

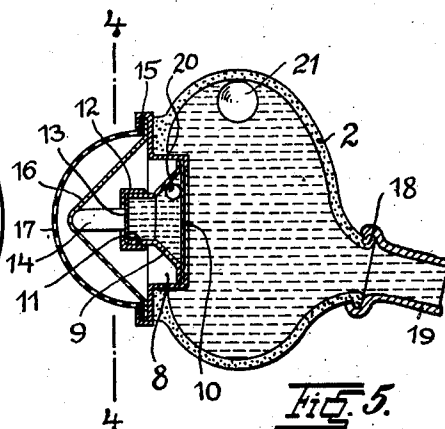
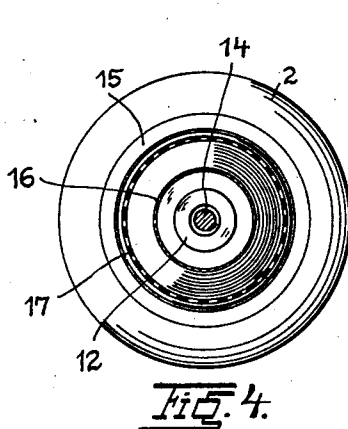
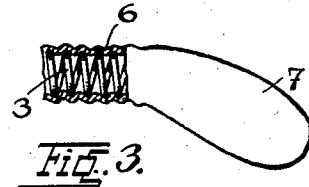
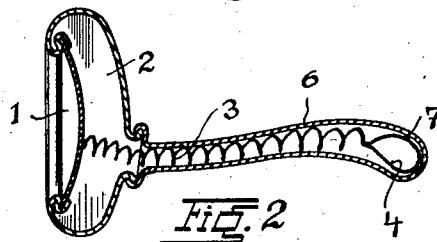
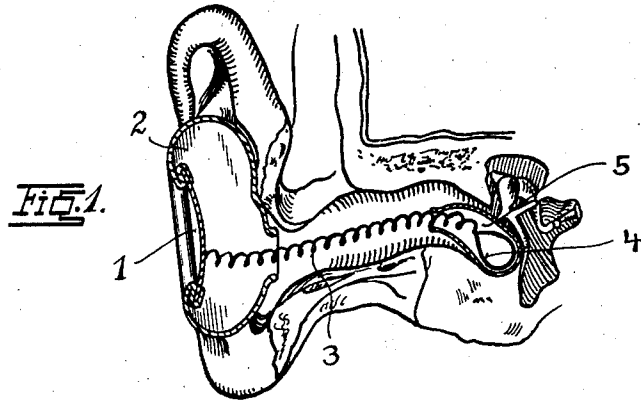
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HEARING APPARATUS

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## UNITED STATES PATENT OFFICE.

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## HEARING APPARATUS.

Application filed July 27, 1925, Serial No. 46,372, and in Germany February 5, 1925.

This invention relates to a device for facilitating the hearing in which a membrane bag bearing against the membrane of the tympanum communicates with a sound receiving diaphragm arranged in the concha, so that the sound waves striking the ear are intensified when transmitted upon the membrane of the tympanum.

In similar hearing devices of known type the membrane bag is connected with the sound receiving diaphragm by a tube of soft rubber and the sound waves are transferred upon the membrane bag by the air column in this tube. The tube of soft rubber is a resonance apparatus and constructed in such a manner that it receives the sound waves, and the air moved thereby is propagated in the tube as a total mass. As in apparatus of known type essential parts of the same, which have to conduct the sound waves, are in contact with the concha and with the wall of the auditory canal and are more or less clamped in the same the propagation of the sound waves is very much impeded, the sound energy is more or less weakened and cannot act upon the membrane of the tympanum with full strength.

