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The Medresco Hearing Aid

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Possibly one of the lesser known, but nevertheless important, benefits of the National Health Service is that of assisting those people who have difficulty with their hearing. In the majority of instances, particularly those in which there is no serious damage to the fundamental mechanism of the ear, very great relief is obtained by the use of a Medresco Hearing Aid. It may not be generally appreciated that the Post Office played a large part in the development of this Aid and is still responsible for its design and production, and this article describes some of these activities.

It is interesting to reflect that despite the great scientific advances that have been made during the last 100 or 150 years, the applications of this knowledge in giving direct assistance to the human senses are still limited to two, i.e. sight and hearing. In fact, the use of spectacles or lorgnettes was known even before that time, although it is probable that they have become available economically to the bulk of the population only in the present century.

Hearing, like sight, tends to deteriorate with advancing years and probably the first attempts to give assistance to this faculty were ear trumpets, which, at the turn of the century, were often used pictorially to denote a "Granny".

With the subsequent development of the telephone instrument, and particularly with improvements in the sensitivity of microphones and receivers when associated with batteries, it was natural that these devices should be considered for use in overcoming difficulties in hearing. Such aids, using a small low-voltage battery, really did magnify or amplify the required sounds. Unfortunately the amount of magnification possible was limited, probably to the order of 20 times, and this, as we now know, is quite insufficient to be really effective in most cases.

It was not until the later 1920's that the idea of inserting a thermionic valve between the microphone and receiver emerged to provide a much greater amplification of sound.

Although the amplification so achieved was substantial, the quality of reproduction was very poor, owing to the use of a carbon microphone. The next step was the replacement of the carbon microphone by one of much higher quality, but of reduced sensitivity, and for effective and satisfactory results a three-stage amplifier became necessary. These aids required both high-tension and low-tension batteries for their operation and as they had to be carried by the user they were made as light and small as possible. Unfortunately the life of a battery tends to fall with decrease in size and the majority of the batteries lasted only a few hours. They were often made in special sizes and as the numbers in use were small replacements were expensive.

The aids themselves were expensive—a good one might cost between £20 and £50—and they were, therefore, beyond the reach of the majority of the sufferers.

In 1943, the Ministry of Health, in considering plans for a comprehensive National Health Service, gave special attention to the needs of the deaf and approached the Medical Research Council for advice upon the matter. The timing of this approach seems to have been a particularly fortunate one, since it coincided not only with advances which were being made in the medical field in the treatment of ear affections, but also with the development of new electrical equipment and, in particular, of miniature valves and telephones which might be specially suitable for use in improved forms of hearing aids.

In 1944, the Medical Research Council appointed three committees to plan and co-ordinate the necessary investigations. These were (i) the

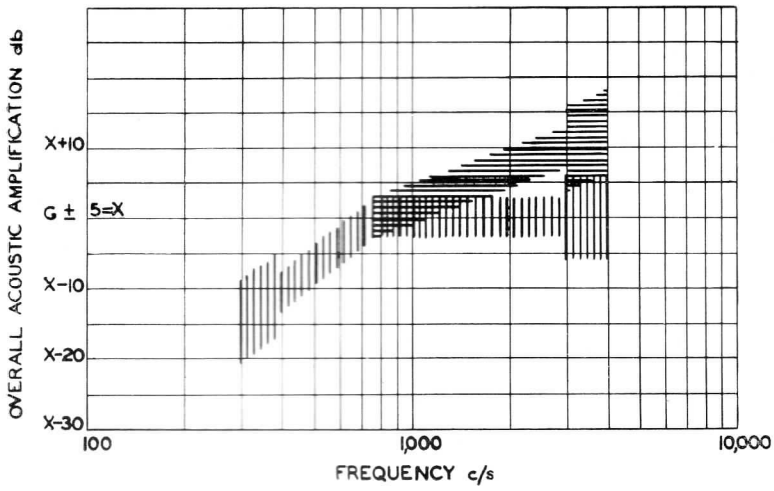

FIG. 1. GRAPH OF FREQUENCY RESPONSE CHARACTERISTICS

Committee upon Medical and Surgical Problems of Deafness, (ii) The Committee on the Education of the Deaf, and (iii) the Electro-Acoustics Committee.

The first two committees were primarily concerned with clinical investigations concerning the causes of deafness, the best types of remedial measures and their means of application, while the last was concerned chiefly with the practicability of developing such measures at a reasonable cost.

