Early microphones ran on town gas!

It wasn't until 1876, when Alexander Graham Bell invented the telephone, that anyone needed a microphone. Indeed the microphone on Bell's first telephone was highly unsatisfactory, although it did pave the way for a flood of new designs. Some of those early microphones even ran on town gas!

by DR CLIVE COOGAN*

"Can you lend me a match? I want to light the microphone." or "Did you remember to fill up the microphone?" These phrases seem to have slipped a bit from popular usage! But they had their heyday – once.

Some of the original microphones were weird and wonderful affairs which operated on principles which we have long since discarded. Or have we? These things have a disconcerting habit of reappearing, often with the principle completely inverted, as we shall see.

When Alexander Graham Bell invented the telephone in 1876, he produced it complete with an earphone similar to that which we know today – an electromagnetic coil which exerts a pull on a thin iron diaphragm, so that variations in current through the coil cause vibrations in the diaphragm and so produce waves. This established itself, with a few improvements, as a highly satisfactory method of converting modulated electric current into sound. But less satisfactory by far were the microphones. In fact none were really very satisfactory until Hughes appeared with his carbon rod microphone, and several generations of telephone "mouth pieces" were based on this simple device. Nevertheless, Bell opened the floodgates of invention with his 'phone, and numerous ingenious attempts were made to produce improved microphones.

The day of the gas-fired microphone is long departed, but a few memories linger on. We find it all very strange today, as we think electrically, but in the gas-based days of last century, with gas light, gas stoves, gas stage lights (lime light) and even gas suicides, it was more normal to think of utilizing what was at hand.

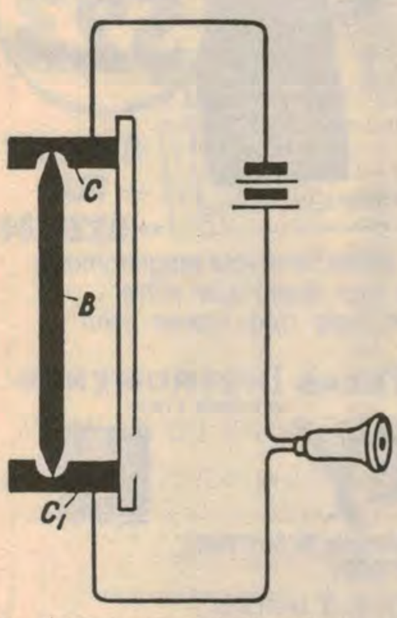

Fig. 1: Hughes' pencil microphone.

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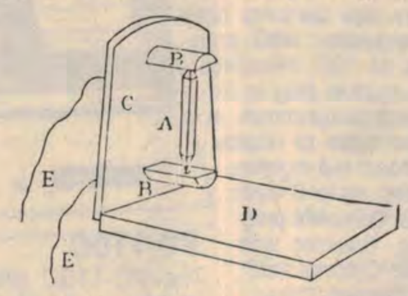


Fig. 2: Physical form of the Hughes microphone. The board at the back acted as a "resonator" (from Deschanel).

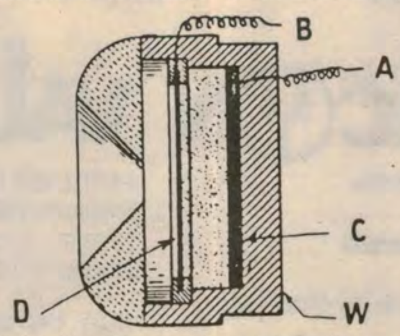


Fig. 3: Hunnings' carbon microphone.

It all started with Bell's telephone. No one needed a microphone (or since it did not have that name in 1876 when Bell made his world-changing invention, a voice transducer) until Bell conceived of the idea of voice transmission.

Bell's own original voice transducer was not very satisfactory. In fact it was identical to the earpiece or, in other words, an unamplified magnetic microphone. However, fortunately Professor G. Hughes came up with the first of a long line of variable contact pressure microphones early in 1878. It is called the "pencil microphone" and consisted of a pointed rod of carbon resting in depressions in carbon cups. Variations in air pressure due to sound wobbled the carbon "pencil", varying the contact between pencil and cups and thus varying the resistance encountered by current flowing in the circuit of Fig. 1.

Hughes gave this device the name microphone because of its great sensitivity (by the standards of the day). The name stuck.

