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TECHNICAL NOTE

A SIMPLE METHOD FOR MEASURING THE GENERAL ACTIVITY OF RATS IN BRAIN STIMULATION AND OTHER STUDIES[1]

In most brain stimulation experiments there is a connection between the rat's head and the source of stimulation. Such a connection might be used to measure general activity because: (1) it usually allows freedom of movement, and (2) it provides a connection between the rat and the scheduling apparatus. The basis for the assumption that head movement is a valid indicator of the general activity of the rat is the observation that the major body movements of the rat correspond with movements of the head. Figure 1 shows how such a stimulation connection can be used to measure general activity. Freedom of movement was allowed through the use of a four-channel mercury commutator (A) that was mounted above the chamber and a flexible stimulation cable (B) that extended down from the mercury commutator and activity device through a hole in the top of the chamber to the rat's head. One end of a nylon retractor line (C) was attached to stimulation cable about 12 in. (30 cm) below the cable plug (D). This retractor line (1) kept the stimulation cable out of the way of the rat because tension was exerted on the other end of the line and, (2) was used to measure movements of the rat because it moved with the stimulation cable and the rat. The other end of the retractor line was attached to and wound around a plastic commutator wheel (E) that rotated on a horizontal, stationary axle. Constant tension was put on the retractor line by a spring (F) around the stationary axle: one end of the spring was attached to the stationary axle and the other end was fastened to the aluminum hub (G) of the plastic commutator wheel. Because of the tension on the retractor line, a pull on the retractor line rotated the commutator wheel in direct proportion to the length of the line pulled and release of tension on the retractor line rotated the commutator wheel in the opposite direction but still in direct proportion to the length of line pulled. Movements of the commutator wheel were recorded by the electrical contact made between a stationary wiper contact (H) and the contacts (I) mounted every 0.6 cm (center to center) along the outside edge of the plastic commutator wheel. Ground reached the contacts on the plastic commutator wheel via the retractor spring. One end of the retractor spring was a ground terminal and the other end was attached to the aluminum hub of the plastic commutator wheel. The contacts of the plastic commutator wheel were connected to the aluminum hub. Electrical signals were transmitted through two of the four channels in the mercury commutator; the other two channels could be used for brain stimulation. The electrical signal from the device operated a solid state pulse former that was adjusted to deliver a 25-msec pulse each time the pulse former operated. These pulses were then used to operate counters and/or a cumulative recorder. Figure 2 is an assembly diagram of the activity device.

The device requires little or no maintenance, it has produced recordings of activity during daily sessions for more than six months with no maintenance problems or readjustments. Figure 3 shows a continuous

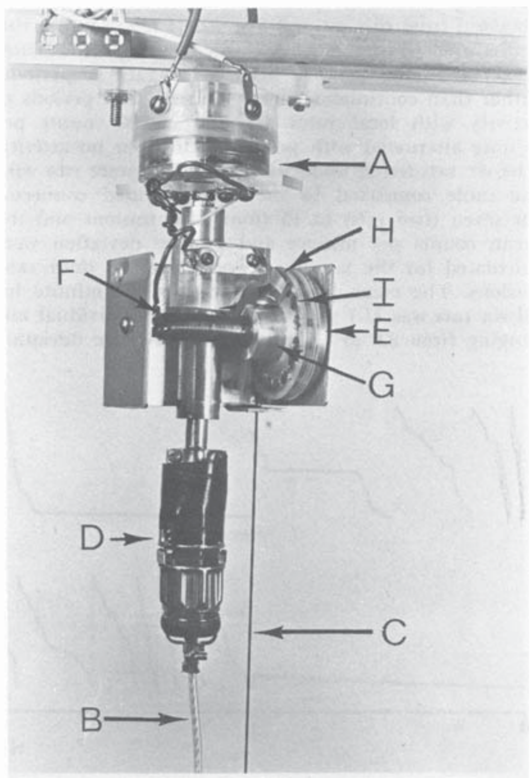

Fig. 1. The activity device shown in series with a stimulation connection that allowed freedom of movement. See text for description of symbols.

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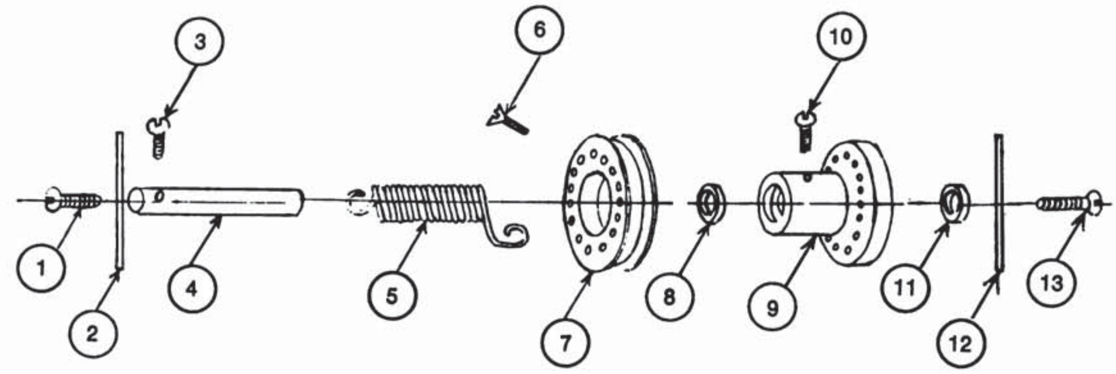