Dr. W. G. Radley, Controller of Research of the P.O. Engineering Dept. (now Deputy Engineer-in-Chief) was appointed Chairman of the third Committee, which also included two officers of the P.O. Research Station at Dollis Hill.

Its terms of reference were as follows:—

"To advise upon the design, performance and application of electro-acoustic equipment used in the investigation and alleviation of deafness, and to institute such fundamental investigations as may be considered necessary in this connection."

In 1947, this Committee issued a report, published by the Medical Research Council as Report No. 261. In this report they surveyed many types of commercial aids manufactured in Great Britain and in the U.S.A. Also, as a result of practical tests made upon some hundreds of persons suffering from

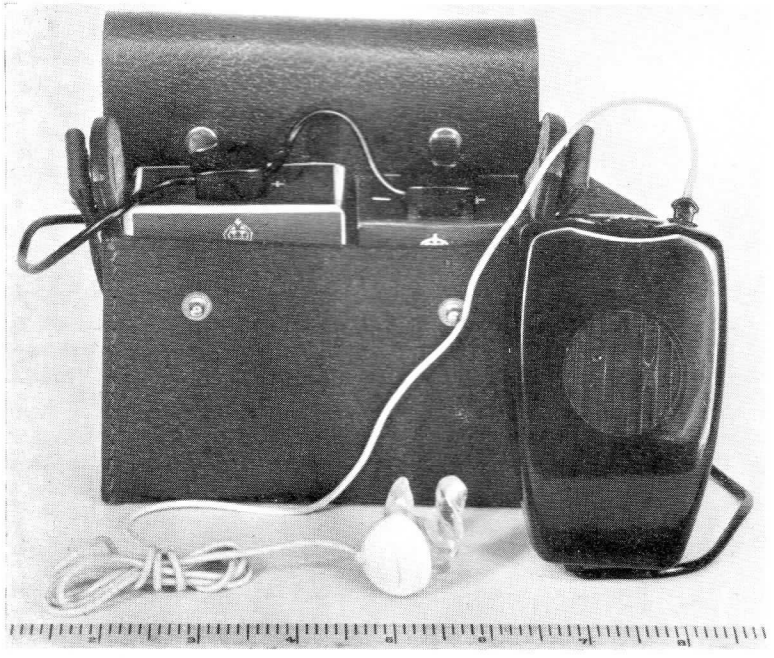

FIG. 2. MEDRESCO HEARING AID — RECEIVER, EARMOULD AND BATTERY POUCH

varying degrees of deafness, they included a specification for an original design of a hearing aid incorporating three thermionic valves and based upon the best available components then in production, of which models had been constructed and subjected to practical trials in clinics both in London and Manchester. The design included, in particular, Raytheon miniature valves, a small crystal microphone and a crystal insert receiver, all of which were available only in the U.S.A.

The Committee also recommended that the design should cater for two alternative ranges of frequency response and that the maximum overall acoustic amplification should be not less than 40db. measured at 750c/s., that is that the overall magnification of the sound power should be not less than 10,000 times. Figure 1 shows the overall frequency response characteristics which were recommended. A recommended design for an aid with an external type of magnetic receiver was also included.

The committee drew attention to the fact that to obtain the full benefit of the above magnification it was essential for the receiver to make a very good acoustic fit to the ear and that this could best be accomplished by the use of ear plugs or individual earmoulds. (Figure 2 shows clearly what is meant by "earmould".)

The Committee also made a survey of audiometers which could be used for assessing the deafness of patients and a specification for a proposed audiometer which could be used in clinics was included.

The Ministry of Health accepted this report in principle and asked the Ministry of Supply to arrange for the production of 50,000 complete hearing aids, which were to be delivered by 1st July, 1948, the date of the introduction of the new National Health Service. The aid was given the name Medresco as an abbreviation of the title of the Medical Research Council. Provision was also to be made of certain testing equipment, e.g. audiometers for diagnostic centres and test gear for clinics.

Development contracts were placed for the production in the United Kingdom of British equivalents to the principal American components, but in order that production of aids should be established quickly it was agreed that a limited number of American components were to be available in this country.

The development of equivalent British valves proceeded satisfactorily and a new factory was established for large-scale production. At this time it was estimated that the vibration and shock to which the aids would be subjected in being carried by the wearer would cause a high rate of valve mortality. Spares were estimated to be necessary and were provided for on the basis of a life of six months.

The establishment of British production of crystal receivers, however, proved to be more difficult than had been expected, while importation from America was cut by dollar shortages. Eventually, in August, 1948, further dollar expenditure was stopped and the Post Office was asked to accept responsibility for the production in 1949 of 100,000 aids. They were to meet the specification laid down by the Medical Research Council and to be wholly of British manufacture.