A little later in the same year Edison took out a patent on a related device, and his was the first to use granular material to multiply the effect Hughes employed. He packed lamp-black into a cavity between a solid metal back and a flexible metal diaphragm. The variations in pressure on the lamp-black caused variations in resistance which could be utilized by putting it into a circuit with a "telephone receiver" as it was then called.

But all was not perfect. The early microphones left much to be desired in terms of reliability and frequency fidelity. So the search went on relentlessly for the next 100 years and maybe we have not yet arrived at the ultimate form.

An English parson named Hunnings started the ball rolling with the type shown in Fig. 3. The body of the microphone was made of wood or ebonite and the current was passed between the carbon plate (via the wire A) through loosely packed carbon granules (instead of lamp black) to a platinum foil diaphram D. Eventually this became, many inventors later, the British "Post Office" microphone of Fig. 4. The movement of the diaphragm D is now allowed to move a plunger in the carbon granule chamber. This reigned supreme for many years.

The only way to increase the output of the carbon granule microphones was to pass more current through them. But this heated the granules, and at higher currents the heating tended to make the carbon granules sinter into a solid pack.

The next logical step was to cool the microphone and Fessenden did this in 1906 with his water cooled microphone of Fig. 5. It would pass 15A without packing the carbon. Its body S was turned from soapstone. Two platinum electrodes at front and back of the space loosely packed with carbon granules are water cooled by jackets W-W_1 and W_2-W_3. Dubilier "improved" on this in 1911 with a very complicated version which could handle 700W, enough power to drive a small steam engine or a motor mower!

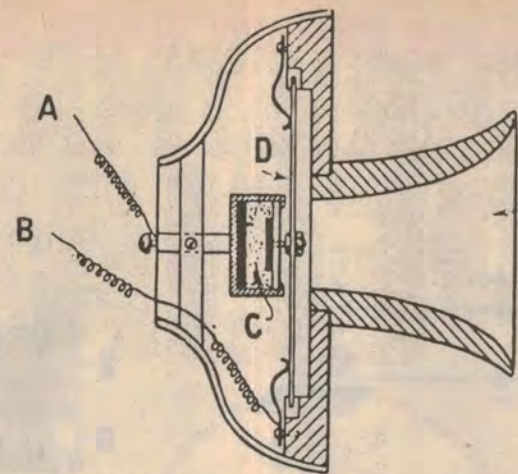
Meanwhile others were trying to exploit different principles. Rayleigh, in the Cavendish Laboratory, had discovered "sensitive flames" which could be vibrated by sound waves. Others had noticed that gas flames were moderately good conductors of electricity, but that the conductivity varied through the flame. These principles sired a new family of microphones – the gas-fired phones.

The first of these was Blondel's manometric microphone of 1902 shown in Fig. 6. The electrodes A, B were set just beyond sparking distance (for the voltage across them), Town gas came into a chamber C via the tube T. When the diaphragm vibrated the pressure in the chamber changed and the flame fluctuated in length, so that sparks occurred in synchronism with the movements of the diaphragm D.

Later, in 1909, Chambers improved on this by lowering the resistance of the flame as shown in Fig. 7, by introducing volatile salts in the cup G. These introduced more ions into the flame and raised its conductivity.

In 1903 Lee de Forrest had patented the flame detector or rectifier, and in 1911 Mellinger elaborated on the invention, combining Chambers' idea of enhanced flame conductivity with de Forrest's principle. The "flame audion" is shown in Fig. 8. The gauze is to minimize flame flicker. The negative electrode above it contains volatile ionizing salts. Bearing in mind the fact that this resembles the flame microphone of Chambers, there must have been wonderful scope for cross modulation from noise in the room, and for acoustic feedback oscillation, although the mind boggles at Nyquist diagrams involving phase lag in flames!

A little later, in 1913, Horton devised a gas amplifier, shown in Fig. 9. The electromagnet B pulled the diaphragms D and D_2, and pressure modulated the gas flame G in the gap between the plates P and P_1.



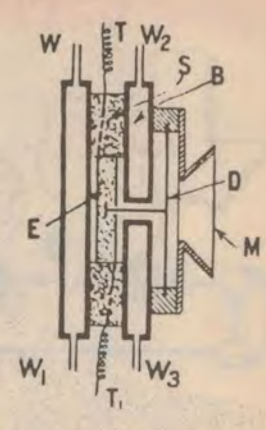


Fig. 4 (left): the English Post Office solid black microphone. Fig. 5 (right): Fessenden's water-cooled carbon granule microphone.

