THE DB-1-57 STEREOTAXIC APPARATUS OF THE INSTITUTE OF NORMAL AND PATHOLOGICAL PHYSIOLOGY OF THE AMN SSSR

R. A. Durinian and A. I. Bartyzel'

From the Institute of Normal and Pathological Physiology (Director – Active Member of the AMN SSSR V. N. Chernigovskii) of the AMN SSSR, Moscow

(Received June 10, 1958. Presented by Active Member of the AMN SSSR V. N. Chernigovskii)

In recent years the stereotaxic technique first suggested by Horsley and Clarke in 1908 [2] has been used on an ever-increasing scale in electrophysiological and morphological investigations of the central nervous system, particularly of the subcortical formations.

Abroad a number of models of stereotaxic apparatus are available, mainly adapted for research on cats, rabbits and small monkeys.

Among these may be mentioned the Gaze and Gordon apparatus [1]; apparatus developed in the USA (see J. Neurophysiol. for the last few years, beginning with 1950); the French apparatus with Dell's modification;* the Loewenfeld and Altman apparatus, and others.

Besides the stereotaxic apparatus working with rectangular coordinates by the Horsley-Clarke system, special instruments are available also which allow the electrode to be directed at a predetermined angle (in a tangential system). One such model was suggested by Harrison [3] in 1938.

The main requirements of any stereotaxic apparatus are as follows:

1. Fixation of the animal's head to correspond with the zero plane of the Horsley-Clarke coordinate system.

2. A manipulator to provide movement of the electrode in three mutually perpendicular planes with an accuracy of not less than one tenth of a millimeter.

However in addition to these fundamental requirements each model possesses a number of devices which increase the scope of the apparatus and facilitate its use. Among these are, for instance, the presence of two or sometimes four manipulators for the introduction of two or four electrodes respectively; a firm and massive stand to fix not only the head but the animal as a whole, which is most essential to avoid vibration, undesirable when working with buried electrodes, and others.

We succeeded in planning and constructing a suitable stereotaxic apparatus to meet modern requirements. The prototype DB-1-57 apparatus was made in the experimental workshops of the institute and tested in the laboratory of general physiology.**

Brief Description of the Apparatus

The stereotaxic apparatus DB-1-57 of the Institute of Normal and Pathological Physiology of the AMN SSSR is constructed in the form of a massive stand for fixation of the whole animal (usually cats). The base of the apparatus consists of a carrier frame, which is composed of two longitudinal steel bars (guides), connected by two triangular steel crosspieces (Fig. 1).

* Manufactured by La Precision Cinematographique, France.

** We have now developed a second model of the stereotaxic apparatus (DB-2-58), a description of which will be published later.

