METHOD FOR THE PRODUCTION OF MICROTOME SLICES AND DEVICE FOR THE IMPLEMENTATION OF THE METHOD

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ABSTRACT

The invention pertains to a method for the production of microtome slices, in which the slices, separated from the object, reach a liquid bath, then are removed from the latter and are prepared for further processing; further, a device for the implementation of the method, with a microtome exhibiting a stationary knife and an object slide (carrier) effecting the cutting movement.

3 Claims, 9 Drawing Figures
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METHOD FOR THE PRODUCTION OF MICROTOME SLICES AND DEVICE FOR THE IMPLEMENTATION OF THE METHOD

BACKGROUND OF THE INVENTION

For microscopic studies, thin sections (slices) of the objects are required, which after subsequent treatment, such as staining, can be microscopically studied. Whereas for the taking of tissue specimens and for the facilitating of microscopic studies, at least partially automatic methods were developed, heretofore only manual methods have become known for the production of microtome slices, aside from the fact that micromotors with motor drive were developed for the cutting movement of the knife or object slice.

By means of the invention, it is intended that the gap existing between the known removal method and the known microscopy method be bridged in such a manner, that a micrometry method is offered for the production of sections, which is appropriate for automatic operation. Further, it is intended that suitable equipment be offered for carrying out this method.

Starting with the fact that in micrometry, it is likewise known how to let the slices slide, after separation from the object by the knife, into a liquid bath, or to cut directly in liquid, the task presented in regard to technical method is so resolved, that the slices are separated from the object in consecutive sequence, and float on a liquid bath, then are removed from the latter, conveyed to a carrier slide, and therewith conducted to further processing, as for instance a staining process.

This method can also be so further advantageously developed, that in a consecutive sequence several slices each time, in a predetermined number, are separated from the object, which adhere to each other on their front surfaces and form a sectional strip, and then the sectional strip, floating on the liquid bath, is removed from the fluid, conveyed to a sectional strip slide-carrier, and conducted to further processing. When the slices, floating in the liquid bath, or the sectional strips consisting of a predetermined number of slices adhering to each other, are raised up out of the bath and laid on the given slide-carriers, this can appropriately take place in such a manner that the sections or sectional strips, with the slide-carriers are removed together from the bath, the application of the slices or sectional strips onto the given slide-carriers taking place directly before, or during, the removal from the liquid bath.

A device for the receiving of the slices already enjoys technical status. This known device utilizes a moving belt as a slice-receiving element, which with intensive directional shift, is conducted upward onto the knife back, and in so doing, receives the slices derived from the knife. In the present case, such a device would be inappropriate, because it is not readily integrable in the flow.

The method according to the invention can also be so characterized, that the objects occurring in the form of small blocks or the like, in which the actual specimens are embedded, are provided, before the cutting, with two inclined surfaces or initial faces bordering the cutting surface having edges running parallel to each other, and are so held during the cutting by the object holder, that the aforementioned edges run essentially parallel to the knife cut.

A further important feature of the invention consists in cutting the object under defined temperature conditions in the knife blade. The slices can also be advantageously extended, directly after the cutting by means of fluid, or a temperature-controlled liquid bath on which the slices float, regardless of whether individual sections are involved, or sectional strips consisting of several slices of predetermined length adhering to each other. Again, in further development of the invention, the removal of the slices or sectional strips out of the liquid bath, can take place in conjunction with the achievement of a predetermined number of slices or predetermined sectional strip length.

In comparison with the present state of the technique, the essential difference in the method presented according to the invention consists in the fact that all the steps of the method are amenable to automation and can proceed in a positive sequence. It has likewise proved advantageous in reference to the task set for the invention, to the extent that the slide-carriers loaded with slices or sectional strips of a predetermined number or length, after drying of the slices if necessary, as well as objects occurring in the form of small blocks, can be stored in greater number in desired position.

The small object-blocks can then be individually removed, one after the other, from the supply, conducted to an object slide-carrier, taken from the latter and then cut, whereupon the storing of the small object-blocks takes place, appropriately in a corresponding storage container.

The method given above thus creates all prerequisites for an automatically-functioning operation in the production of micromotome slices, which begins with the storage, if necessary, of small object-blocks previously prepared, and extends over the cutting, extending and laying of the slices or of sectional strips formed of individual connected slices, onto slide-carriers, for instance small, thin glass lamina, up to the point of storing the slide-carriers loaded with slices or sectional strips.