De Forrest took it all a little further in 1923. He used a "batwing" flame of town gas or oxy-acetylene, and obtained excellent fidelity with music. In his best model, the platinum electrodes were encased in quartz, which he found to be conducting at the temperature used. It was said to be very sensitive; a gramophone placed one metre away could be clearly heard in the earphones!

Of course the principle of sound waves wiggling a conductive body of ionized gas can be applied to gases ionized otherwise, regardless of the origin of the ionization. So it was logical to try the same phenomena using electric discharges, which produce ionized gases. Phillips Thomas of the USA produced this kind, using a glow discharge, in 1923, as shown in Fig. 10. Fig. 10A shows the basic circuit he used, 10B the form of the hardware, suspended from a spring mount to isolate it from vibration, 10C the shape of the glow, and 10D a variation in design using a third electrode, close to the anode, as the sensitivity was found to be almost entirely in the positive portion of the discharge.

In 1924 the Westinghouse station KDKA in New York broadcast the beating of a human heart using a Phillips Thomas glow discharge microphone placed on the patient's chest. This broadcast was picked up in Europe.

It seems that about 1923 gas-flame microphones burnt themselves out, so to speak, thus ending what now seems to us to have been a rather strange dalliance in the development of the microphone. Not much seems to have been heard of them since. Why then? Did the price of gas rise suddenly? Were there new fire regulations? Perhaps it was the onset of widescale commercial broadcasting, which happened just about then, which accelerated the comparisons between the various competing microphones.

In a sense they re-emerged in 1958, in an entirely different form. Until 1958 there was a progress-halting need for a better detector of organic molecules in what was then the new technique of gas chromatography, which (briefly) is a technique of sorting out the types of

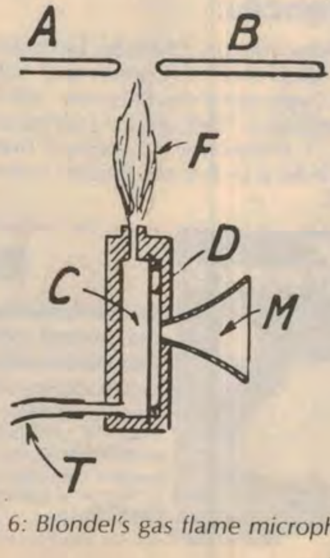


Fig. 6: Blondel's gas flame microphone.

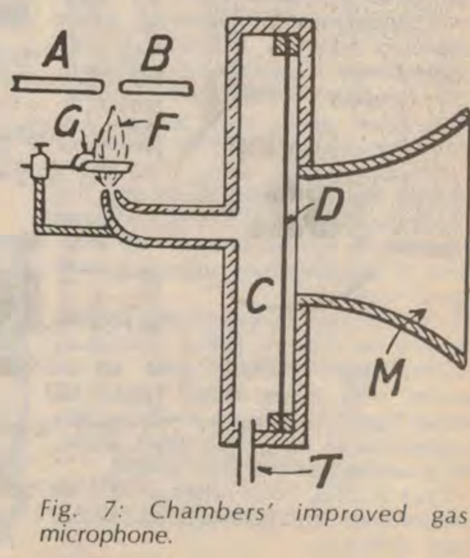


Fig. 7: Chambers' improved gas microphone.

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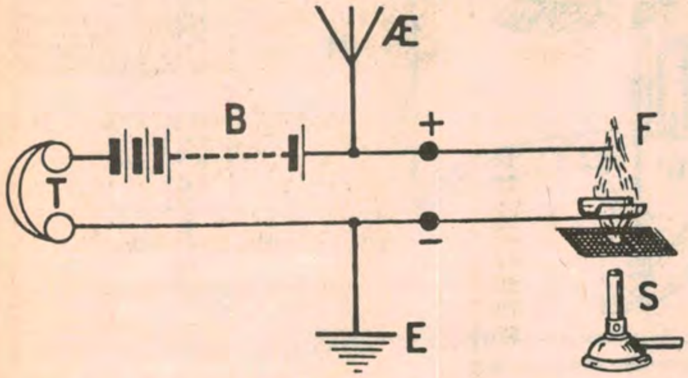

Fig. 8: The "flame audion" of Mellinger. The receptacle in the flame contained volatile ionizing salts.

