

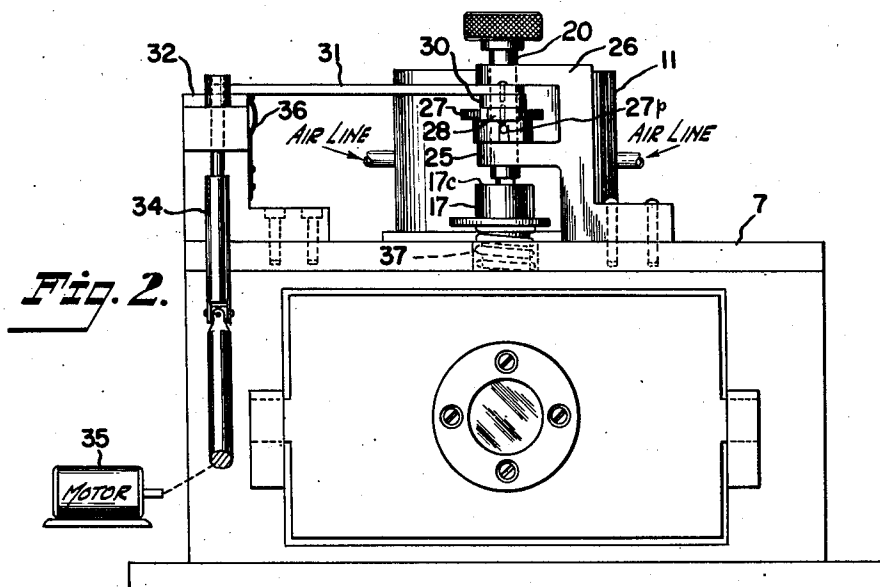
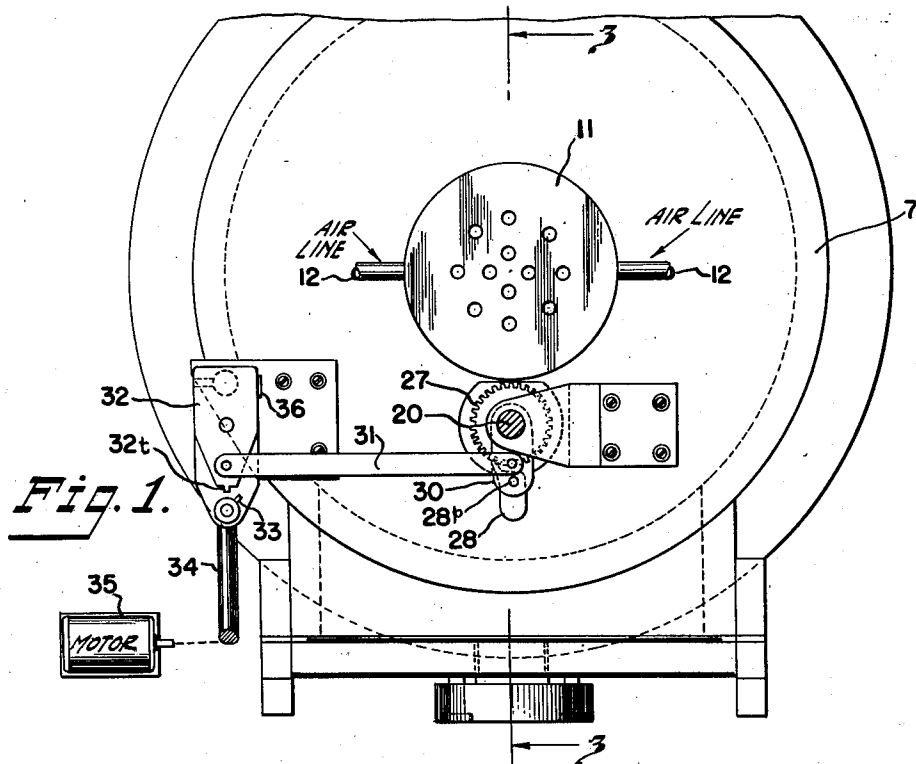
March 2, 1954

