher frequency vibration, such as would be developed by the motor, must be eliminated from that portion of the system directly associated with the cutting stage. Consequently there is a vibration absorbing pad 32 surrounding the pin 26 in the hole 28 of the wheel 30. The pad 32 may be made of sponge rubber, of woven metal sponge, or of a combination of both. To further prevent the motor vibration from influencing the cutting stage of the system, the mounting arrangement for the motor, including the alternate layers of lead 4 and 8 and rubber 6 and 10 serves as

a mechanical filter, absorbing any relatively high frequency vibrations.

The spring **52** is compressed between the step **48** on the spindle **34** and the shoulder **50** of the bore of the bearing **46**, tending to press the spindle **34**, together with the specimen wheel **36**, toward the knife **76**. However, the needle thrust bearing **62** prevents the advance of the wheel toward the knife.

When it is desired to cut specimen sections from the sample mounted on the specimen wheel, the heating coil **68** is energized, heating the thrust bearing **62**. The thrust bearing expands in accordance with the usual laws of thermal expansion. While maintaining the temperature of the thrust bearing **62**, and while the specimen wheel is being rotated by the motor **2**, the knife bracket **78** is positioned to the approximate position to engage the specimen. A fine adjustment may be made by turning the adjusting screw **60**. The circuit control means **72** is adjusted to allow the thrust bearing **62** to cool according to a predetermined schedule. As the thrust bearing **62** cools, it contracts, allowing the spring **52** to urge the specimen wheel **36**, together with the specimen, toward the knife.

As previously indicated, static friction has played a large part, in prior art microtomes, in the irregularity of the specimen sections obtained. In the instant machine, static friction is eliminated. There is only one moving part in the cutting stage of the system, the assembly comprising the spindle **34** and wheel **36**. Since that assembly is being rotated by the motor **2**, there is only dynamic friction to be encountered. Dynamic friction may, of course, be overcome with a much smoother motion than static friction.

Further, the control of the advancement of the specimen into the knife by the contraction of the thrust bearing produces a smoother, steadier motion than would some of the more conventional feed screw arrangements.

The rate of contraction of the thrust bearing may be controlled by controlling the initial temperature to which the bearing was raised, and the rate of cooling thereof. The thickness of the sections of the specimen will be a function of the rate of contraction of the thrust bearing and the angular velocity of the specimen wheel.

Thus it may be seen that there has been provided an improved microtome which is characterized in that it is substantially free from mechanical vibrations from the drive motor, that it is free from static friction in the advancement of the specimen toward the knife, and that the advancement of the specimen toward the knife is controlled by the relaxation of a restraining force.

What is claimed is:

1. A microtome for obtaining ultra thin sections of a specimen comprising a holder for said specimen having a shaft and means attached to one end of said shaft for securing said specimen in a position eccentric to the axis of rotation of said shaft, a support bearing for said holder having a bore therein, said shaft being inserted in said bore, means providing for the rotation of said shaft, means for holding a blade for sectioning said specimen, means for elastically biasing said shaft for translatory movement towards said blade, a thrust bearing engaging said specimen holder and disposed to cooperate with said one end of said shaft, and means coupled in heat exchange relationship with said thrust bearing to provide for the thermal expansion and contraction thereof thereby controlling the advancement of said holder towards said blade.

2. A microtome for obtaining ultra thin sections of a specimen comprising a holder for said specimen having a shaft and means attached to one end of said shaft for securing said specimen in a position eccentric with the axis of rotation of said shaft, a support bearing for said holder having a bore therein, said shaft being inserted in said bore, means providing for the rotation of said shaft, means for holding a blade for sectioning said specimen, means for elastically biasing said shaft for translatory movement towards said blade, a thrust bearing engaging said specimen holder and being disposed to cooperate with said one end of said shaft in restraining the advancement of said specimen holder towards said blade, and electric heating means coupled in heat exchange relationship with said thrust bearing to vary the temperature of said thrust bearing and to thereby vary the length thereof in accordance with the laws of thermal expansion.

3. A microtome according to claim 2 including means for controlling the energization of said heating means whereby to establish a predetermined schedule of cooling of said thrust bearing, the contraction of said thrust bearing upon cooling constituting a control over the advancement of said holder toward said blade under the influence of said biasing means.

4. A microtome for obtaining ultra thin sections of a specimen comprising a rotatable holder for said specimen formed from a shaft, a wheel having a common axis of rotation with said shaft attached to one end thereof, and means for clamping said specimen to said wheel in a position eccentric with said axis, a support bearing for said holder having a bore therein, said shaft being inserted in said bore, the diameter of said bore being larger than the diameter of said shaft to provide for free translatory movement of said shaft along said axis, means for holding a blade for sectioning said specimen, a spring for biasing said shaft for translatory movement towards said blade, a thrust bearing disposed on the side of said wheel opposite from said shaft, said thrust bearing engaging said wheel at the center thereof, heating means coupled in heat exchange relationship with said thrust bearing to provide for the thermal expansion and contraction thereof thereby controlling the advancement of said holder towards said blade, a motor coupled to said shaft for rotating said holder for said specimen, and mechanical filter means separating said motor from said holder and supporting said motor whereby vibrations originating at said motor are prevented from influencing the sectioning of said specimen.

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