After consideration of all the factors involved and bearing in mind the production difficulties, it was considered that an electro-magnetic type of receiver offered more advantage than a crystal type. It was decided, therefore, to develop a magnetic receiver of the insert type for production in this country. As this would have different electrical characteristics from the crystal type, it would be necessary to modify the design of the microphone and the amplifier so that the overall performance of the complete aid would be substantially unaltered.

By this time also a limited number of aids incorporating American components had been constructed and distributed to the public and as a result of this practical though somewhat limited experience, it was also decided to develop improved types of volume controls and switches. All these new components were incorporated in the design, together with several other mechanical improvements which had been found to be desirable, and although the external appearance remained substantially unaltered, for stocking and maintenance purposes these aids were designated Mark II. Production commenced in April, 1949, and quickly reached the required figure of 2,000 per week. All the specified requirements were met and as a matter of fact the maximum overall acoustic amplification of the insert type exceeded 100,000.

Figure 2 shows a complete Medresco Aid with insert receiver, individual earmould and battery pouch.

These aids operated with the same batteries as the Mark I types, but while the Post Office was not concerned with choosing the size of the bat-

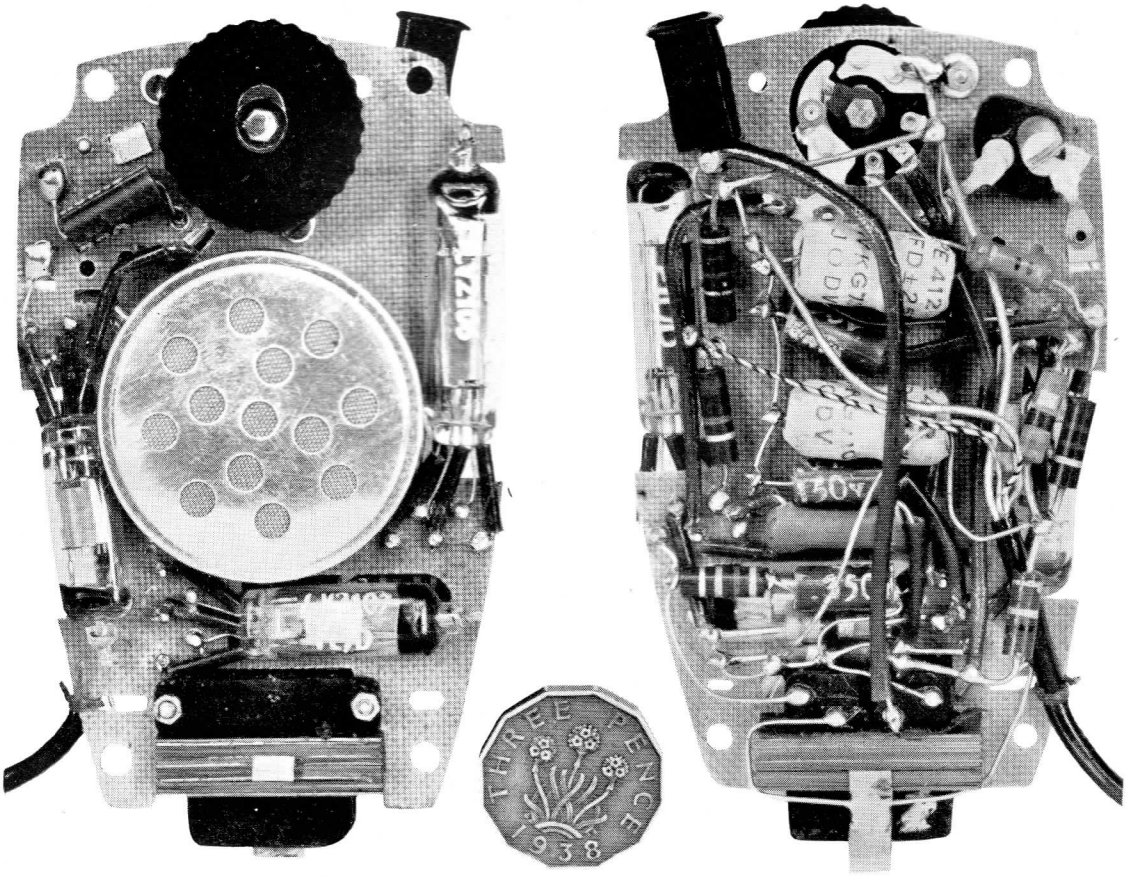

FIG. 3. THE RECEIVER—COMPACTNESS ITSELF

teries, the decision as to the actual size presented some difficulty. A compromise was necessary between the desire of the user on the one hand, who naturally wanted to carry around the smallest possible batteries, and the administrative and financial aspect on the other. Smaller batteries involved more frequent visits to clinics for renewals and they were but little less costly than the larger types.

