ENGINEERING DIVISION TRAINING MANUAL

1942

THE BRITISH BROADCASTING CORPORATION

As regards its directional properties, it is like the carbon type in being one-sided, and therefore most suitable for the close-up technique of talks. But being free from 'blasting', it can also be used for a greater range of volume, and is reasonably good for orchestral and general work. It is however considerably less sensitive than the carbon microphone.

The Ribbon Microphone

Last, but by no means least, is the ribbon microphone. The models used are a BBC development based on principles which date back as far as 1913. However, it was not until 1934/5 that the present model was produced, and it has not yet been superseded. The actual principle of operation is the same as the moving-coil in that it consists of a conductor which moves in a magnetic field; but this time the whole of the moving element is the conductor.

Fig. 41 shows the principal parts in elevation and section.

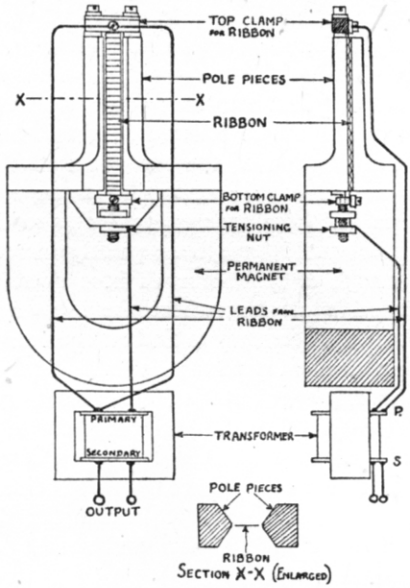

FIG. 41. RIBBON MICROPHONE: FRONT AND SIDE VIEW (WITHOUT COVERS) AND SECTION

A strong, horseshoe-shaped permanent magnet has a specially shaped pole-piece attached to each of the two poles. They form a very intense but narrow field over a gap which is about $2\frac{1}{2}''$ long and $\frac{1}{4}''$ wide. In this gap is suspended a 'ribbon' of aluminium foil, only ·0002″ thick and delicately tensioned so that its edges are just clear of the pole-pieces. It is corrugated for reasons to be described later. The action is quite straightforward. When sound waves impinge on the corrugated 'face' of the ribbon, it vibrates backwards and forwards and so 'cuts' the magnetic field. This, of course, causes alternating voltages to be set up across the ribbon conductor and these voltages constitute the microphone output. It is an extremely small voltage that appears across the ends of the ribbon, and again we have the problem of matching the impedance of the ribbon (this time, only 0·15 ohm) to that of the succeeding apparatus (300 ohms) in order not to lose the output by inefficient transfer. So a transformer is incorporated in the microphone itself to perform this impedance step-up. Its 'turns ratio' is 1:45, because the impedance ratio is proportional to the square of the turns ratio (see Appendix III).

One of the first things to be noticed is that the microphone presents two 'faces', and is equally sensitive to sound on either face; a very important feature, as will be realized soon. On the other hand, the pole-pieces themselves shield the ribbon from sound waves approaching it from each side. Such waves would also form equal and cancelling pressures on each face of the ribbon. The net result is that the sides of the microphone are virtually 'dead' areas as far as sounds coming from that area are concerned. In fact, a plan of the relative response areas could be drawn as in Fig. 42. It means that both