The device according to the invention differs from the hearing apparatus of known type in that the sound receiving diaphragm is connected with the membrane bag by a spiral spring or by a liquid medium whereby the above stated inconveniences of the apparatus of known type are overcome. The use of a spiral spring for connecting the sound receiving diaphragm with the membrane bag presents further the advantage that it exerts continuously a soft massaging action upon the fatigued, cartilaginified or calcified portions of the auditory canal so that these portions are constantly excited to normal activity as the sound waves striking upon the sound receiving diaphragm produce fine oscillations of this diaphragm which are transmitted by the spiral spring upon the membrane of the tympanum and further by the auditory bones upon the inner ear or labyrinth. The walls of the auditory canal are at the same time softly massaged by the oscillations of the windings of the wire without any mechanical operation of the apparatus merely by the action of the sound waves upon the outer surface of the sound receiving diaphragm. As the deepest musical tone causes

about 48 sound oscillations per second, the higher tones however up to 4000 sound oscillations per second many millions of sound oscillations will act during a day as soft permanent massage upon the auditory organ so that the defects of the ear, even in bad cases, are rapidly cured by the use of the improved apparatus.

An embodiment of the invention is shown, by way of example, on the accompanying drawings in which

Fig. 1 shows the apparatus working by means of a wire spiral in longitudinal section inserted in an ear which is also shown in section.

Fig. 2 shows in longitudinal section the apparatus alone, the wire spiral being covered by a thin rubber tube.

Fig. 3 shows the rear end of the rubber tube with wire spiral as shown in Fig. 2 on larger scale partly in section and partly in elevation.

Fig. 4 shows in section on line 4—4 of Fig. 5 an ear capsule working with a liquid medium and to be inserted into the concha.

Fig. 5 shows this ear capsule in longitudinal section.

Referring to Fig. 1 a sound diaphragm 1 of metal is mounted on a rubber shell 2 adapted to the shape of the concha. On this diaphragm 1 a spiral spring 3 is fixed the other end of which forms a loop 4 upon which a membrane bag 5 is mounted which, when the apparatus is inserted into the ear, bears against the membrane of the tympanum. The sound waves which strike upon the diaphragm, make this diaphragm oscillate whereby fine oscillations of the windings of the wire spiral are caused which are transmitted upon the membrane of the tympanum and by the ear bones upon the inner ear, the labyrinth. At the same time the spiral spring exerts continuously a soft massaging of the cartilaginified and calcified portions of the auditory canal.

As shown in Fig. 2 a thin rubber tube 6 covers the spiral spring 3, the end 7 of this tube forming the membrane bag into which engages the loop shaped end 4 of the spiral spring. Owing to the undulations produced in the rubber tube by the windings of the spiral spring the active surface of this rubber tube is considerably enlarged so that the air in the auditory canal is oscillated in the

same manner as the membrane of the tympanum is oscillated by the point of the membrane bag. The spiral spring 3 is, according to the shape of the auditory canal, of oval cross section and wound like a cork screw whereby the inserting of the spiral spring into the auditory canal and a seating free of pressure is obtained.

According to Figs. 4 and 5 a rubber tube 19 is used as connection between the membrane bag and the sound receiving diaphragm, which is filled with water or any other convenient liquid with which the shell 2 is filled also, so that the sound transmission between the diaphragm 1 and the membrane bag is effected by the liquid. A spiral spring might also be used as additional connection between the diaphragm and the membrane bag, said spiral spring being enclosed in the rubber tube 19.

The effect will be the same as with the apparatus shown in Figs. 1 to 3, but the use of a liquid for transmitting has the advantage that the sound energy can be intensified by a convenient construction of the shell 2. With this object in view the shell 2 is preferably made from glass and its outer shape is adapted to the shape of the concha. A ring 8 is inserted in this shell 2 and a metal cone 9 is inserted in this ring. Between the metal cone 9 and the ring 8 a diaphragm 10 is clamped so that it is tightly packed. In the edge 11 of cone 9 a diaphragm 13 is clamped by means of a cap 12, a pin 14 being fixed on this diaphragm 13 the diameter of which pin being slightly shorter than the inner diameter of the diaphragm 13. A rubber diaphragm 16 is clamped on a ring 15. This rubber diaphragm 16 may be covered by a cover 17 of wire gauze or perforated sheet metal, so that it is well protected. The rubber tube 19 of soft rubber is placed on the mouthpiece 18 of the shell 2 and adapted to the shape of the auditory canal.

