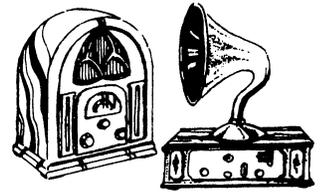


Vintage Radio

by PETER LANKSHEAR



The first moving coil speaker

Radio historians find that it is very unwise to claim a particular piece of equipment as being the first, the last, the only – or for that matter, to use any superlative. Invariably, someone will come up with some obscure model that shoots down the argument. But there is an exception. There is general agreement that the first commercially successful moving coil paper cone loudspeaker system was the RCA 104, introduced late in 1925.

Loudspeakers were vital to the early success of broadcasting. Had listening been restricted to headphones, the rapid and universal acceptance of domestic radio would have been unlikely. The problem was to translate a wide range of audio frequency alternating voltages into accurate mechanical motion of a piston coupled to the surrounding air.

By 1923, three systems, two of which have been described previously, were evolving. The earliest was to couple the transducer, generally a headphone type, to the air by means of a horn. An improvement on this was the magnetic speaker, based on the polarised telegraph relay with the armature connected to a lightweight cone.

The third method used a moving coil in an annular magnetic field – a principle first patented by the Siemens Company in 1877, with improvements filed by Oliver Lodge in 1898. Lack of efficiency and the need for a massive magnet resulted in its remaining a good idea with few applications, for more than 20 years.

In 1921 the 'Phonotron' appeared, for converting telephone and telegraph signals into sound. With an electromagnetic field, a voice coil and a cone diaphragm, it had all the elements of a moving coil speaker, but was not a commercial success. Dependence on battery power for receivers limited the available audio power to a few dozen milliwatts.

The prime requirements of early speaker designs were high sensitivity and the use of permanent magnets, conditions met by the horn and magnetic types.

Rice and Kellogg

Prior to 1930, RCA was solely a marketing and operating organisation – much of their research being carried out by one of their shareholders, the giant General Electric Company. Two of GEC's talented group of electronic engineers, Chester W. Rice and Edward W. Kellogg considered that the moving coil speaker was worth developing further. (Despite their names, this pair had nothing to do with breakfast cereals!)

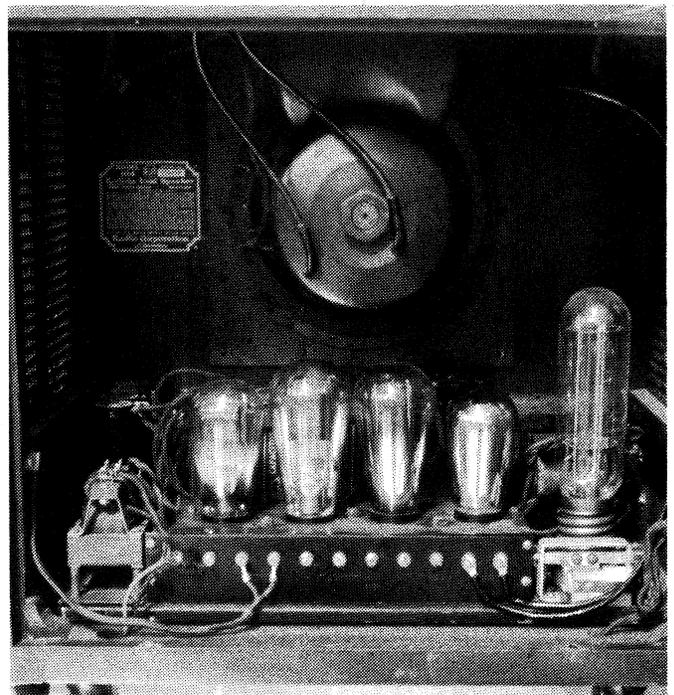
The two researchers realised that if they accepted its inherent lack of sensitivity, the moving coil system had many potential advantages over the moving iron type. But the immediate problem was that there was no way that receiver output stages using the standard 201A valve could deliver enough power, with an anode current of 3mA at 135 volts.