P. C. SMITH ET AL
HIGH-SPEED MICROTOMY

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2 Sheets-Sheet 1



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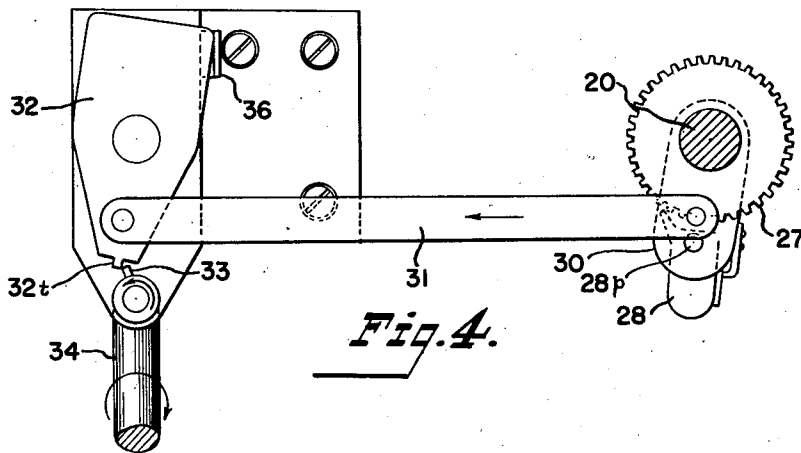
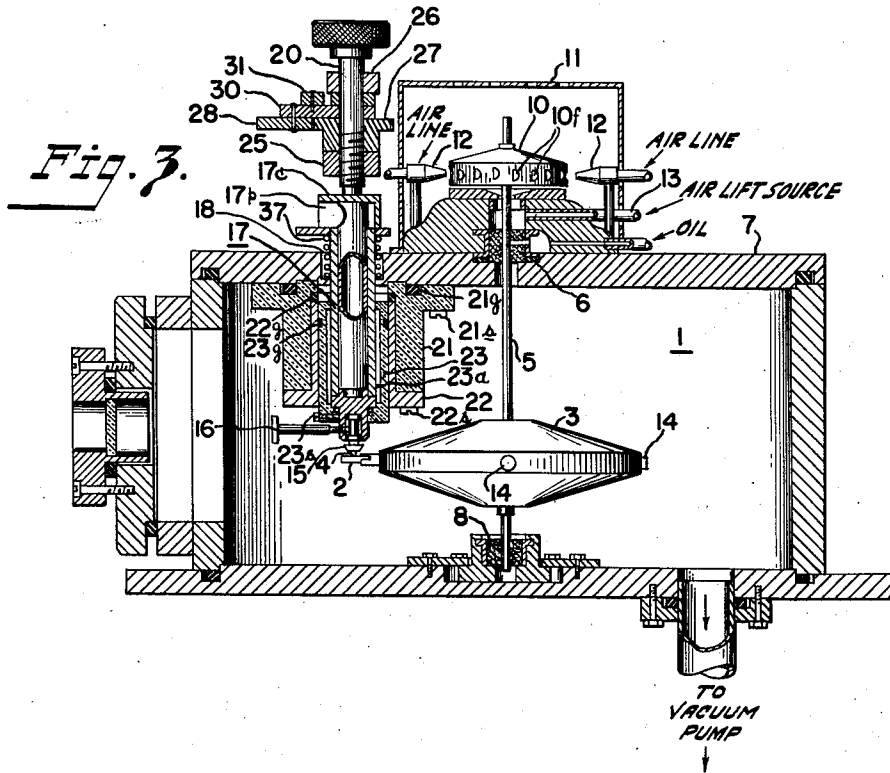
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UNITED STATES PATENT OFFICE

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HIGH SPEED MICROTOMY

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1 Claim. (Cl. 88—40)

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This invention relates to improvements in the art of high speed microtomy.

