Sound Engineering Explained (2nd ed)
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4 Microphones

Part 1 – Microphone Types

Microphones are amongst the most important tools in any sound recording work and an understanding of their properties is vital. Fuller technical details can be found in books listed under 'Further reading' – here we must confine ourselves to an outline.

There are two principal characteristics of any microphone. One is the *transducer system* – in other words, the means by which sound waves are converted into electrical signals. The other is the *polar response* – the way in which the microphone responds to sounds arriving from different directions. We will look at these two things in turn, but first we will look briefly at the main components of a microphone. These are:

1. The *diaphragm*. This is a thin circular sheet of metal or plastic which is caused to move by the varying pressures of an incident sound wave. It is invariably placed behind a protective metal grille or a piece of metallic gauze. The diaphragm either forms part of, or is mechanically linked to, the transducer.
2. The *transducer*. This can be one of a number of forms which are outlined below.
3. The *microphone casing*. Besides protecting the diaphragm and transducer, the nature of the casing affects the polar response of the microphones, as explained in Part 2 of this chapter.

Microphone transducers

The following is a brief description of the most important types.

1. Moving coil (A.K.A. "Dynamic")

Figure 4.1 shows a simplified section through a transducer of this type. The diaphragm is slightly domed to give it extra rigidity and fixed to it is a coil of very thin wire, often of aluminium because of this metal's

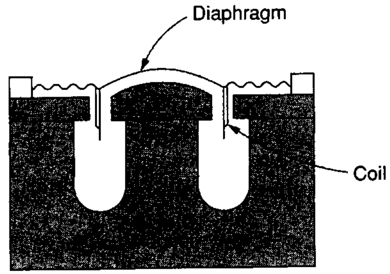

Figure 4.1 Moving coil microphone

lightness. The outside area of the domed section is corrugated to allow the diaphragm to vibrate. As it does so, the movements of the coil in the magnetic field cause a voltage to be generated in it. This voltage is extremely small – of the order of 1 millivolt (one thousandth of a volt) or less – and is a replica of the diaphragm movements and hence of the sound waves which are striking it.

Moving coil microphones are sometimes called 'dynamic' microphones. This doesn't seem to me to be a very good term, as 'dynamic' simply means a system in which things are constantly changing – as opposed to 'static'. Any microphone, therefore, is in a sense *dynamic*. It's far better to call these microphones 'moving coil', which says what they are!

2. Ribbon microphones (Not really used for Film)

Figure 4.2 shows the idea.

Here the very thin corrugated ribbon is itself the diaphragm. Its movement to and fro causes a voltage to be induced in it, but because the

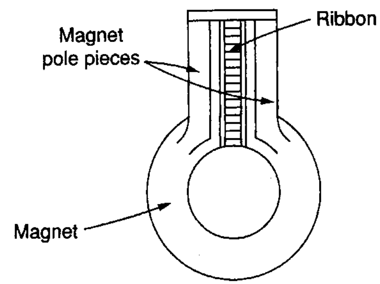

Figure 4.2 Ribbon microphone

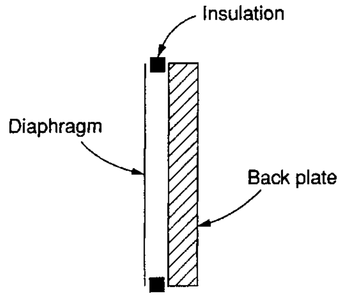

Figure 4.3 Basic electrostatic microphone

total length of the ribbon is relatively small, being rarely more than a couple of centimetres, the induced voltage is also very small, generally much less than that produced in the coil of a moving coil microphone.

3. Electrostatic ('condenser') microphones

The diaphragm and backplate form a capacitor. As the diaphragm vibrates the capacitance varies and, as is explained a little more fully in Part 2, a corresponding voltage is produced. *Electret* microphones are a form of electrostatic microphone and are mentioned further in Part 2.

Other types of transducer exist but they are not of great importance today. For the sake of completeness though, we might mention the *carbon granule microphone*. A layer of small grains of carbon is held between the diaphragm and a rigid plate. Vibrations of the diaphragm cause the pressure on the granules to change and this varies their electrical resistance. A current (produced by, say, a battery) flowing through the granules is thus caused to vary also. For many years, this type of transducer was used in telephones and it was widely used in the very early days of broadcasting. Its drawbacks are that it generates a very detectable hiss in its output, apparently caused by minute electrical arcs between the granules, it is less reliable than more modern types and it is not easy to have different polar diagrams – a point which will be better appreciated when that topic is dealt with a little later. Also, the granules tended to pack together so the whole thing had to be tapped firmly from time to time. The carbon microphone's advantages were that it gave a high output and it was cheap. It is very rarely encountered now.

Another type of microphone which is obsolete in the broadcasting/recording world but might be found occasionally in second-hand shops is the *crystal microphone*. Carefully chosen slices of crystals of certain materials show what is known as the *piezo-electric* effect. In other words,

Table 4.1 Comparison of moving coil, ribbon and electrostatic microphones

Moving coil (Dynamic)		
For:	(a)	Usually very reliable and robust (although all microphones should be treated with as much care as possible).
	(b)	Can be used on the end of considerable lengths of cable without the need for amplifiers close to the microphone (unlike electrostatic microphones which, for reasons given in Part 2, have to have some form of amplifier near to the microphone).
Against:	(a)	Tend to be expensive as skilled labour is needed in their assembly.
	(b)	The quality of their output, although as a rule good, is not likely to match that of a high-grade electrostatic microphone.
Ribbon		
For:	(a)	The quality can be very good indeed because of the extreme lightness of the ribbon.
Against:	(a)	Rather fragile.
	(b)	Cannot normally be used out of doors as the slightest wind on the ribbon causes serious rumble noises in the output.
	(c)	Usually expensive.
Electrostatic		
For:	(a)	Excellent quality is possible.
	(b)	While the very best microphones of this type are costly, reasonable quality microphones can be quite cheap.
Against:	(a)	For reasons explained in Part 2 it is necessary to have an amplifier close to the diaphragm assembly, either within the body of the microphone or not more than about a metre away. Generally, though, when one buys an electrostatic microphone one gets the complete unit.
	(b)	Apt to be affected by moisture – not necessarily permanently but if, for example, one is taken from a cold environment into a warm room there is a likelihood of condensation causing loud crackling or 'frying' noises in the output until the microphone has dried out, which, even in a warm room, might take some time. Placing the microphone on a warm (but not too hot!) radiator speeds up the drying-out process.

when the piece of crystal is deformed a small voltage is generated. Quartz is one such material and the ubiquitous quartz watch makes use of this electro-mechanical property to give very accurate time keeping. The crystal microphone suffers from a number of disadvantages, one being that crystals appear to vary in their acoustic properties, so that while quartz is good in watches it is less satisfactory than other types of transducer in microphones.