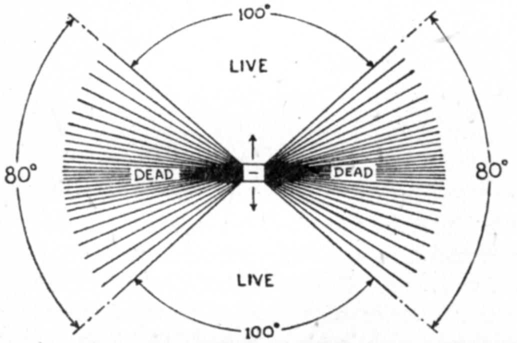

FIG. 42. DIAGRAM SHOWING DIRECTIONAL PROPERTIES OF RIBBON MICROPHONE

in front and behind the microphone, a sector which is 100° wide embraces the area in which the sensitivity is practically uniform. Of course, the usual rule applies that the further one gets away within that angle the weaker the output will be. But if one moves into the 'shaded' angle of 80°, the relative output gets gradually weaker as one approaches the exact plane of the ribbon. At this point it is absolutely dead, although it may not be apparent in actual practice. This is due to the fact that we rarely listen to sounds which come from one point only. As has been explained before, nearly all sounds in nature are reinforced by reverberations which come from surrounding walls, objects, etc. Therefore, unless the studio is quite 'dead', we shall probably hear something even if the source of the sound is in the 'dead area'.

Before going on to discuss the merits of the ribbon microphone, we will consider the remaining features of its construction. The reasons for the corrugations in the ribbon are threefold. Firstly, they increase the effective length and, therefore, the impedance of the ribbon. Secondly, they allow of delicate tensioning; in fact the ribbon itself is the 'spring'. Lastly, the sound waves hitting the ribbon are 'scattered' by the corrugations, thereby producing a more uniformly distributed movement over the whole length of the ribbon.

The overall frequency response is extremely good, being almost equally sensitive from 20 to 16,000 cycles. There is a slight increase in sensitivity at the very low frequencies, and a very small drop at the higher frequencies, but these can easily be compensated for in the design of the amplifiers which follow.

The finished microphone is always fitted with protective screens or covers. These not only protect the ribbon from injury or dust, but serve a very special purpose. When a singer, particularly a soprano, is singing near the microphone, the ribbon is not only vibrated in the normal way, but is often subjected to 'puffs' of air. These puffs would blow the ribbon out in a bowed form and the conductor would therefore be right out of the gap! The microphone response would be materially altered and serious distortion would result. So the screens (there are two, one inside the other) are made of some material which will not stop the sound waves, but will effectively cut off the puffs of air. Chiffon was found to be the most suitable material, and this is glued on to perforated metal screens. Even so, there are still some sopranos who are guaranteed to blow the ribbon out of the gap at 10 feet! So a later type of microphone has been modified to incorporate three such screens.

Finally, the microphone is built with special 'lugs' and fixings, so that it may be put on a stand or slung from wires, and may be swivelled or tilted to any position.

The Decibel again

It has been stated that the outputs of each of the microphones, particularly of the ribbon and moving coil, are 'extremely low'. This is, of course, far too vague and some scale of measurement is obviously required for precision. Here our old friend, the decibel, will help. For what could be a better unit to represent the equivalent electrical power of a particular sound than the unit which was used to compare the relative levels of sound itself? You will notice we have said that the decibel is a unit which is used to measure the relative or comparative sound volumes, because that is all the decibel is—a ratio. If one sound is louder than another, we say that it is 'so many decibels above the other' because its ratio is greater than unity and its logarithm will be positive. For example, a sound will be 20 db. above another if its power ratio is 100 times greater than the first, or ratio of $\frac{100}{1}$. On the other hand, we could say that one sound became weakened by 30 db. (or had a 'loss' of 30 db., usually written as -30 db.) if its power fell to $\frac{1}{1,000}$ of its original value.

The above shows how useful the decibel is when dealing with electrical speech currents; for we are constantly amplifying (multiplying) by valve amplifiers, and we want to know how much louder the equivalent sound will appear on the output as compared with the input. Such an amplification would be called the 'gain' and conveniently expressed in decibels. Likewise, the loss of speech currents due to resistance or impedance will be expressed in decibels, with the negative sign in front of it to denote the ratio of less than unity.

But note that we still do not know the actual, or absolute, power referred to simply by quoting the magic word 'decibel'. It has only told us the ratio between two quantities: rather like one man asking another how much he pays his servant, and getting the reply: 'Oh, I pay him one-tenth of my own salary'. Now if we only knew how much the employer was getting, it would be quite a different matter. Similarly, if we could say that a certain