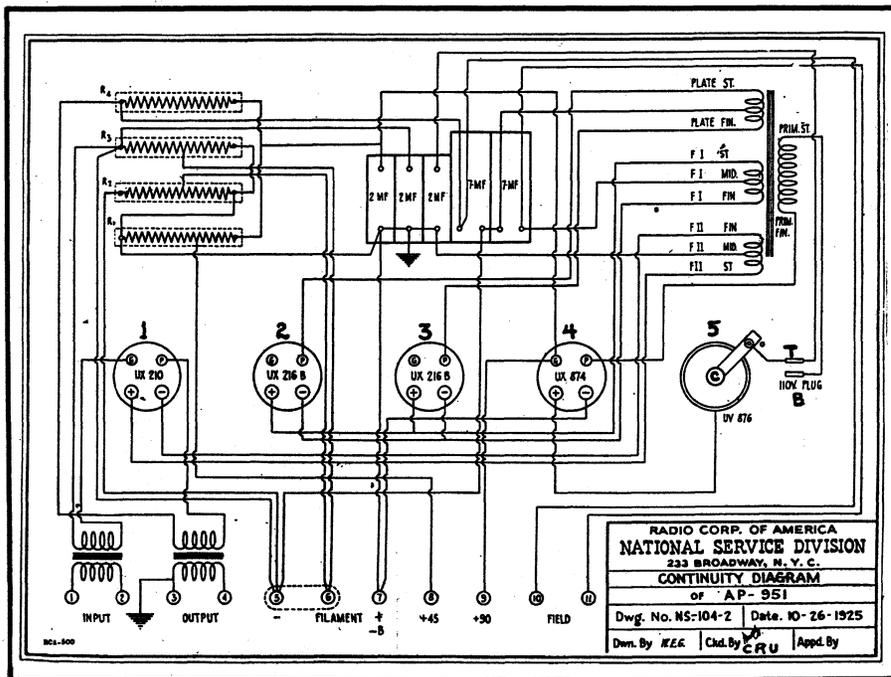
Priority was given to the design of a mains operated high powered audio amplifier. The first requirement was a high



Fig.1: In 1926, the long legs of the RCA 104 Loudspeaker System were very fashionable.

Fig.2: The combined audio amplifier and power supply was quite an impressive unit. Not shown is a black steel shroud which prevented accidental contact with the terminals – some carrying 425V HT!





The 'continuity diagram' for the RCA 104. RCA frequently published these diagrams, which related to the physical layout of the equipment, and made it look much more complicated than with a conventional schematic.

power valve, so GEC scaled up the 201A to create the type UX210. The amplification factor remained the same at 8, with the mutual conductance doubled to 1.6mA/V, but the anode voltage rating was increased by a factor of three to 425 volts and the anode current six times to 18mA. These massive increases enabled the 210 to deliver more than one WATT – at the time, a large amount of audio power!

Favourite valve

Used in carrier current telephone systems, the RCA transoceanic radio telephone service and later in RCA's 'Photophone' movie sound systems, the 210 also proved to be most successful for low powered transmitters. Amateurs loved the '10, and for more than a decade it filled the niche that eventually was occupied by the equally ubiquitous 807.

Rice and Kellogg's amplifier was simple enough, consisting of a single transformer-coupled 210 operated as an 'add on' to standard radio receivers. Its associated power supply was however quite large and complex. Not only did it supply the 7.5 volt filament and 425 volts HT for the 210, but there was also DC power available for a speaker field coil.

For good measure the power unit incorporated a regulated HT supply for its associated receiver, and for use with the RCA superhets there was a 60mA filament supply for series-connected UV199

valves.

A UV876 voltage regulating ballast resistor was used to counter voltage variations in mains power. This consisted of a long length of fine wire, probably iron, in an evacuated bulb, much like a large tall tubular lamp. Two large half-wave UX216B rectifiers and a UX874 90-volt gaseous voltage regulator completed the valve lineup.

