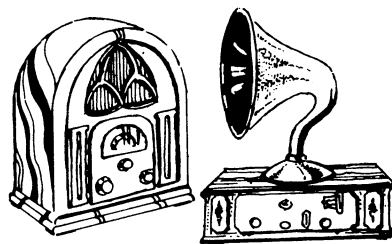


# Vintage Radio

by PETER LANKSHEAR



Previously we have looked at the earliest type of loudspeaker, the horn type, which had evolved from the headphone. The shortcomings of the horn speaker soon became apparent, and other developments followed rapidly. Here we look at the next development: the so-called 'magnetic' speakers.

A horn speaker has the advantage of high efficiency, but if it is to have an adequate bass response, its dimensions become so large as to be domestically unacceptable.

Before long it was found that the use of a horn could be avoided by increasing the area of the driver unit diaphragm, and although efficiency was lost, there was a noticeable improvement in sound quality. However, large diaphragms needed to have low mass combined with rigidity.

The material most commonly used was paper, generally shaped in the form of a cone to achieve the necessary stiffness. But other materials, such as doped linen were sometimes used.

Headphone-type drivers using reed mounted iron armatures were the first development. However these gave high distortion as a result of the one-sided operation of the magnetic system. Reed resonance also caused poor tonal quality, and so better drivers were soon sought.

## Expensive solution

One method developed was the use of a moving coil in a strong magnetic field, first patented by Siemens in 1877. In 1925 Chester Rice and Edward Kellogg of the American General Electric company developed what is generally regarded as the first successful moving coil loudspeaker. Together with a mains powered 1.0 watt amplifier, this was marketed by RCA in 1926 – but was very expensive.

Although it had superior reproduction, the new speaker was insensitive and needed a powerful magnetic field, which could not be provided by the carbon steel permanent magnets available at the time. The only practical method

was to use a massive mains-energised electromagnet, but mains powering of receivers was very much in its infancy at the time and universal acceptance of the superior moving coil speaker had to wait for receiver technology to catch up.

## Immediate answer

As battery powered receivers produced only a few dozen milliwatts of audio power, sensitive loudspeakers incorporating the available permanent magnets were essential.

The efficient moving iron speaker was improved with a balanced armature system, magnetically polarised by a horseshoe magnet and surrounded by a winding of fine wire. One end of the armature was centred by a reed and the other end drove the cone through a rod and a reduction lever. This is illustrated in Fig.1, which is reproduced from *Drakes Radio Cyclopedica* of 1931.

Signal currents through the winding

caused the armature to move between the pole pieces and the motion was transferred to the cone through a drive rod and lever. The balanced armature movement eliminated some of the worst features of the traditional headphone, with the result that some headphones and even a few horn speakers still being made at the time, used the improved system.

Similarity of the balanced armature movement to a polarised telegraph relay led it to being known originally in Britain as a relay speaker. The earlier unbalanced magnetic reed moving iron loudspeaker soon became obsolete, but old advertisements can be confusing because eventually the balanced armature type became known also as the magnetic or moving iron speaker.

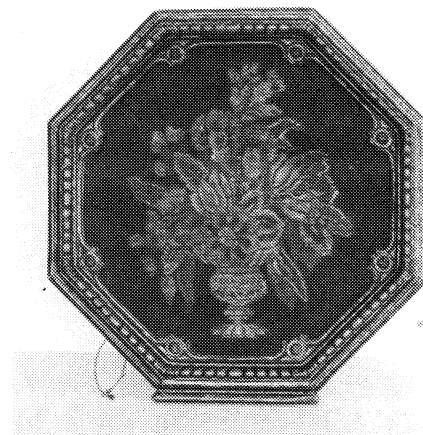
## Various stages

Although the circular cone was by far the most common shape, some experiments included off centre mounting and square or rectangular cones. In one model, the diaphragm took the form of a cylinder, with the driver unit working between the edges of a lengthwise slot.

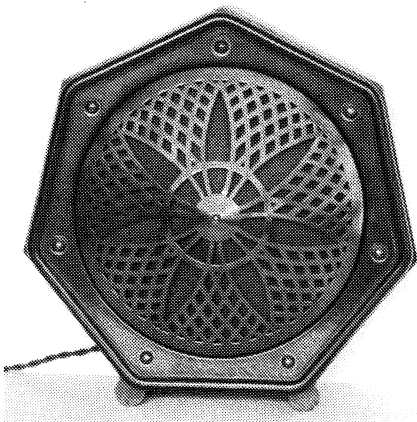
Initially, speakers were free standing, with drive units mounted inside the cone. But eventually the familiar rear



