A CRITICAL APPRAISAL OF AUDIOMETERS MANUFACTURED IN INDIA

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BEL Audiometer

In 1962 Bharath Electronics Limited manufactured the first audiometer in India. It was demonstrated in Jaipur in the same year. The latest model which differs from the earlier one in only one feature is being used at the All India Institute of Speech and Hearing. The feature that has been added to this model is the Normal/Reverse switch used to present continuous tone or to interrupt the same. An attempt is made in this article to express the views of a user.

BEL Model KM 222A is a dual channel mains operated audiometer fully designed and manufactured by Indian engineers without any foreign collaboration. Because of its small size and its weight of 22 Kgs the manufacturers claim it to be portable. Perhaps, the weight and size could have been still reduced to make it more portable.

It covers a frequency range of 125 to 12,000 cps, a range perhaps a little wider for hearing measurements in the clinic, since generally frequencies beyond 8000 cps are not used. The maximum hearing loss that can be tested at 12000, Hz is 75 dB; at 125, 250, 6000, 8000 Hz. it is 85 dB; at 1000, 1500, 2000, 3000, 4000 Hz it is 100 dB for air conduction testing. For bone conduction testing the maximum intensity available is 40 dB at 125, 250 Hz; 50 dB at 500 Hz; and 55 dB at 1000, 1500, 2000, 3000, 4000 Hz. The lowest level for all the frequencies for the two modes is -10 dB. The maximum level at 250, 500, 6000, 8000 Hz. falls short by 5dB for air conduction and by 15 dB for bone conduction at 500 Hz. and 10 dB for frequencies 1000 to 4000 Hz for the two modes when compared to other standard audiometers. This does put the audiometer at a disadvantage, since it does not permit the testing of persons with severe hearing impairment who could otherwise be evaluated on other audiometers.

By manipulating the function selector switch provided for the two channels, pure tones, speech or masking noise can be fed either through the earphones or through the bone conduction vibrator. The signal may be kept out of the nontest ear by turning this switch to the 'Blank' position.

The magic eye provided indicates whether the audiometer is ready for use. During speech audiometry, the same serves to monitor speech by showing whether correct intensity and levels as indicated on the dial are being maintained. Jacks have been provided for using a VU meter and an external microphone to deliver

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speech. A jack is provided for delivering recorded speech either on tape or on disc.

The interrupter switch can be used to interrupt the signal. This helps to check the responses of the patient.

The Normal/Reverse Switch, which is the special feature of this model helps to present continuous signal. It can also be used to stop the continuous signal. This avoids the frequent use of interrupter switch while administering threshold tests.

The Balance Check switch when depressed transfers the programme fed to one ear to the opposite ear. This provision is to check the validity of patient responses. A patient signal is also provided.

The audiometer can be used to measure the bone conduction thresholds and it can be used to test either monaurally or binaurally the air conduction thresholds, speech reception threshold and to measure discrimination scores. White noise provided for masking helps to mask the nontest ear. Perhaps, the maximum noise of 100 dB provided may not be sufficient for practical purposes. Thus the audiometer can be used for the above tests as claimed by the manufacturers in their manual.

Some tests that could still be administered and not included in the manual are the Tone-decay test, Stenger test and the Lombard test.

The interrupter switch button and the other buttons are very hard to press and they sometimes come out exposing the springs. This can be overcome by using interrupters of the type that are easy to operate and noiseless.

Though jacks have been provided in the front panel it would be convenient to have them in the back or at the side of the audiometer as provided in most of the standard audiometers.

The two function switches, one mode switch and the three interrupters are superfluous. This complicates the operations of the audiometer. These may be reduced to a single function selector a mode selector and an interrupter. This makes the audiometer simpler and easier to operate.

Pulse tones cannot be presented through this audiometer. Provision for this should be made so that fixed time pulses can also be presented. Provision should also be made to include a bulb to denote whether the signal is being fed or not as provided in most of the audiometers.

The suggested modifications when incorporated will make the audiometer fully equipped to administer the routine audiometric tests mentioned earlier. The manufacturers can, by introducing these modifications and if possible, by reducing the size and weight of the instrument, produce audiometers at a price within the reach of every otologist and audiologist. This will cater to their minimum needs in terms of audiological testing.

If the cost of the audiometer cannot be reduced considerably, it would then be preferable to modify it to include some of the special tests that are very essential for diagnostic purposes. Though this would mean an increase in. the existing

price of the audiometer, the buyer will not hesitate to purchase the same, since he is fully convinced of the importance of the special features that are incorporated. For this purpose, the tests that are to be included are: Monaural Loudness Balance (MLB) test; Alternate Lpudness Balance (ABLB) test; Short Increment Sensitivity Index (SISI) test; Sensory Acuity Level (SAL) test; Difference Limen (DL) test; and free-field test. When these are included, the audiometer will be more useful and versatile.

Arphi Audiometer

Arphi Incorporated manufactured the first battery operated diagnostic audiometer in India in 1968. A revised model of this is being used at the All India Institute of Speech and Hearing.

