A NEW BRAIN MICROTOME.

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With Plates XIX and XX.

There are now in use several forms of microtome for sectioning a brain or other large organ. Some of these are merely enlarged copies of the instruments in use for ordinary histological work. Others are modified to some extent in order to better adapt them to the more difficult work of producing so large a section in perfect form. This difficulty is by no means small, and in most of the instruments now to be had, is only partially overcome.

It is generally considered necessary to have the section cut into liquid—water or alcohol—so that it can be floated out smoothly. Two well known machines embody this principle. One is the von Gudden. In this instrument the object to be cut is embedded in a well of sufficient size to contain it, the top of which is crowned with a rim of plate glass. By means of a micrometer screw the object is raised in the well while the glass rim serves as a guide for the knife which is moved "free hand" over its surface. Outside of the glass rim is a good sized pan which is filled with alcohol or water to such a depth as to cover the knife. The section is thus cut under water and floats off without injury.

A more recent instrument is one invented by Bruce.[1] It differs from the Von Gudden, chiefly in replacing the "free hand" cutting by a machine cut. It consists of a heavy metal tank 2 cm. deep, 20 cm. wide, 90 cm. long. A square middle section is 6 cm. deeper than other portions of the tank. This

[1] Described and illustrated in Journal of Nervous and Mental Disease, Vol. 25, No. 12, Dec., 1898.

contains the object holder. The knife has a width of 5 cm. and a cutting edge of 30 cm. It requires from 1.5 to 2 litres of fluid to fill the tank. In cutting, the knife is drawn back by a treadle and when released "the weight and pulley gives the cutting stroke," In the description referred to, the writer says "Exceedingly thin sections may be cut on it without skipping." But he does not tell us just how thin. He further adds that the object-holder is not sufficiently delicate in its adjustment, for the finest embryological work.

The machine we are about to describe was made two years ago at Clark University, in response to the demand for a microtome that would cut a whole human brain, in any plane, into sections of, say, 50 micra thickness, without wasting a section from beginning to end, and with the consequent possibility of determining the location of every section.

This instrument embodies two principles new to brain microtomes. First the brain is made to move instead of the knife. Secondly, the knife is made to hold the fluid into which the section is to be cut. The advantages of this arrangement are easily seen. The blade being fixed at both ends can be made sufficiently long and thick to insure a clean oblique cut, without sagging or springing out of correct position. Being placed horizontal it can be flowed with alcohol, a small quantity being sufficient to float the section.

The details of construction and the *modus operandi* will be readily understood from the following description and from reference to the cuts.

The finished microtome is 34 inches high and 35 inches long, and is made wholly of iron. The cutting blade is made of finely tempered steel, 36 inches long, 2½ in. wide and ⅞ in. thick at the back. It is strongly concaved on the upper surface, and slightly so on the under surface. To the back edge is screwed a zinc pan flush with the concaved upper surface of the blade. This with the concavity of the blade itself, forms the receptacle for the alcohol into which the section slides as it is cut. This pool is 8 inches wide, and ¼ inch deep at the back, and in front shoals gradually to the very edge of the blade.

This gives sufficient room to manipulate the largest section of a human brain, and a very small quantity of alcohol—a pint at most—is sufficient for all requirements.

The carriage for the brain, comprises two parts: an *inner* part to which the brain is fastened, and which slides up and down within an *outer* part. The outer part slides horizontally along a track from one end of the machine to the other. The inner part is box-like, $7 \times 6 \times 6\frac{1}{2}$ inches, open on two sides. It is very accurately adjusted to the outer case, within which it is moved up and down by a micrometer screw. The head of the screw is graduated so that a single click gives a section of 12.5 micra. The outer case is $11.5 \times 7.5 \times 7$ inches. It slides between the two rails which form the track, and it extends about half its length below them, thus securing great stability and smoothness of movement. It is moved along the track by means of a rack and pinion similar to that used on lathes.

The dimensions of this carriage and the excursion of the inner part are such that the largest human brain may be mounted in any position, and sectioned completely from one end to the other without waste or loss of material. Small sections are cut equally well.

In constructing the machine, the blade was first put in position since it must be exactly level in order to hold the alcohol. The "cut" must be oblique, therefore the blade was placed obliquely from the back left hand corner to the front right hand corner of the supporting frame. In order to give the brain a movement parallel to this *obliquely placed* cutting edge, the track slopes downward from left to right; and in order for the brain to pass under the knife and clear the bevel, the track slopes downward from front to back. The amount of these two inclinations can be judged from the pictures.

In operating the machine, the brain is first embedded in celloidin and mounted as nearly as possible in the plane in which it is desired to section it, on a slab of suitable material—vulcanized wood fiber is used at present, but this is liable to warp if specimen is kept long in 80% alcohol. This slab is then fastened to the top of the inner part of the carriage by

means of clamps or screws. This plan enables one to use specimens at will, not being compelled to finish with one before another can be cut, as is generally the case with those machines which embed the object in a well.

Small adjustments for changing the plane of section, may be made by moving the blade, one end of which is slotted so as to be clamped in different positions. One end of the blade being fixed, sliding the other end *forward* or pushing it *backward* has the effect of changing the plane of section. This is convenient also for adjusting whenever the brain has been removed from the machine and it is desired to replace it so as to continue cutting in the same plane as on a former occasion. Larger adjustments are conveniently made by wedging the fiber as it is clamped to the carriage.