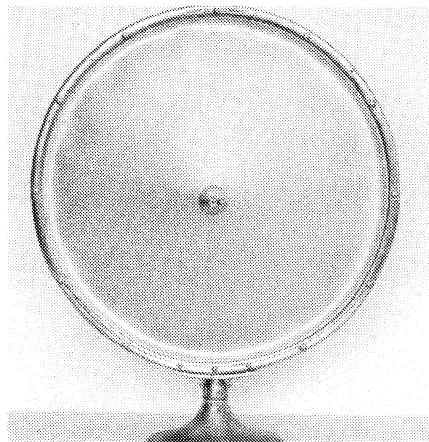
**A 1927 Western Electric model 650 professional balanced armature speaker with 24" diameter cone.**



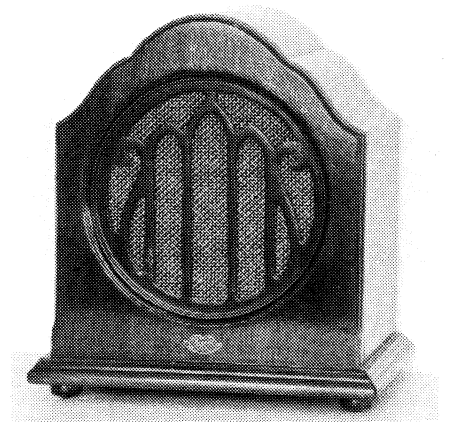
**A 1927 RCA model 103 with tapestry cloth cover. Missing is a small composition base.**



**A Philips 'Sevenette' model of 1930, well made in a 12" high Bakelite case with bronze fret.**



**A French 'Sferavox' with 11" diameter fabric cone doped with aluminium paint.**



**An American Bremer Tully balanced armature unit of 1928, measuring 12" x 10" and with a chamois leather cone surround. The cabinet contains flock-filled pads to reduce internal resonances.**

mounted driver and basket chassis suitable for cabinet installation became general. Various methods of cone suspension were used. The free standing speakers had rigidly mounted cone edges, but some free edge cones were used. Moving coil speaker design had an influence with cloth, leather and corrugated paper surrounds all being tried.

The impedance of the winding varied enormously over the audio range, making matching to the output stage a compromise. Matching transformers were not often used, and it will be seen that direct current through the windings would bias the armature. A degree of compensation could be made with the adjusting screw, but generally receivers with output valves drawing more than a few milliamperes were fitted with output chokes, and fed the audio to the speaker via a series coupling capacitor of a microfarad or more.

To improve the sound by damping

down some of the more strident high frequencies, some speakers had a small choke and a capacitor connected in series with the armature winding.

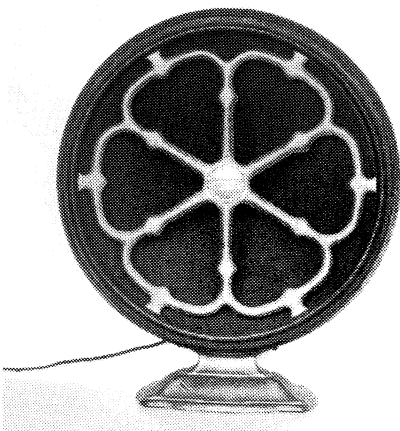
### Various disguises

The balanced armature loudspeaker was very successful, and was produced in large numbers. Radio was still establishing itself and appearance was an important acceptance factor. Conservative households were catered for by making speakers as decorative as possible, or disguising them to look like something else.

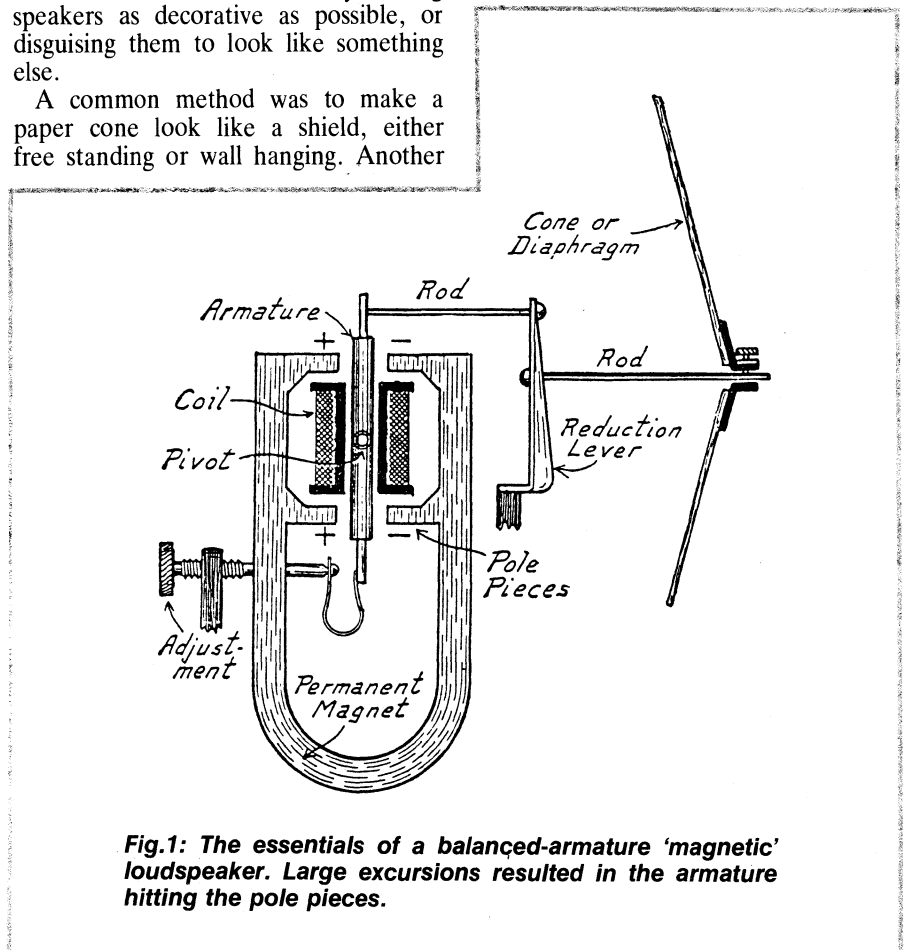
A common method was to make a paper cone look like a shield, either free standing or wall hanging. Another

