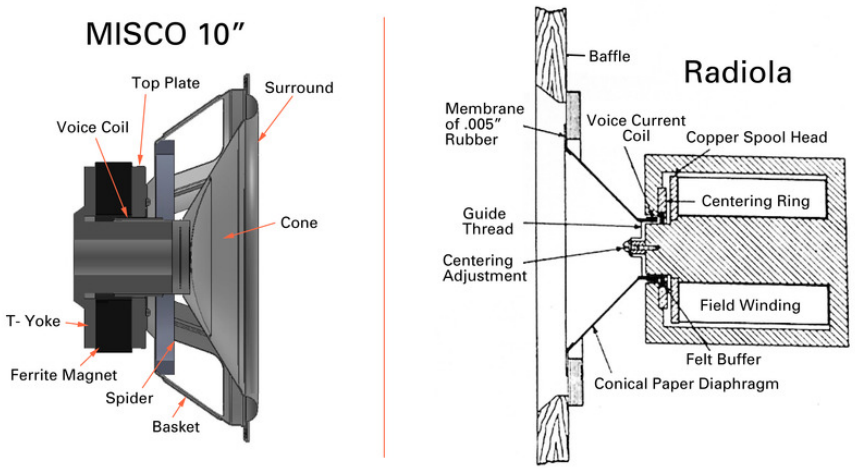
Has loudspeaker design changed in 90 years?

In 1925, Chester W. Rice and Edward W. Kellogg, two General Electric engineers, defined the basic principles of a voice-coil-driven and cone-type direct-radiator loudspeaker in a landmark research paper. Their work led to the Radiola, an RCA loudspeaker commercially available in 1926. Today, while the direct-radiator loudspeaker is remarkably unchanged (it still uses a voice coil in a magnetic field, coupled to a cone), loudspeaker design has entered the 21st century thanks to computer aided design and testing technology as well as vast innovations in materials - primarily magnetics, voice coils, cones, and adhesives.

Magnetics

Electromagnet field coils were considered a giant step forward in their day but were superseded by the Alnico permanent magnet (an alloy of aluminum, nickel, and cobalt), prized for its strength. Today, cost effective ceramic ferrites and lightweight rare-earth magnets, like neodymium, have largely replaced Alnico except in very special applications like vintage guitar or radio speakers. Ongoing research may produce magnets, which have the cost effectiveness of ferrites; but the energy of rare earth material.



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Voice Coils

Decades ago the typical voice-coil was made of round copper wire wound tightly on paper formers. This graduated to multiple-layered copper, copper-clad aluminum, and aluminum flat-wire coils. These are typically wound on aluminum or polyimide formers, which are better suited to today's more powerful amplifiers. In addition, round wire can be flattened and wound on edge to reduce the interstitial space and increase the motor force factor.

Cones

One-piece seamed paper cones of long ago evolved into paper cones with leather or cloth surrounds. In more recent years, materials such as polypropylene, aluminum, and injection-molded composites like carbon fiber have mimicked paper's high stiffness-to-mass ratio yet are tougher and less susceptible to moisture. Cone surround materials are now made with treated cloth, UV stabilized foam, rubber, and thermoplastic rubber surrounds.

Adhesives

The high-power amplification applications used today demand new, high-temperature adhesives in critical bonds to the voice coil. Voice coils themselves can now be wound with adhesives rated at 250° C.

In the early days of loudspeaker design, acoustical measurements required expensive and elaborate equipment and were often laborious to make. Trial and error methodology was part of the learning process. Today's computer-based design and measurement tools, with their ability to quickly confirm design parameters, have had a powerful effect on loudspeaker design. These include finite element analysis (FEA) of electromagnetic circuits; simulations of cone and suspension performance; and mechanical CAD software, which leads to rapid prototyping through 3D printing. In the specific area of test/measurement, the use of hardware/software combinations can quickly provide in-depth loudspeaker-performance data. Also now available are end-of-line 100% production test systems, which are used to collect, provide, and support loudspeaker quality-assurance programs.

Of course, the basic laws of physics have not changed: loudspeakers still use a force to drive a suspended mass to produce acoustical output. The design itself is also largely the same: a voice coil in a magnetic field, coupled to a cone. But as new high-tech materials and state-of-the-art computer technology become available, we can design and build higher-performance speakers with lower distortion and higher reliability in less time for lower costs. Today's testing systems assure optimum functionality and performance.