

A SOUND PERIMETER.

Recent studies in auditory space perception have shown that the power to localize sounds rests, to a great extent, upon secondary factors. What unaided introspection would lead us to consider direct acoustic sensory data, exact experiment often reveals to be only associations or the result of subconscious influences of some sort. In future experiments more attention must be paid to the elimination or control of these associations and suggestions. Within the last few years, much good work has been done in the study of the localization of sound, but all with crude and often inadequate apparatus. None of the sound cages, or substitutes for the same, which have been used, could have been operated without giving suggestions that would tend to invalidate the results. Only those who, like the writer, have been engaged in these experiments, can fully appreciate this criticism. Results have been obtained at the expense of wasted time and patience in the effort to conduct the experiments on such plans that the shortcomings of the apparatus might be overcome.

In order to be adequate for most purposes, the apparatus for the producing and registering of the sound which is to be located should permit, among others, the following variations in the stimulus without giving any suggestion or counter-suggestion to the observer: (1) the direction of the stimuli from the middle of the aural axis, (2) the intensity of each of the stimuli, (3) the distance of one stimulus, (4) the number of stimuli to be given simultaneously or in succession, and (5) the order and frequency of stimuli from a given position.

The sound perimeter shown in Fig. 1, has been designed to meet these requirements. It consists of a system of telephone receivers so mounted and connected as to make the above-named variations possible. The main frame is made of iron tubing and braced in such a way as to afford the maximum rigidity with a minimum of material which might reflect sound. The receivers through which the stimuli are produced, are mounted on movable arms, which may be denoted as *A*, *B*, *C*, and *D*, respectively. Arms *A* and *B*, each representing an arc of 135° of a circle whose radius is one meter, are so mounted on a common center at the top that they may swing in the same course, describing a part of the surface of a sphere one meter in radius. Each of these arms carries a pointer, which moves under the circular scale placed above the bearings. This scale is graduated in five-degree units and marked with large figures, which may be read from the experimenter's position behind the tablet on the main sup-

port of the frame. The two arms are mounted on a common axis, but they turn on independent bearings, so that there is no friction between

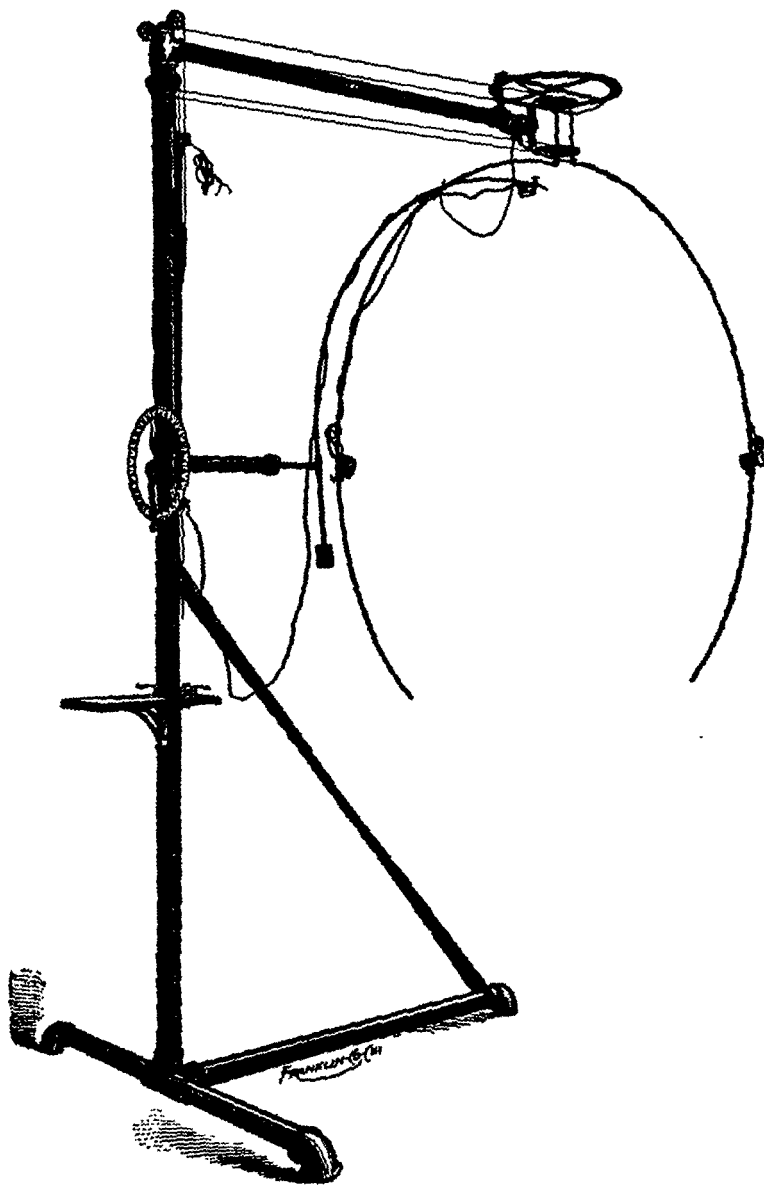


FIG. 1.

them. The arms are turned by means of cords which run from the experimenter's tablet up to pulleys at the top of the frame and thence

to wheels mounted on the upward projections of the arms. There are two of these cords for each arm; pulling one cord turns the arm to the left, and pulling the other turns it in the opposite direction.