The sizes finally decided upon are such that under average conditions of use an L.T. battery lasts for about 10 days and an H.T. battery for six weeks. Although smaller H.T. batteries can be manufactured, they are liable to serious deterioration if stored for a long period and are not recommended for the Health Service at present.

The battery plugs are both non-interchangeable and non-reversible, so that there is no possibility of damage to the Aid or failure to operate due to wrong connections.

By mid-summer, 1949, the question of placing further orders for Hearing Aids had to be considered, to ensure continuity of production, and detailed specifications and drawings were therefore prepared for competitive tendering. As it was then expected that further improvements, particularly in valve efficiency, would become available, the Ministry of Health agreed to limit additional

orders to a further six months' supplies, i.e. 50,000 Aids. It is interesting to note that as a result of the above efforts the design had been made so suitable for bulk production that these Aids were purchased at a fraction of the cost of a commercial aid. The new range of valves (shown in Figure 3), besides being smaller, showed an economy of 40 per cent. in the filament current consumption and were incorporated in a modified design of the Aid known as Mark IIA. Although the external appearance was again subtsantially unchanged, advantage was taken of the redesign to incorporate numerous small but important improvements which experience, both in production and in service, had shown to be desirable. These included the redesign of the terminations of both ends of the receiver cords, the soldered termination to the Aids being replaced by a new miniature plug and socket and the receiver slide plug being redesigned to improve the contact. The battery plugs were also both completely redesigned, the cord grip strengthened and the wiring simplified. After a number of these Aids had been given practical tests, the Ministry of Health asked the Post Office to purchase 37,000 for production in the latter half of 1950/51. Subsequently, further orders for 85,000 were placed for production in 1951/2.

Figures 3 and 4 show the two sides of the complete chassis assembly of the Mark IIA design. On the one side will be seen the microphone, the three valves and combined volume-control and switch, and on the other, at the top, the miniature socket and the screw head for adjustment of the frequency response characteristic. It will be noticed also that to keep the size to the minimum the chassis has been cut away to allow the valves to be recessed.

In parallel with the above work, experiments were made to determine how far it was practicable or economic to modify the original Mark I design so that some use could be made of the stocks that had accumulated by being returned as faulty by the users. Eventually a rather novel system of graduated repair and conversion was evolved. Close statistical control has shown that some 70 per cent. of the Aids can be made suitable for reissue at a reasonable cost.

Individual earmoulds are supplied by the hospital which issues the Aid. The Post Office is not brought into the manufacture, as the techniques are more akin to those used in dentistry. The actual procedure is that a plaster cast of the patient's ear is taken at the local clinic and sent in a sealed container to the moulder. Individual moulds are made from these casts in a material known as methyl methacrylate (Diakon) and sent in individual containers to the clinics. The original cast is destroyed in the moulding process, so that if any losses in transit or errors in identification occur, new casts have to be taken from the patient.

Some of the original forecasts of the fault liability of the Aids and life of the components have not been confirmed in practice. The valve, which had been feared to be the weakest link, has turned out to be far the most robust and reliable, and replacements have been less than 0.1 per cent. It is now confidently expected that the valves will outlive the Aids. On the other hand, the cords, which have been deliberately made small and light, have quickly become faulty, involving rather tedious repairing at clinics, and although, as already mentioned, all the terminations have been completely redesigned, they are still probably one of the weakest parts.

As a measure of the technical progress that has been made during the time that the Post Office has been associated with the work, it is of interest to note that the filament consumption of the three Raytheon-type valves recommended in the Medical Research Council Report was 80 mA, whereas that of the latest Mark IIA Aid is only 30 mA.

Further advances in the development of improved components are constantly occurring and will be incorporated as opportunity offers, since it is known that the ultimate limit of increased efficiency and reduction in size of the Aid has by no means been reached.

To conclude, while the activities described in this article cannot strictly be regarded as falling within the field of telecommunications, the Post Office can claim that it has played a big part in a project which is of real value to the community and in a field remote from that usually associated with the Post Office in the mind of the public.