was to conceal the speaker behind a tapestry screen.

Exposed paper cones are vulnerable to damage, and metal or Bakelite cases became common. Eventually, speakers were built into the receiver cabinets or given their own separate wooden cabinets.



**An Atwater Kent type 'E' balanced armature unit of 1927. The 11" diameter cone is a free-edge type, without a surround.**



**Fig.1: The essentials of a balanced-armature 'magnetic' loudspeaker. Large excursions resulted in the armature hitting the pole pieces.**

## Still limited

As the quality of receivers and transmissions improved, and mains powered receivers – many fitted with moving coil speakers – became available, the limitations of the balanced armature speaker became more apparent.

The stiffness of the armature suspension and inadequate baffling limited the bass response to 100Hz or more, and the small movement of the armature between the pole pieces restricted the power handling ability.

An improvement was the 'Inductor' derivative of the balanced armature system (Fig.2). Here the lateral movement of the armature was changed to a fore and aft motion, greatly increasing the range of travel and consequently, the power handling ability. These inductor speakers are similar in appearance to the moving coil type, but can often be recognised by a pair of large horse shoe magnets projecting to the rear.

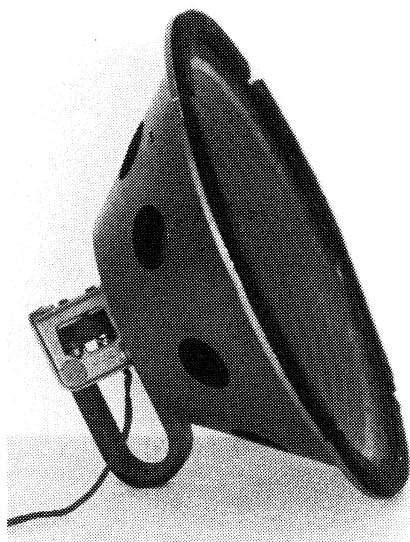
## Eventual decline

By 1930, the success of the moving coil speaker was assured. Mains powered receivers could produce adequate audio power, and energising of electromagnetic fields was no longer a problem.

Although still less efficient than moving armature types, permanent magnet moving coil speakers were becoming a practical proposition for battery receivers, but there were exceptions.

For example, from 1934 until he closed down in 1936, the major American manufacturer Atwater Kent reverted to using balanced armature speakers for his battery receivers. Some of these used centre-tapped windings, to cater for push pull class B output stages.

Although generally superseded in receivers, balanced armature 'magnetic' speakers were still available as inexpensive extension speakers and for hobby



**Balanced-armature speakers like this 'Blue Spot' unit were sold through the 1930's to hobbyists, as inexpensive alternatives to moving-coil speakers.**

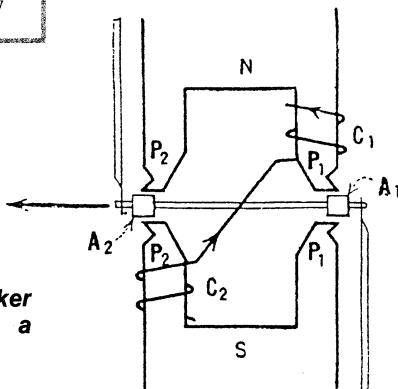
projects right up to the outbreak of World War II.

## Australian Philco

After sending off my last column, describing the American Philco 39-55 receiver with its 'Mystery' wireless remote control, I discovered important additional information. This was that the Australian branch of Philco produced their version of the same design.

Called the model 930, the data available shows it to be very similar in essentials to the 39-55, but with a single ended 6V6G output stage and minor differences in valve types. Specialist components would have been imported from America.

I have no details of the cabinet, but it is likely that a locally made console was used. The description of the controller applies to both the American and Australian versions. (2)



**Fig.2: The 'inductor' type speaker drove the armature with a fore-and-aft motion.**