Fig. 2. Assembly diagram of the activity device. (1) 6/32-in. round head screw, (2) mini box, (3) 4/40-in. round head screw, (4) axle, 5 cm in length, (5) spring, (6) 16 contacts (2/56-in. flat head screws), (7) 3.5-cm diameter plastic commutator wheel, (8) ball bearing, (9) aluminum hub, (10) 4/40-in. round head screw, (11) ball bearing, (12) mini box, (13) 6/32-in. round head screw.

record of activity obtained by having each pulse from the activity device step the response pen of a cumulative recorder. This record was obtained from a satiated rat that had just been placed in a sound-attenuating, illuminated chamber, the internal dimensions of which were 15 by 16 by 17 in. (28 by 30 by 33 cm) high. Recording started after a 15-min session delay that was provided to allow for recovery from the effects of handling. This 8-hr. record, which is typical of those obtained from this rat and five others tested under this procedure, illustrates the classic finding of Richter (1922) that the general activity of rats is periodic rather than continuous. It can be seen that periods of activity with local rates as high as 200 counts per minute alternated with periods of little or no activity. The six rats tested under this procedure were run with the cable connected to the skull-mounted connector for seven (two rats) to 15 (four rats) sessions and the mean counts per minute and average deviation were calculated for the last five (two rats) or 10 (four rats) sessions. The mean number of counts per minute for all six rats was 11.1 with the means for individual rats ranging from 8.6 to 15.2. The mean average deviation for the group was 16% with the range being from 10 to 21%.

The ease with which the device can be added to existing brain stimulation apparatus makes it particularly relevant to brain stimulation studies. However, the device can also be used in other types of research because it requires only that the rat have a skull-mounted connector or a harness to which the cable can be connected. Four of the six rats tested with the skull-mounted connector were also tested on alternate days with the cable connected to a body harness. The mean number of counts per minute and average deviation were calculated for the last five (two rats) or 10 (two rats) sessions. The mean number of counts per minute for the four rats with the harness was 8.9 with the means for individual rats ranging from 5.8 to 12.8. The mean average deviation for the group was 13%, with a range from 10 to 16%. For three of the four rats tested under both the harness and skull-mounted connector, the activity device detected more activity with the skull-mounted connector, but for only one rat was there a sizable difference in mean counts per minute (15.2 to 6.5).

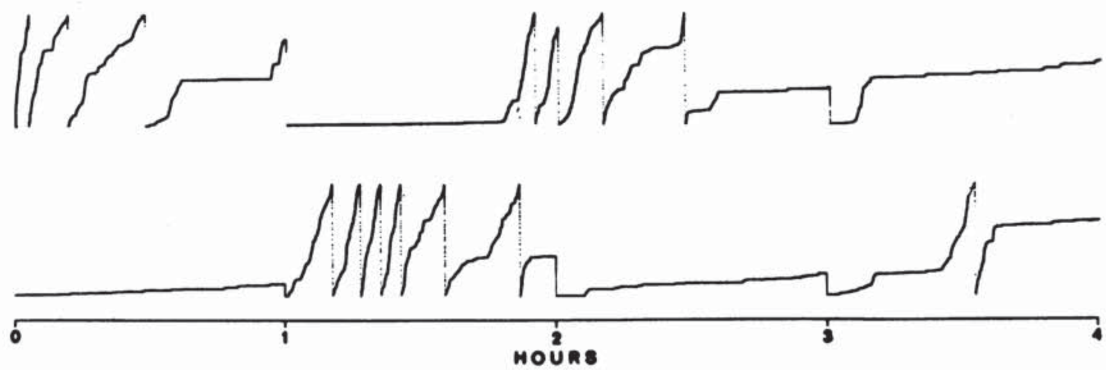

Fig. 3. Continuous 8-hr record of activity obtained by having each count from the activity device step the response pen of a cumulative recorder. The response pen reset after each hour: a full excursion of the response pen represents 500 counts. The top record shows the first 4 hr of the session and the bottom record shows the last 4 hr of the same session.

The activity device did not appear to produce any feedback or fatigue. The tension on the rat with either a skull-mounted connector or a harness was only 10 to 25 g and the differences between the first half and the last half of the sessions (11.2 to 11.1 counts per minute for the skull-mounted connector and 10.3 to 7.6 counts per minute for the harness) were not large and may have been due to other factors, such as an initially higher rate of exploratory behavior.

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REFERENCES

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[2]Mr. Enoch, an instrument designer at the Behavior Research Laboratory, was responsible for the development and construction of the activity device. The authors thank Dr. Harris Rubin and Dr. Robert Campbell for their careful reading of the manuscript.