Modern high-speed microtomes consist, essentially, of a mechanism capable of rotating a blade at a speed of, say, 500 to 1200 revolutions per second, and a specimen holder, usually driven by an electric motor, for advancing the specimen in the path of the blade. The thickness of the sections cut from the specimen by the rapidly rotating blade corresponds to the distance that the specimen is advanced during a single revolution of the blade. The desired section thickness is generally between 0.1 of a micron and 1.0 micron. Where knife speeds of the order of 60,000 revolutions per minute are employed, a specimen advance lasting one second will result in the production of 1000 cut sections. Such a superabundance of cut sections is not in itself undesirable but nevertheless has certain undesirable features, such as: (a) mechanical generation of heat in the specimen being cut and (b) damage to the blade due both to heat and to the force of impact. Instances have occurred wherein the edge of the blade was destroyed upon cutting a very few sections. Subsequent action of the destroyed edge on the specimen may produce undesirable fragmentation of the specimen which appears on the section collecting device of the microtome as undesirable waste matter which may hide or contaminate the properly cut sections.

Accordingly, the principal object of the present invention is to provide a method of, and apparatus for, preventing the generation of excessive heat within, and consequent damage to, the specimen and the knife of a microtome of the type wherein the specimen is presented to a knife rotating at a speed of upwards of, say, 500 revolutions per second.

Stated generally, the foregoing and related objects are achieved in accordance with the invention by continuously advancing the specimen into the path of the rapidly rotating knife during a succession of time-spaced cutting intervals.

The invention will be described in greater detail in connection with the accompanying drawings, wherein:

Fig. 1 is a top plan view of a high speed microtome showing the specimen advance mechanism of the present invention;

Fig. 2 is a front elevation of the microtome,

Fig. 3 is a section taken on the line 3—3 of Fig. 1 and

Fig. 4 is an enlarged plan view of the specimen advancing mechanism shown in Fig. 1.

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In the drawings, wherein the same reference characters have been applied to all figures, 1 designates an evacuable chamber containing a cutting blade 2 which is secured to the periphery of a rotor 3, and 4 designates a specimen which is mounted, in a manner later described, for movement into the path of the blade. The rotor 3 which may be, say, four inches in diameter, is preferably constituted of solid metal in order to withstand the highest practical speed, in the range of from 500 to 1200 cycles per second, to which it may be subjected. The shaft 5 upon which the rotor is mounted extends through a rubber or other suitable vacuum-tight bushing 6 in the lid 7 of the chamber 1. The bearing 8 for the lower end of the shaft 5 is contained within the chamber 1. This shaft terminates, exterior of the chamber 1, in a Pelton wheel 10 which is arranged in a housing 11, to be driven by compressed air applied to the flutes 10f of the wheel through nozzles 12.

In order to minimize drag in the supporting bearing, the rotor 3 and its shaft 5 are mounted to permit of slight axial movement. Such movement is provided by an auxiliary source of air 13 which operates to lift the wheel 10 (say, one or two thousandths of an inch) so that there is no load or thrust on the ends of the shaft 5. The shaft 5 is relatively thin (say, $\frac{3}{32}$ " diameter) so that it can flex, making the rotor substantially free to seek its own center of rotation. The unbalance which might be occasioned by the presence of the blade 2 is compensated by small weights 14 suitably distributed on the periphery of the rotor 3.

The specimen 4, which is to be cut, protrudes from an embedment (not shown) in a small receptacle 15 which is secured as by a set screw 16 to the lower closed end of a hollow rod 17 which extends an adjustable distance through an opening 18 in the lid 7 of the chamber 1. The outer end of this hollow rod is covered by a cap 17c having a flat top against which a force is applied, in a manner later described, by a screw 20, for the purpose of moving the rod 17 downwardly during operating intervals in order to feed successive surface portions of the specimen to the blade 2. A refrigerant (e. g. "Dry Ice") for abstracting heat from the specimen may be entered into the hollow interior of the rod 17 through a port 17p in the side of the rod beneath the cap 17c.