Arphi Model 700 MK II is a dual channel audiometer. This has provision for operating on external power supply also. Thus it has an added advantage over the other audiometers which can either be battery or mains operated.

It covers a fairly wide range of frequencies from 125 to 10,000 cps. This range is sufficient for hearing measurements. The maximum hearing loss that can be tested including the + 10 dB to the dial reading is 70 dB at 125 Hz; 90 dB at 8000 Hz; 100 dB at 250 Hz; and 110 dB at 1000 to 6000 Hz. for air conduction testing. For bone conduction the maximum intensity available is 40 dB at 125 Hz; 50 dB at 250; and 60 dB at 500 to 4000 Hz. These levels are more than sufficient for audiometric tests. The lowest level for all the frequencies for the two modes of conduction is —10 dB.

On the left side of the front panel, the interrupter, the frequency selector, and the tone attenuator are provided facilitating easy one hand operation of the audiometer and aids in using the other hand for recording the test results.

The limited number of control switches and interrupters used have made the audiometer simple and easy to operate.

All the dials employed are easy to operate and noiseless.

The Interrupter Switch can be manipulated to 'Auto' or 'Man' position to feed either pulse tones or continuous tones. In the normal position the tone is cut off. This type of interrupter is undesirable, as it gets stuck either to 'Man' or 'Auto' position. It is difficult to get it back to the normal position. The switch has to be pushed back and forth to get it back to the normal position. The. same is true when pulses are to be fed. Interrupters of the type used in other standard audiometers may be employed.

Instead of the + 10 dB provision as a special feature it would have been much easier both in view of operation and simplicity to incorporate this in the hearing dial itself. This will avoid pressing the interrupter and the + 10 dB button when necessary.

A function selector switch and a mode selector switch enables the examiner to administer the following tests: Pure tone air conduction and bone conduction

threshold tests, speech tests, Alternate Loudness Balance tests, Tone decay test, Short Increment Sensitivity Index test, Rainville test, Sensory Acuity Level test, Difference Limen test and Langenbeck test which are widely used for differential diagnostic purposes.

The pulse generator helps to present fixed time pulses from 0.25 to 2 pulses per second.

The Difference Limen dial can be used to present small increments from 0.2 to 6 dB.

White noise provided helps to mask the non-test ear, when necessary. The maximum noise provided is 100 dB, which may not be sufficient to mask the nontest ear in some cases.

The voltage indicator serves two purposes. It acts as an indicator to show the Examiner whether the signal is on or off and it acts as a VU meter to monitor speech during speech tests.

The built-in microphone provided in the front panel helps the examiner to directly talk to the subject while administering speech tests. However, provision is also made to use an external microphone.

The talk interrupter can be used by the examiners to give instructions to the patient while pure tone tests are in progress. This is indeed a helpful feature.

The patient signal is very confusing, since it is seen superimposed on the battery voltage deflections. Infact, it becomes impossible to distinguish the patient's responses from the small increments presented, while administering Short Increment Sensitivity Index test and also when pulse tones are being presented. This can be overcome by providing an accessory bulb for this purpose. This perhaps cannot be provided as the audiometer is already overloaded. Also, with the accessory bulb that has to be provided outside the audiometer, it can no longer remain portable.

The controlling dials become loose quite often and sometimes come off the shaft. This can be avoided by drilling a hole in the shaft and fixing the dial firmly into it with screws.

Masking noise cannot be fed to both ears simultaneously. This provision if present helps to administer Lombard test used in the detection of cases of functional hearing impairment.

The maximum amount of masking noise provided (at the 50 dB setting on the masking dial) is not sufficient while administering SAL test. The normal threshold shifts measured in the case of 20 normal subjects with this audiometer at the All India Institute of Speech and Hearing are very low compared to the normal threshold shifts given in the Manual to compute SAL figures. It is therefore necessary to increase the amount of masking noise provided (through the BC vibrator) so as to produce the specified threshold shifts at different frequencies as mentioned in the Manual.

Though it is claimed in the Manual that speech can be fed through the bone conduction vibrator upto a maximum level of 50 dB, speech is not available through

BC vibrator until the dial reads 30 dB. Thus it is not clearly known whether the speech attenuator dial readings really conform to the Speech level fed through bone conduction.

Since the audiometer is claimed to be a diagnostic audiometer, it would be proper to include the following tests also. The tests to be included are Stenger test, Monaural Loudness Balance test and Lombard test.

These improvements will enable the audiologist to administer various audiometric tests which are crucial for differential diagnosis.

Both the audiometers are calibrated to ISO zero reference hearing levels. The ASA standard procedure for calibration has been employed in both the audiometers.

The fact that the two manufacturers have modified their first model of audiometers is itself a healthy sign. This shows that they have modified their earlier models to eliminate the defects noticed and also to provide certain desirable features which were absent, in them. It is hoped that the suggestions made in this paper will help improve upon the existing audiometers.

REFERENCES

Arphi **Incorporated:** Instructions manual for **Arphi Model 700 Mark II audiometer.**

Bharath Electronics Limited: Instructions manual for B.E.L. Clinical audiometer Model K.M. 222 A.