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THE USE OF EAR PLUGS IN AVIATION.

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Everyone who has flown for a considerable period of time, especially in bimotored ships, is familiar with the bothersome after-ringing in the ears and partial deafness lasting for several hours. These disturbances are caused by the sharp crack of the exhaust from the airplane motor, and if this condition is endured there will develop, eventually, more or less permanent impairment of hearing, inasmuch as the inner ear is a delicate organ and will not tolerate abuse without showing effects. The temporary effects of this exposure of the ear to massive sound are the ringing and temporary deafness, as stated above. In addition, however, if the abuse is continued, the temporary deafness may result in permanent partial deafness. It would seem wise, therefore, to remedy this condition, if possible, in order that the air life of the flier may not be shortened.

Three possible means of accomplishing this present themselves. One is the abolishment of the exhaust noise of the motor by a muffler, inasmuch as this sharp crack of the exhaust is the sound that causes the trouble. The remaining noise of the motor, the noise of the propeller, struts, etc., is either too low pitched or of not sufficient intensity to be harmful. Airplane motors have been successfully muffled, but at the expense of some of their efficiency, so that fighting planes will probably remain unmuffled. Secondly, a cabinet, nearly soundproof, can be constructed which will eliminate enough of the noise. This has also been done, but again at the expense of the efficiency of the airplane. It would seem, there-

fore, that at the present time nothing can be done with the airplane itself to eliminate enough of the motor noise. This being true, the fliers themselves offer the only means of abolishing this menace. For this reason, various substances were placed in pilots' ears to determine if one could be found which would not interfere with the flier hearing his motor, which would not hurt or annoy the pilot in any way, which could be easily and readily inserted or removed, which was reasonably inexpensive, and which would eliminate enough of the sound so that the flier would have no bothersome after-ringing or deafness.

Most fliers use cotton in their ears. This helps some, but does not usually abolish sufficient sound, and becomes easily displaced. Rubber plugs of various sizes and shapes satisfy certain fliers, but, due to the difference in the shape of the ear canal, a plug that will fit one man's ear will not necessarily fit the ear of another, hence, if used, will result in pain, discomfort or displacement if too large, and in insufficient protection and displacement if too small. In fact, any solid substance which cannot be moulded to the outer ear canal, even if composed of material as soft as rubber, must, in order to be efficient, be placed in so tightly that it will cause irritation of the delicate membrane lining the canal. Consequently, research work was undertaken here to find some substance, pliable enough when warm, to mould itself into the form of the outer ear canal and hard enough to retain its shape after being so moulded. Various substances, like parresine, beeswax, printer's wax, and gum were tried. The Navy Aviation Medical Service had previously tried parresine alone with some success. We found here that better results were obtained with a mixture of parresine and beeswax: five parts of parresine with one part of beeswax for summer use, and four parts of parresine with one part of beeswax for winter use, as beeswax softens the mixture and more of it is necessary in colder weather. Ear plugs of this mixture seemed of the right consistency, but lost their form too readily; hence, solid substances were used as a core to give "body" to the plugs, make them hold their shape better, and permit of easy withdrawal. Absorbent cotton does not possess the necessary resiliency and becomes too easily packed. After considerable experi-

mentation it was discovered that lamb's wool (surgical wool) was ideal. It does not pack as easily as cotton, yet is readily moulded; consequently the plugs hold their shape better and can be easily withdrawn.

In order that a large number of plugs can be made at one time, moulds were prepared from plaster of Paris blocks. These moulds are in two sections, thus enabling the completed plugs to be easily removed. Figure 1 shows a photograph of one of these sections, and from it some idea of the shape of the plugs can be ascertained, as well as from Figure 2, a photograph of an actual plug.

In making the plugs we first grease the moulds with a thin coating of vaseline; this prevents the wax from adhering to the mould. The two sections were then apposed and a small tuft of lamb's wool is placed in each depression. The melted mixture of parresine and beeswax, in the proportions required, is next poured in and allowed to cool, after which the moulds are separated, the plugs removed and any irregularities in their shape smoothed off. For shipping, the plugs are packed in an ordinary pasteboard box.

The plugs must be warmed and moulded before inserting. This is accomplished by holding a plug in the palm of one hand and kneading it with the fingers of the other hand. When it is soft enough, it is moulded into about the form depicted in Figure 3, and is then ready for insertion. When the plug is placed in the ear, the main thing to be observed is to avoid having the conical end so long that it will impinge upon the ear drum. This will not do any material damage but will cause discomfort when inserted. The plug is firmly inserted with the conical end in the external ear canal, and the remaining flat portion moulded over the end of the canal in the ear outside. A pledget of absorbent cotton, or, preferably, wool, about the size of a small egg is next placed in the ear on top of the plug and the helmet drawn down over this. This cotton or wool serves the purpose of maintaining constant slight pressure upon the plug, thus preventing its becoming dislodged by vibration. Withdrawal of the plug is easily accomplished by engaging any portion of it with the finger nail. Figure 4, the photograph of a withdrawn plug, shows the general shape which the plugs assume in the ear.

Several hundred of these plugs were sent to each of the flying fields throughout the country, and the Flight Surgeons of these fields were requested to report upon their use, adding any suggestions or criticisms that they or others cared to offer which would make for a better plug. A number of letters have been received from these Flight Surgeons stating that while the plugs are not in universal use at their fields, those fliers who had used them were very much pleased with them. A number of pilots still share the belief that any artificial means tending to preserve their health must not be used because they might be adjudged to be "soft" or timorous. This attitude, however, is becoming less and less prevalent, and it is believed that in time ear plugs of a type similar to those described above will constitute part of the equipment of every flier.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 1.