The hollow spaces in the cone 9 and in the shell 2, which are separated the one from the other by the diaphragm 10 are filled with water, oil or another suitable liquid. The liquid in the tube 19 communicates directly with the liquid in shell 2, while the liquid in shell 2 is separated from the liquid in the cone 9 by the diaphragm 10. The hollow spaces are preferably filled in such a manner that in each hollow space a small air bulb 20 and 21 remains.

The operation of the apparatus is as follows:—

The large, stretched rubber diaphragm 16 offers, owing to the conical shape, a large surface for the reception of the sound waves and also a specially good reverberating capability.

This rubber diaphragm 16 when put under tension presses upon the pin 14 of diaphragm 13 and as this pin 14 is of a diameter only

very little shorter than the inner diameter of the diaphragm 13 it acts upon the diaphragm 13 in a similar manner as the piston of a hydraulic press and maintains under tension the diaphragm 13 which presses upon the liquid. By the air bulb 20 in cone 9 every movement of the liquid in the space becomes elastic and this air bulb prevents further the rupture of the diaphragm at sudden strong sound impulses.

The diaphragm 10 is smaller than diaphragm 16, so that, when diaphragm 16 vibrates the vibration of diaphragm 10 is increased and also by the intermediate action of diaphragm 13. These stronger vibrations of diaphragm 10 are transmitted directly upon the liquid in shell 2 and thence upon the liquid in the tube 19 so that the vibrations of the diaphragm 16 produced by the sound waves are transmitted upon the membrane of the tympanum considerably intensified. The air bulb 21 in shell 2 serves as pressure regulator for the liquid in the shell 2.

If a wire spiral 3 is mounted in the rubber tube 19 of shell 2, as in the form of construction shown in Figs. 2 and 3, the undulations 6 produced in the wall of the tube by said wire spiral (Fig. 3) increase the transmitting surface so that a portion of the sound energy is transmitted by the excited liquid upon the air in the auditory canal so that this air is agitated in the same manner as the membrane of the tympanum is vibrated by the point of the diaphragm 7.

I claim:—

1. An apparatus for persons who are hard of hearing, comprising in combination a sound receiving diaphragm in the concha, a membrane bag on the membrane of the ear, a spiral spring connecting said diaphragm with said membrane bag and being of shorter diameter than the auditory canal so that it is not in contact with the walls of said auditory canal.

2. Apparatus for persons who are hard of hearing comprising in combination a sound receiving diaphragm in the concha, a membrane bag on the membrane of the tympanum and a liquid medium connecting said diaphragm with said membrane bag.

3. Apparatus for persons who are hard of hearing comprising in combination a sound receiving diaphragm in the concha, a membrane bag on the membrane of the tympanum, a spiral spring connecting said diaphragm with said membrane bag and a tube of soft rubber sheathing said spiral spring.

4. Apparatus for persons who are hard of hearing, comprising in combination a sound receiving diaphragm in the concha, a spiral spring fixed at one end to said diaphragm, a tube of soft rubber sheathing said spiral spring and having its free end formed as a membrane bag in contact with the membrane of the tympanum.

5. Apparatus for persons who are hard of hearing, comprising in combination a shell adapted to the shape of the concha and inserted in said concha, a sound receiving diaphragm in said shell, a rubber tube fixed at one end to said shell and having its other end formed as a membrane bag in contact with the membrane of the tympanum, said shell and said tube being filled with a liquid designed to transmit the vibrations of said diaphragm upon said membrane bag. 10

In testimony whereof I affix my signature.

ANTON v. SUCHORZYNSKI.