The third arm, *C*, turns in the surface of the same sphere as the other two arms, but is mounted on the side and counterbalanced, so that it may be turned readily by means of the crank which is seen directly above the tablet. The pointer on the crank runs over a circular scale which is graduated in five-degree units, in the same manner as the scale for arms *A* and *B*. The axle which carries this arm may be drawn back through the frame so that the arm may pass the other two arms without striking at the top, and so as to be out of the way when not in use.

Arm *C* may be removed by pulling the axle out after detaching the crank, and arm *D*, a straight rod, will fit in its place of support. In Fig. 1, arm *D* is seen only in part, being stored away on the side of the main upright of the frame. This arm carries the receiver on one end, and is graduated in centimeters for guidance in the adjustment of the distance of the receiver from the center of the sphere. The arm is three meters long and slides freely in the horizontal direction.

For ordinary purposes only one receiver is needed on each arm, but it is evident that any number of receivers desired may be mounted on each arm for the purpose of special experiments. The receivers are clamped by a thumb screw and may be placed in any position on the arms. In order to eliminate conduction along the arms, the receivers are insulated from their clamps by means of soft rubber.

Soft and flexible wires run from the receivers to terminals on the surface of the frame and permanent wires are laid from these terminals, inside of the frame, to the tablet. The same circuit is used for arms *C* and *D*, as they are never used simultaneously. There is a knife switch for each circuit on the tablet and all the circuits are completed through the same battery and mercury key (not shown in the cut). Thus, when the key is pressed, a click will be heard in a receiver if the switch in its circuit is closed; and if two or three switches remain closed at the same time, the current is distributed equally to the corresponding receivers and the clicks will occur simultaneously in all.

Resistance may be put in the main circuit or in one or more of the branch circuits, as the needs may be, to vary the intensity of the click. If a dry-battery is used it may be fastened to the frame and then the apparatus will be complete without any further accessories.

To vary the quality of the stimulus, tones of different pitch may be substituted for the click. For that purpose it is necessary to have electric tuning-forks of the desired pitch in a distant room and to complete the perimeter circuit as a shunt through the fork. The tone will then be heard in the receiver whenever the key is pressed.

The center of the sphere described by the arms is 1.73 meters above the floor. A high, adjustable stool is placed under this center and adjusted for the observer so that the center of the observer's head occupies the center of the sphere. If a head rest is used great precautions should be taken to prevent disturbing effects. It is best not to use any head rest, but to check the position of the observer frequently by putting arms *A* and *B* at opposite points and sighting across. The height is determined by reference to the axis of arm *C* or arm *D*.

The scheme for numbering the points on the scale is of considerable importance. That plan has been adopted which students tend to follow spontaneously when asked to describe the location of a point in space. In this there is no number higher than 90. The upper scale gives the reading for horizontal planes and the side scale for vertical planes. The nomenclature adopted may be described without any diagram. The horizontal scale has two zero-points, one in the median plane in front and the other in the median plane behind; *i. e.*, every point in the median plane of the head is at 0° with reference to the horizontal plane of space, and degrees are counted toward the right and toward the left from the median plane both in front and behind. In the vertical scale, the two zero-points are at the level of the ears; *i. e.*, every point in the horizontal plane through the ears is at 0° , and degrees are counted upward and downward from this level. This gives a simple and natural nomenclature for direction, *e. g.*, a point is 'in front, 15° left and 25° up.' The upper scale may be turned so that this system will correspond to any desired position of the observer.

This apparatus will favor the use of the method of right and wrong cases and the method of minimal changes, in which it is not necessary for the observer to estimate degrees. However, it is sometimes advantageous to allow the observer to indicate the direction with a pointer; the experimenter may then swing the perimeter arms to such a point and read off the result on the scales.

This brief statement, supplemented by the figure, may suffice to give a general idea of the apparatus. Its special merits are, that it enables the experimenter to stand in one place throughout complicated

series of experiments and operate all the parts of the apparatus without giving any suggestion by movement or delay, that the movable parts of the apparatus are made to act without sound or jar, and that it makes it possible to vary, measure, and control the essential factors.

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