To resolve the task further involved in the invention, it is intended that a suitable device be described for the application of the method which, based on micrometry exhibiting a stationary knife and an object slide-carrier effecting the cutting movement, is so characterized that a liquid container with a liquid bath on which the slices separated from the object float, is attached to the knife, and that a device is planned for the automatic removal of the slices from the liquid bath, and for the transfer of the slices to the carrier-slides receiving the latter.

A device of the type indicated here can also advantageously exhibit an initial coordinated cutting or pre-cutting station, adjoining the actual cutting station, with the section of the knife located in the liquid bath attached with the knife, so that when initially cutting a small object-block, the resultant pre-cut slices do not go into the liquid bath, and into the further processing procedure. The implementation of such an initial cutting station can be characterized by a knife holder carrying the knife and a liquid bath extending over a portion of the knife width. The knife holder is constituted as a carriage which can be shifted along the knife-blade edge facilitating a knife displacement in such a manner that the knife section coordinated with the initial cutting station is located in the path of movement of the object, while after the pre-cutting, the knife is displaced by means of its displaceable holder, parallel to the knife blade edge, until the knife section is coordi-
nated with the liquid bath and the main cutting station.

Naturally, within the scope of the present invention, the knife can be stationarily arranged with two adjoining sections, one each of which is coordinated with a pre-cutting station and a main cutting station. In which case, however, it is necessary to have a movable object slide-carrier so that the object may be movable between the knife sections coordinated with the pre-cutting station and the main cutting station.

The device according to the invention can also be so characterized, that the device can be coordinated with the liquid bath and at least the knife section coordinated with the main cutting station, for the cooling or heating of the knife and for the temperature control of the liquid bath. By so doing, required conditions are fulfilled for many specimens under defined temperatures at the knife blade, and a defined temperature control of the liquid bath, whereby a waving or crimping of the slices which is practically unavoidable during the cutting, is removed. The slices are therefore extended and thereby placed in a form which is serviceable for further processing.

Finally, the device indicated here can also be further characterized by an apparatus for the removal of the slices from the liquid bath, and for the placement of same on carrier plates, which exhibit a lifting head which is movable between the surface of the liquid bath and a slice delivery station, which head is closed on its underside by a perforated supporting plate capable of admitting an indraft (vacuum). Differing from the previously mentioned form of exemplification, the apparatus for the receiving of the slices from the liquid bath can also consist of a mounting receiving a carrier plate in each case, which mounting is so controlled that the carrier plates are immersed in the liquid bath, are brought into contact with the slices floating in the bath, and together with the slices are removed from the bath, whereupon the storing of the carrier plates takes place. The carrier plates can be brought into contact with the slices in such a manner that by means of the mounting, they are immersed in the liquid bath and removed, in the course of which, at about maximum immersion depth, the end of a slice or sectional strip located at a distance from the knife comes into contact with the given carrier plate, and the raising onto the carrier plate takes place when removing same from the bath through adhesion. Another possibility consists in bringing the carrier plates by means of the mounting, under the slices floating on the liquid bath, and to receive these slices, during the raising movement of the carrier plates, onto the latter. The device can then further possess a plate supply container, receiving the carrier plates from the mounting, in which container the introduction of the carrier plates takes place by means of the mounting for the carrier plates.

For the implementation of an essentially automatic operation of the method according to the invention, for the production of object slices, the device can also possess a block supply container, which receives prepared small object-blocks in a predetermined number for cutting, with which the object slide-carrier is loaded one after the other. Further, a block container can be provided, to receive the small blocks after the cutting.

Below, it is intended to clarify the invention in greater detail, reference being made to the attached drawings, which on the one hand show the flow of the method and on the other hand, the essential features of the device without, however, establishing any restriction. The following are show in schematic views:

FIG. 1, the flow of the method, reference being made to a block diagram;
FIG. 2, the basic construction of the device, in agreement with the diagram according to FIG. 1;
FIG. 3, a cutting station with a tank receiving the liquid bath, and the knife;
FIG. 4, a cross-section through knife and tank, along the line IV—IV in FIG. 3;
FIG. 5, a cross-section through knife and tank showing the removal of the slices or sectional strips out of a liquid bath, with simultaneous conveyance onto a carrier plate;
FIG. 6, a cross-section through knife and tank showing removal of the slices or sectional strips out of the liquid bath;
FIG. 7, functional schematic showing the removal of the slices out of the liquid bath by means of indraft (vacuum);
FIG. 8, functional schematic showing the placement of the slices onto a carrier plate; and
FIG. 9, schematic representation of the preparation of the objects occurring as small blocks.