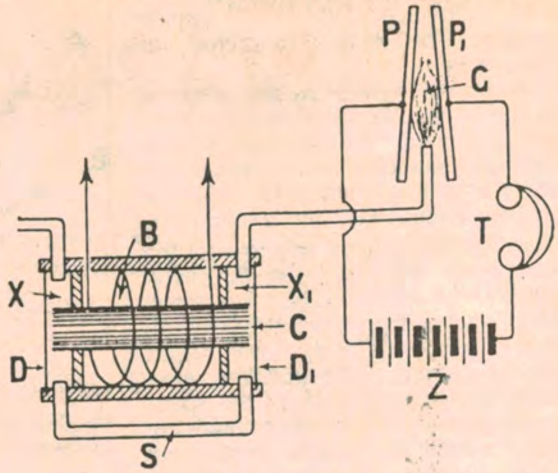

Fig. 9: Horton's flame amplifier. The pump modulated the gas pressure.

molecules in a gas mixture in order to analyse them.

The fact that today gas chromatography is one of the most widely used analytical techniques in modern science owes much to the invention in 1958, in the ICI ANZ Melbourne laboratory by Ian McWilliam and Ray Dewar, of the Flame Ionization Detector. They used the fact that an oxy-hydrogen flame has very little longlived ionization in it, but if organic molecules are injected into it ionization appears. The FID apparatus is somewhat like Fig. 6 and is incredibly simple in view of its amazing sensitivity.

In their initial paper McWilliam and Dewar reported that they had filled a syringe with acetone vapour, and had then expelled the vapour and refilled (and expelled) with air 200 times. They then injected the 201st refill of clean air into the FID and got full scale deflection due to the lingering remnants of acetone!

There are other interesting by-paths along which we could have ambled. For example there was Dubilier's arc, used for "long-distance" broadcasting, which performed well for the day. It was declared most satisfactory after tests in 1911 between Seattle and Tacoma, about 50km, giving clear speech. On several occasions it was even picked up at Tatoosh, 200km away. Oh, did I mention that it needed to be drip fed with alcohol! No doubt this was an early experimental appreciation of the FIDs secret of long-lived ions originating from organic molecules.

Be gas microphones as strange as may be, they are not one half as strange as another species which grew up in parallel with them: those based on various liquid phenomena. I will describe a collection of these in another article, Editor willing and the Muse stirring.

Meanwhile, do check if all microphones are extinguished before going to bed.

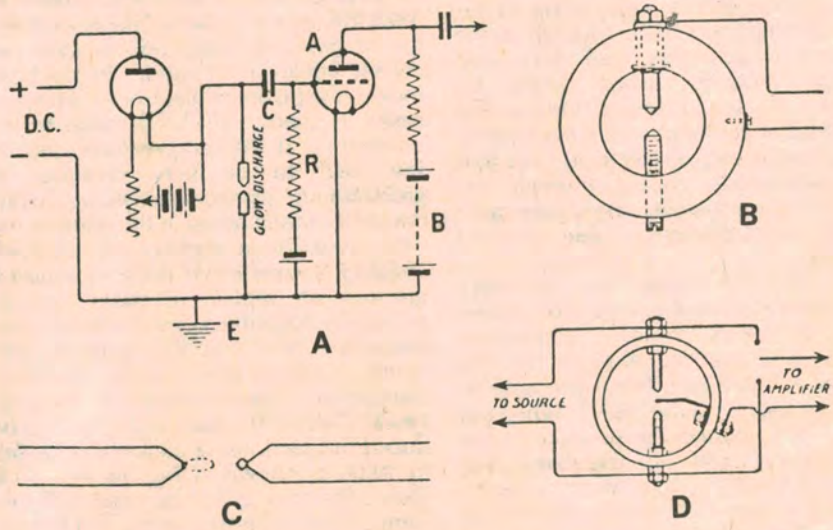

Fig. 10: Phillips Thomas' "glow discharge microphone". A: the microphone amplifier circuit. B: the physical form of the microphone (less suspension springs). C: the nature of the glow discharge. D: the 3-electrode model.

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