Giant 6" speaker

The essentials of the ancestral moving coil 'dynamic' loudspeaker that Rice and Kellogg developed are still fundamental to today's speakers. These are a

lightweight voice coil connected to the apex of a paper cone with compliant surround and centering spider, operating in a strong magnetic field concentrated in a circular gap. Several of the parameters were to become industry standards.

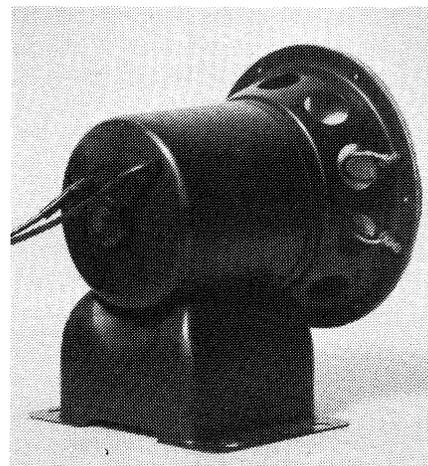
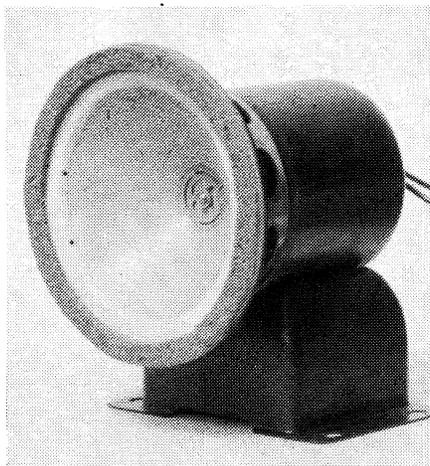
Weighing 11 kilograms (25lb), there can hardly ever have been a more massive 150mm or '6 inch' speaker. Much of the weight was contributed by the huge electromagnetic field magnet, whose 125mm (5") diameter was nearly as large as the paper section of the cone! The field coil resistance was 1000 ohms, a standard value for later electromagnetic (EM) speakers.

The cone surround was of very fine leather, considered to be superior to the cheaper corrugated paper that was generally used in later speakers. Compliant materials other than paper have always been popular in high quality models.

Nominal impedance of the voice coil was around 15 ohms and its diameter was 1" (25.4mm), even today a popular size for medium sized speakers. The toughened paper cone centering spider was mounted at the front of the centre polepiece. This type gradually gave way to the wider diameter and longer throw rear mounted spider, and eventually to the modern corrugated annulus.

Separate cabinet

Although the combination of the new moving coil speaker and a modified version of its associated power unit was incorporated in late 1926 'top of the market' RCA and RCA Victor radios and phonographs, the Rice Kellogg speaker, amplifier, and power supply units were first sold as an independent system in a free standing separate cabinet – the



Figs.3 and 4: Front and rear views of the 104's 6" speaker unit, giving some idea of the relatively enormous electromagnetic field magnet. The voice coil leads are terminated on the rim of the basket.

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combination being known as the RCA 104 Loudspeaker. The 104 could be connected to any receiver, and some existing RCA superheterodyne models were modified to take advantage of the filament and HT supplies it provided.

Fashionable receivers of the mid 1920's often stood on spinet type legs, and a similar styling was adopted for the 104 cabinet. The assembly looks to be top heavy, but the sheer weight of the contents made it reasonably stable, and quite enough for one person to handle. The side panels and rear cover had cane grills; probably more for ventilation than acoustic reasons.

Superior sound

To compare the reproduction of the 104 with that from contemporary horn and magnetic speakers is a revelation. In 1926 it must have created a sensation, with quality equivalent to a more modern large mantel radio. The catch was that the 104 sold for around \$250, at a time when it was possible to buy a good magnetic speaker for \$35.

However, RCA had shown the way, and by 1930 the moving coil speaker was practically universal in mains powered receivers.