

and meatus. All these vibrations are increased in effect by the resonance of the column of air in the external passage.

In order to understand the functions of the parts of the middle ear, we must be acquainted with the results of some experiments made regarding the propagation of sound from one medium to another. It was found that sonorous vibrations passing from air to solids suffered a very serious diminution of intensity while in passing from air directly to water a very considerable though not so great diminution also occurred. Experiment showed that if between the air and the water there was interposed an elastic membrane the vibrations were transmitted from one medium to the other with very great, in fact with undiminished intensity. Here we have the explanation of the foramen rotundum already mentioned. This opening, closed by an elastic membrane, serves to convey unimpaired the vibrations from the cavity of the tympanum to the labyrinth of the inner ear. It has also been experimentally demonstrated that if to the elastic membrane between air and water, there be fastened a small solid body occupying the greater surface of the membrane and alone coming in contact with the water, the vibrations are in no way lessened in intensity. Hence the solid stapes, connected with the circumference of the fenestra ovalis by a ring of membrane transmits with almost their original vigour the vibrations received. But though a small body thus fixed in an opening by means of a border of membrane transmits sounds very freely, it is found that the propagation is greatly increased when the solid body thus occupying the opening is attached by the other end to a stretched membrane which has atmospheric pressure on both sides of it. This condition is found perfectly in the ear. The stapes is the solid piece held in the fenestra ovalis by a membranous border and in direct touch with the fluid of the inner ear, while the drum or tympanic membrane, to which the stapes is also attached by connection with the incus and malleus, forms the elastic membrane surrounded by atmospheric air. Thus we find in the ear a condition which experiment shows to be of the maximum efficiency in transferring vibrations from air to liquid.

Another factor in securing intensity of the transmitted vibrations is by the isolation of the three bones of the middle ear from all other bony substance. It is a demonstrable fact that a body surrounded by air will convey vibrations more readily through its own substance than it will impart them to the surrounding medium. To secure this result we find the bones of the middle ear enter into contact with no other bony substance, being connected at one end with the tympanum, surrounded by