The sections thus made are easily handled by floating a sheet of paper under them, by which they may be lifted from the alcohol, stained and mounted in balsam like any other specimen. For gross anatomy an unstained section mounted in gum glycerine makes a very nice preparation showing white and grey matter in their natural colors.

The slides thus made furnish a clean, neat and easily handled specimen which can serve to demonstrate either macroscopic or microscopic structures. A series, taken at intervals of, say from one to two centimeters, and in each of the three directions, gives about as complete a picture of the anatomy of the brain, as could be desired.

The cost of this first machine has been about $150. Considerable difficulty was experienced in finding anyone who would undertake to make a blade of such large dimensions, warranted to be of uniform temper throughout, and to preserve a perfectly true and straight edge, without warping or twisting out of shape. After consulting several of the manufacturers of microtome knives, both abroad and in this country, we finally found in Worcester a firm that was willing to undertake the work. Accordingly the blade was made by Loring Coes & Co. It consists of a soft iron body (thus doing away with the danger

of warping) into which is welded an edge of finest razor steel. It is without flaw and is a model of accurate workmanship.

After two years use, this microtome continues to be satisfactory. Were we to make another machine now, only two variations from the foregoing description would be made. It would in no way be a detriment to have the blade thicker on the back—one inch or even an inch and an eighth. It would probably be an advantage in the matter of keeping it sharp—the edge not being quite so thin would not nick as easily. Secondly, the supporting frame might be somewhat heavier. There is a slight vibration, which, while of no inconvenience as yet, may in time have some effect upon the delicacy of the adjustments.

The writer is very largely indebted to Dr. C. F. Hodge, at whose suggestion the work was undertaken, for constant help and suggestion in designing the machine, as well as valuable aid in bringing out the completed microtome.

West Chester, Pa., December Fourth, 1899.

EXPLANATION OF PLATES.

PLATE XIX. Figs. 1 and 2.

Two views of the machine with brain in place ready for sectioning.

A.—Blade, with pan attached, filled with alcohol.

B.—Brain in position for cutting.

C.—Wood fiber upon which brain is mounted.

D.—Inner "box" which is raised and lowered by micrometer screw I.

E.—Outer case which slides on the track F. (Fig. 2.)

F.—Track. (Fig. 2.)

G.—Rack and pinion for moving carriage along F.

H.—Graduated head of micrometer screw.

I.—Micrometer screw. (Fig. 1.)

K.—Clicking attachment. (Fig. 2.)

PLATE XX.

Fig. 3. Shows a sagittal section of the brain about 100 μ thick cut on this microtome, and reproduced in the following manner: The unstained section mounted in gum glycerine was printed directly onto velox paper, the paper being put into the plate holder and exposed through the camera like a plate. The mounted section was set up in front of the camera with the blue sky for background. Finer details of course do not come out in the reproduction, although they are beautifully shown in the section. The photograph is reduced to about $\frac{2}{3}$ natural size.

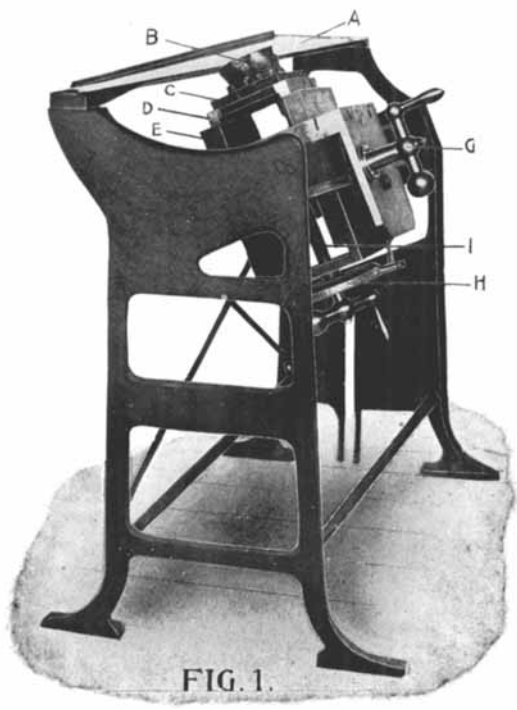

FIG. 1.

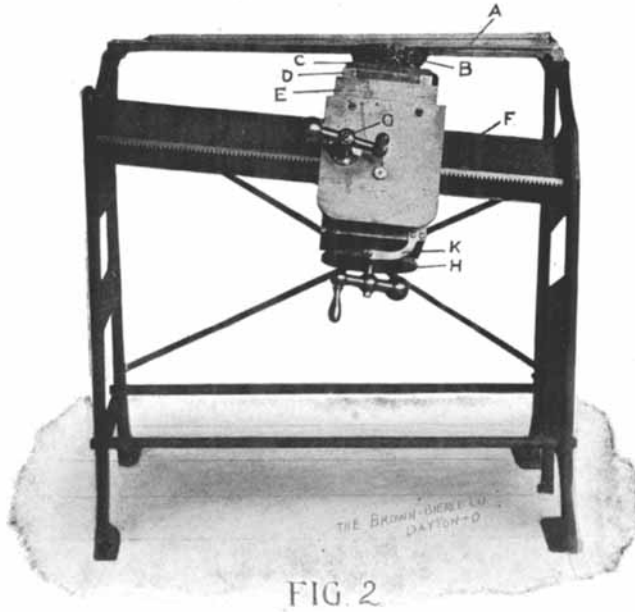

FIG. 2.