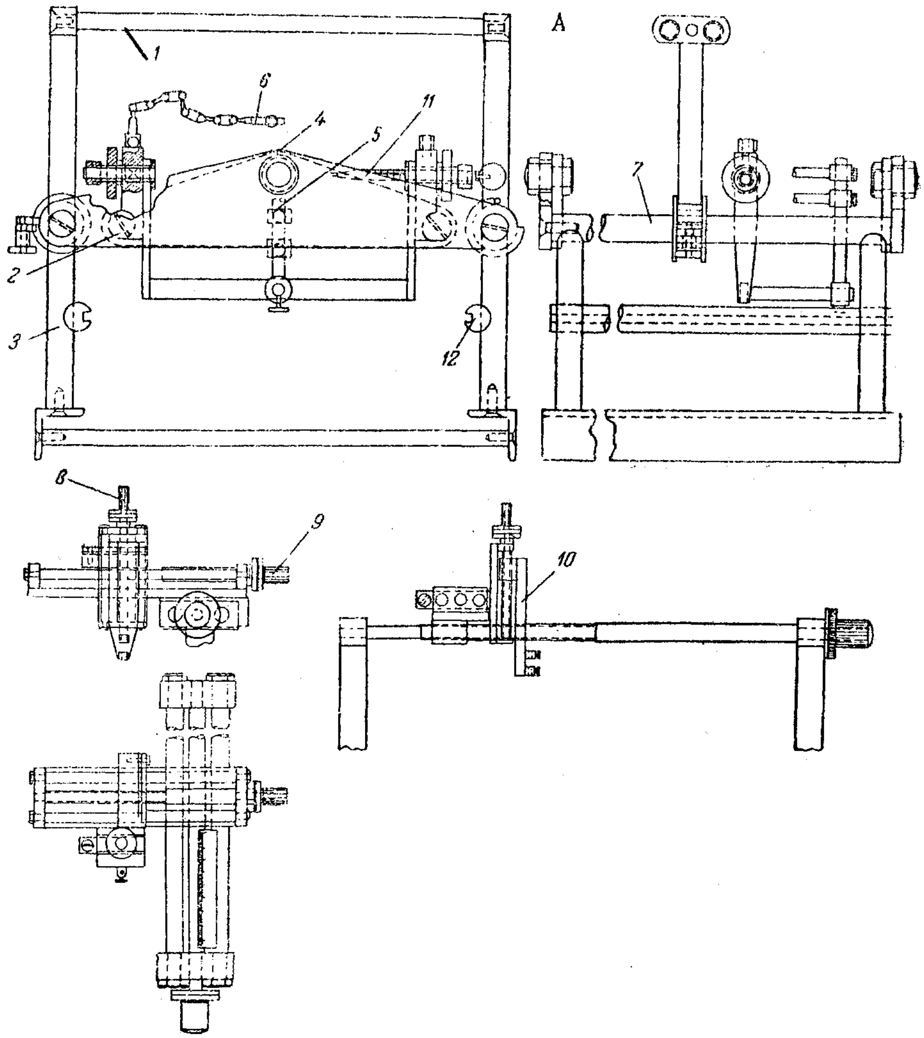

Fig. 1. General outline of the stereotaxic apparatus and manipulator. 1) Guide for the manipulator as a whole; 2) turning frame; 3) main upright; 4) bearing for rotation of the central frame; 5) support for the head-piece; 6) hinged electrode holder; 7) main carrying frame; 80 limb of the "x" axis; 9) limb of the "y" axis; 10) electrode carrier; 11) ear holder; 12) runners for the heated table.

The carrier frame is firmly connected to the base of the apparatus by means of four steel uprights, the base consisting in its turn of two longitudinal steel angle girders and four round steel tie bars. Parallel to the longitudinal bars of the carrier frame and slightly below it are a further two firmly attached bars, which increase the rigidity of the construction and at the same time act as guides for the heated table on which the animal lies (Fig. 1).

The heated table slides freely in the grooves of these bars and can be withdrawn backwards in case of necessity. The base of the apparatus is covered with duralumic sheet, on which is placed a trough with a wastepipe.

The longitudinal bars of the carrying frame act as guides for the manipulator which is attached to two clamped sliding bushes. Consequently, the manipulator may be moved along the whole length of the animal's body, from the beginning of the head to the end of the trunk. Therefore in this model the manipulator may be used also for investigations in the whole of the spinal cord which alone greatly widens the scope of the apparatus..

For the convenience of the experimentor (during preparation and so on), the manipulator can be retracted on the left side through an angle of 120° (Fig. 3).

The manipulator itself is made in the form of a ⊓-shaped bridge, whose vertical sides are massive T-shaped steel bars with reversible steel shackles, by which the manipulator is attached to the sliding bosses of the carrying frame (see Fig. 1).

To the T-shaped bars are fixed two transverse,round steel guides, on which slides a brass runner, permitting movement of the electrode in a sagittal plane. Displacement of the runner is carried out by turning a transverse screw, with a pitch of 1 mm, which is also fixed to the T-shaped bars. The graduated scale of this screw is divided into 100 parts, so that when the scale is deflected through 1 division, the runner (or electrode) is displaced through 10 μ in the sagittal plane. The range of the runner to right and left of the zero line is 50 mm. To this "sagittal" runner is attached a steel rectangular plate with sidepieces, also with round steel guides and a screw to allow displacement of a further brass runner in the frontal plane for a distance of 40 mm forwards and backwards from the zero position, with an accuracy of 10 μ.