The space about the opening 18 in the lid 7 through which the rod 17 extends is rendered vacuum-tight by a nest of three bushings 21, 22, and 23 of a special construction and arrangement

designed to prevent the refrigerant from being dissipated by heat conducted from the walls of the housing to the interior of the rod. The outermost bushing 21 comprises an open-ended cylinder formed of a suitable heat-insulating material (e.g. methyl-methacrylate resin) which bears against a gasket 21g surrounding the opening 18 in the lid 7 and which is secured to the lid as by means of screws 21s. The middle bushing 22 is constituted of a heat conducting material, such as brass, and contains a gasket 22g which is clamped on a shoulder within the outermost bushing by the force applied thereto by screws 22s which extend into the lower end of the outermost bushing 21. The innermost bushing 23 is made of heat insulating material and is of a diameter sufficiently large to provide a dead air-space 23a about the rod 15 throughout a portion of its length. This inner bushing 23 and the gasket 23g in its side wall, is maintained in the brass bushing 22 as by a set screw 23s.

The screw 20 which serves to advance the specimen 4 on the rod 17, intermittently into the path of the rapidly rotating knife 2, is supported in an internally threaded arm 25 of a bracket 26 on the lid 7 of the chamber 1. The force required to advance the screw 20 and the rod 17 on which the specimen 4 is supported, is applied to the screw by a ratchet 27 and pawl 28. The ratchet 27 is keyed to the unthreaded portion of the screw 20 by a pin 27p, and the pawl 28 is attached, by a pivot 28p, to the outer end of a short arm 30 which is free to move about the screw as an axis. The movable arm 30 and hence the pawl 28 are connected by a link 31 to a cam 32 having a single tooth 32t to which a driving force is intermittently applied by a single-toothed gear 33 which is driven by a shaft 34 connected to a variable speed motor 35 (Figs. 1 and 2). The force required for the return movement of the cam 32, the link 31 and the pawl 28 is provided by a spring 36 which exerts its force against the free end of the cam. The specimen may be backed away from the knife 2 by manually releasing the pawl 28 and turning the screw 20, and the ratchet 27, in a counterclockwise direction. As shown more clearly in Figs. 2 and 3, the specimen holding rod 17 is biased upwardly by a coil spring 37 which normally exerts its force against the intermittent downward movement of the screw 20.

By limiting the time spaced intervals during which the specimen is advancing into the path of the rapidly rotating blade to a period of, say 0.1 second, and by establishing a period of rest of, say 0.9 second, between the said periods of advance, the heating rate corresponds to 100 sec-

tions per second, rather than 1,000 sections per second. Thus, the heating problem is reduced by a factor of ten. A rest period of 0.9 second is long enough to permit starting or stopping of the feed mechanism, hence under the conditions mentioned above the total number of sections cut from the specimen may be limited to one hundred.

The above specified cutting and idle periods have proved to be entirely satisfactory in the cutting of sections of bone (and other materials of similar hardness) for examination in an electron-microscope of the transmission type. A cutting period less than 0.1 second is recommended in the cutting of specimens, constituted of solid metal. The duration of the cutting periods may be altered simply by varying the speed of the motor 35 which drives the single toothed gear 33.

What is claimed is:

In a microtome, a rotor, a knife carried by said rotor, means for continuously driving said rotor at a predetermined high rotational speed, a specimen holder mounted for movement into the path of said knife along a line substantially normal to said path, means for repeatedly advancing said specimen holder continuously toward said path during a plurality of rotations of said rotor and holding said specimen holder against advancement during another plurality of rotations of said rotor, said last mentioned means including a screw mounted to move said specimen holder along its said line of movement, a ratchet mounted on said screw for imparting said motion to said screw, a pawl mounted in driving engagement with said ratchet, an actuating link connected adjacent to one of its ends to said pawl, a cam connected to said link adjacent to the other end, a gear mounted for rotation adjacent to said cam and having a single tooth for periodically actuating said cam whereby said link is reciprocated by the actuation of said cam to thereby actuate said pawl, and means for continuously rotating said gear.

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