According to FIG. 1 and FIG. 2 of the invention, the small object-blocks 10 prepared for cutting are received by a block holder 11, and from the latter, one after another, reach a microtome 13 in the direction of the arrow 12. There, the small blocks are received by the holder 14 of an object slide-carrier 15, which executes a down-and-up directed cutting and return movement (double arrow 16 in FIG. 2) as well as the infeed movement, not further represented here, to a stationary microtome knife 17 and a corresponding return movement on the return stroke. After the cutting, the sliced objects from the object slide-carrier 15, according to arrow 18, reach a block storing container 19, and are kept in the latter. In each case after the release of a sliced object block, and its placement in a block supply container, an unsliced object is conducted to the object slide-carrier, and is taken up by its holder. The control of the device takes place by means of a central control element 20.

Parallely to the object conveyance to the object slide-carrier 15, and for disposal of the small object-blocks sliced, there takes place, likewise controlled through the central control element 20, the conveyance from a carrier holder 24 of lamina carriers 25 in the direction of the arrow 26 to the slicing station; the placement of the slices onto the carriers at 27 and, with insertion of a drying process at 28, the disposal of lamina carriers loaded with slices, in a supply container 29 (indicated by arrow 30), so as then to be conducted to further processing, for instance a staining procedure, or else subjected to the stored position. The transition of the slices from the slicing station onto the lamina carriers 25 is identified in FIG. 1 by arrow 32.

As FIGS. 2 and 3 especially show, the knife 17 of the microtome 13 is taken up by a knife holder 35, which in turn is arranged on a guide plate 36, and in longitudinal direction of the knife is displaceable according to the double arrow 37, clear across to the cutting movement of the object slide-carrier 15 and parallel to the knife blade edge 38 without modification of the slicing thickness which was set. About half way on the width extension of the knife 17, a stationary liquid container
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40 is attached to the knife back, hence on the side most distant from the object slide-carrier 15, arranged on the knife holder and hermetically sealed against the knife back. The knife section 41 located in the area of the liquid holder is coordinated with the slicing station itself, while the section 42 located nearby forms the precutting (first cut) station. The knife can be so adjusted through displacement of the knife holder 35 in the direction of the double arrow 37, that either the knife section 42 coordinated with the precutting (first cut) station, or the knife section 41 coordinated with the main slicing station, are located in the path of movement of the object received by the object slide-carrier 15.

According to the details which can be seen in FIG. 4, the liquid container 40 is constructed from a tank, whose bottom extends, joining the knife back, at only slight depth from the latter, and then runs steeply downward. In the vicinity of the knife blade, the liquid bath 44 received by the liquid container 40 therefore has only slight depth. Between the knife back and the bottom courses steeply downward, attaching to the tank section of slight depth, a hollow space is located, in which the cooling and heating element 45 is located, which it not important to specify here in detail. On the adjoining side of the container wall, a further heating element 46 is arranged. The cooling and heating device 45 and the heating device 46 serve, on the one hand, for the adjustment of the cutting blade 38 to a defined temperature, and on the other hand, for the heating up of the liquid bath 44, likewise at a defined temperature. In a model developed, a cooling of the knife took place, by means of the device 45, at about −10°C, while the liquid bath 44 was heated to about +50°C. In so doing, a stable cutting temperature of +10°C was established on the knife blade. The temperature-influencing of the knife blade by the higher bath temperature was slight, due to the slight liquid depth in the vicinity of the knife blade. A slice or a sectional strip flowing from the knife back (identified by 48 in FIG. 4) thus reaches, leaving the knife blade, the area of the liquid bath which is gradually becoming warmer. The slice (or sectional strip) floating on the liquid bath receives, in so doing, a surface extension which is advantageous for further processing.

FIG. 5 shows, in simplified representation of the liquid container 40 with the liquid bath 44, a slice 48 floating on the latter, which is removed from a lamina carrier 25, vertically immersed in the liquid bath 44, by means of a mounting 50. The slice or the sectional strip 48 attaches, with its edge which was distant from the blade edge 38 of the knife 17, to the lamina carrier 25 due to adhesion, so that during the removal taking place in the direction of the arrow 51, the sectional strip lies flat on the lamina carrier 25. The further movement of the lamina carrier 25 is so controlled by means of the mounting 50, in a known manner which is not further represented here, that the lamina carrier 25 is inserted, in the manner demonstrated in FIG. 2, in a plate supply container 29.

In FIG. 6, a mounting 50' is demonstrated, which receives a lamina carrier 25 in a position slightly inclined against the horizontal. When in operation, the mounting 51 immerses the lamina carrier 25 into the liquid bath 44, whereupon, after reaching a predetermined section strip length, the cutting process is interrupted for a short while and the lamina carrier 25 is removed out of the liquid bath in the direction of the arrow 51'.