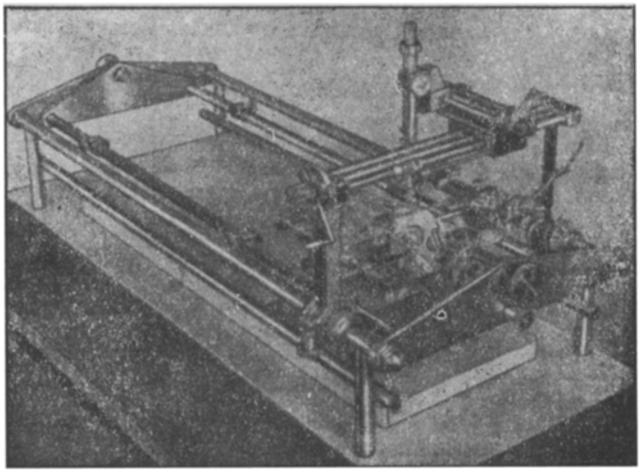

Fig. 2. The DB-1-57 stereotaxic apparatus in its working position.

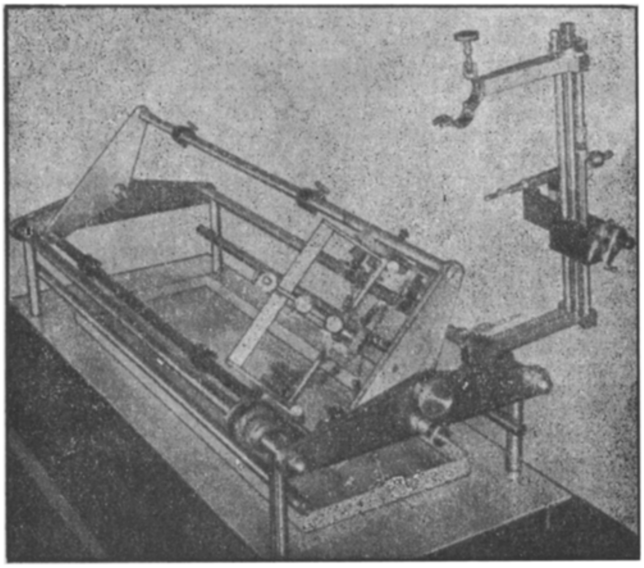

Fig. 3. The same: manipulator retracted, inner frame rotated, head support strongly inclined.

To the "frontal" runner in turn is fixed a vertical arm, to which is attached a texolite plate. To this plate is fixed a brass boss with a screw, equipped with a special micrometer to allow movement of the electrode in a vertical direction. The micrometer is freely movable in this boss upwards and downwards for 60 mm, and may be securely fixed at any level by the screw. In this way the coarse movement of the electrode is achieved. By turning the graduated scale of the micrometer a fine movement of the micrometer rod may be obtained for a distance of 60 mm in an upward and downward direction with an accuracy of 10 μ. At the end of the micrometer rod there is a threaded hole with a screw, to which is attached the hinged electrode-holder or a special platform with a cathode repeater for working with a microelectrode.

Thus, the manipulator can produce movement of the electrode in three mutually perpendicular planes with an accuracy of 10 μ.

In our model, the animal is fixed in a special frame which is placed inside the main carrier frame of the apparatus. To this inner frame are attached the head support and 4 arms for fixation of the limbs (the limbs are tied with straps to the 4 arms of this frame). This inner revolving frame, in contrast to the outer (carrier) is not firmly secured and can turn freely through 360° on two semiaxes, together with the affixed animal (see Fig. 3).

The construction of the inner revolving frame is identical with that of the outer.

Into the triangular crosspieces of the outer frame are inset brass bearings which receive the semiaxes emerging from the triangular crosspieces of the inner revolving frame. Into the ends of these semiaxes, from the outer side, are inserted strong screws which, when tightened, fix the inner frame in any desired position. In addition, in the side of the outer triangular crosspiece corresponding to the head end of the frame there is a futher counter-pin screw which serves for accurate fixation of the inner frame in the horizontal plane (parallel to the horizontal plane of the manipulator) in the working position, i.e. in the prone position of the animal (Fig. 2).