In so doing, the placement is effected of the sectional strip 48, which was floating in the liquid bath, on the end of the lamina carrier 25 most distant from the mounting 50, and in this manner removed from the liquid bath. After this, the placement of the lamina carrier 25 into a plate supply container is effected, in the same way as with the device described in conjunction with FIG. 5. Before placement in the plate supply container, the sectional strip or else a single slice, can be subjected to a drying.

In FIGS. 7 and 8, finally, a further possibility is represented of the slice or sectional strip removal from the liquid bath 44, as well as of the slice or sectional strip placement onto a lamina carrier 25. This device consists of a lift-head 55, which is closed on its underside by a perforated holding plate 56 amenable to indraft (vacuum) which is displaceable as demonstrated in FIG. 8 for the placement of the slices or sectional strips onto a lamina carrier 25. The fact that during the placement of the slice or sectional strip taken up by the suction head onto a lamina carrier, the suctional effect is removed or the slice or sectional strip must be conveyed through a short air-pressure blast, can be readily understood by any technician.

FIG. 9, finally, demonstrates a possibility for the processing of the small object-blocks in such a manner, that the latter after being taken up in holder 14 of the object slide-carrier 15, exhibit two edges, parallel to each other, running at right angles to the cutting surface. The block processing can take place in a simple manner by means of two knives 58, 59, which provide the small object-blocks, arranged in series, with initial faces 60, 61, running toward each other at about 90°.

As was already initially clarified in the description of the figures, the small object-blocks 10 provided with initial faces 60, 61 go from the block supply container 11 into the object slide-carrier 15, and are subjected to tension by the latter in a manner which is known, but however is automatic. The knife 17 is so adjusted (set), through corresponding displacement of the knife holder 35, that for the formation of a pre-cutting (first cut) station, the knife section 42 is located in the vertically flowing path of movement of the object displaced in the direction of the double arrow 16. In this position, the object block, placed under tension, is pre-cut. After the completion of the initial cutting process, the knife section 41, which is coordinated with the actual cutting station, is shifted in the path of movement of the small object-block taken up by the holder 14, and the slices occurring during the cutting flow away from the knife blade into the liquid bath 44, to float on the latter, as demonstrated by 48 in FIG. 4. The slices or sectional strips are removed from the liquid bath, in the manner described above in conjunction with FIGS. 5 to 8, and stored, possibly after prior drying, on lamina carries 25, resting in the plate storage container 29. This is clarified with arrows 30, 65 in FIG. 2. In the exemplification shown in FIG. 2, and before the storage of the lamina carriers loaded with slices or sectional strips in the storage container, a 90° rotation of the lamina takes place, along their longitudinal axes, as indicated by the curved arrow 66. After the storing of the lamina carriers, loaded with slices or sectional strips, in the storage container, they are passed along in the direction of the
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arrow 67 in FIG. 2, to processing which is not repre-

We claim:

1. A method for the production of microtome slices,
in which the separated slices from the object specimen
reach a liquid bath, and are then removed from the
bath and prepared for further processing, said method
comprising the steps of:
a. preliminarily cutting the object specimen at a first
cutting station before the object specimen slicing
step;
b. cutting the object specimen to produce object
slices in consecutive sequence and predetermined
number so that the slices adhere to each other on
their edges forming a sectional strip;
c. maintaining a predetermined temperature at the
blade which performs the cutting;
d. floating the sectional strip on the liquid bath;
e. floatingly transporting the sectional strip to a car-
rier immersed in the bath;
f. adhering the sectional strips to the carrier and re-
moving together therewith when a predetermined
number of slices is attained; and
g. thereafter conducting the object slices to further
processing.
2. The method according to claim 1 and wherein the
method comprises the further step of forming the ob-
jects in small blocks and storing said blocks in a desired
position, then conveying said blocks to an object car-
rrier, then placing said blocks in an object holder, and
then slicing said blocks.
3. A device for slicing object specimens comprising
in combination a microtome having a stationary knife,
wherein a section of the knife forms a first cutting sta-
tion for making an initial pre-cut prior to slicing the ob-
ject specimen, means for positioning said section for
said initial pre-cut, an object holder for moving said ob-
ject specimen thereby effecting a slicing operation, a
liquid container mounted to the knife containing a bath
on which the object specimen slices are floated, means
for controlling the temperature of the knife and the
temperature of the bath, means for automatically re-
moving the slices from the bath and for conveying the
slices to a carrier, and wherein said removing and con-
vveying means includes a lifting head for producing a
suction force on the slices.

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