The possibility of turning the affixed animal during the course of the experiment provides free access to any part of the animal's body, which is extremely important during research connected with the study of cortico-visceral problems (see Fig. 3).

Another essential detail of the apparatus is the head support, which is constructed as follows: to the longitudinal bars of the inner frame are firmly fixed two vertical steel bars, the arms of the head support. Into the arms are screwed brass bosses which project slightly inwards. These bosses serve a dual function: 1) they are guides for the clamps of the external auditory meatus; these clamps are usually two round steel pegs with ebonite tips which are attached by means of a screw clip (see Figs. 1, 2 and 3); 2) they serve as bearings for rotation of the П-shaped frame of the head support around an axis passing through the external auditory meati.

On the crossbeam of the П-shaped frame there is a tailpiece along which moves a vertical bar which carries the clamp for the upper jaw. This clamp is made in the form of two pieces, each of which can move along the vertical bar.

The lower platform serves as a support for the upper jaw, and the upper, inclined platform presses on the dorsum of the nose. For better tightening of the nasal clamp from above a compression nut is screwed home.

This construction provides secure fixation of the animal's head.

The П-shaped frame of the head support may be fixed in any position on its bearings by two screws.

On the left side of the head support there is an inclinometer by means of which the animal's head can be placed at any angle to the horizontal plane (see Fig. 2).

Thus, without disturbind the principal of fixation of the head, the construction of the head support enables the head to be turned about the axis of the external auditory meati. This makes it possible to insert the electrode not only vertically but also at any angle (usually not more than ± 45°), i.e. to employ the tangential method. In addition the ability to incline the head downwards strongly makes working in the cerebellar region, and expecially the medulla, much easier.

These two features considerably widen the scope of this particular model.

Finally, the last constructional feature of the apparatus is an adaptor which permits simultaneous working with 8 buried electrodes (this adaptor can be used with success also for work with superficial electrodes).

In the upper part of the arms of the head support there is a hole in which are inserted round horizontal rods (along the axis of the apparatus), fixed with screw clamps. On these rods are set the flexible electrodes of the support, 4, on each side (8 in all). Each holder is constructed independently and the experimenter may arrange them in any combination (an equal number on each side, all on the same side, and so on).

The flexible electrode holders consist of two parts: a) the holder arm, fixed to the rod, with a texolite platform and a receptacle for the next part, and b) the holder itself, which is a flexible, hinged combination, terminating in a miniature spring clip. On this clip there is a shackle which, in the forward position clamps it and in the backward position releases it (see Figs. 1, 2 and 3).

By means of this clip the electrode is easily and firmly fixed in any position.

The flexible electrode holder is used as follows. At first the electrode, fixed in the grip of the manipulator, is inserted stereotaxically in the brain. Next, without releasing the grip of the manipulator, the tip of the flexible electrode holder is passed beneath it, and the projecting end of the electrode is seized and clipped. Afterwards the grip of the manipulator is released and the latter is withdrawn upwards. The electrode remains in situ.

By repeating this procedure up to 8 electrodes can be inserted in the brain by means of one coordinate manipulator.

It should be emphasized that during rotation of the animal, the flexible electrode holders rotate also and the position of the inserted electrodes is not disturbed (Fig. 3).

Thus, the ability to work with 8 buried electrodes at the same time is an essential feature of this particular model of stereotaxic apparatus.

SUMMARY

The authors present a description of a stereotaxic apparatus for cats which has the following advantages over the existing models:

1. A massive stand for fixation of the animal.

2. A device for rotating the fixated animal.

3. The possiblity to bend the head of the animal in any direction.

4. The presence of elastic electrode-holders which permit to work simulatneously with 8 immersed electrodes.

LITERATURE CITED

[1] R. M. Gaze, and W. Gordon, Quart. J. Exper. Physiol. 1954, V. 39, 4, p. 279-304.

[2] V. Horsley and R. Clarke, Brain 1908, V. 31, p. 45.

[3] F. Harrison, Arch. Neurol. a. Psychiatr. 1938, V. 40, p. 563-565.

[4] I. Loewenfeld and R. Altman, J. Neuropath. a. Exper. Neurol. 1956, V. 15, p. 181-189.