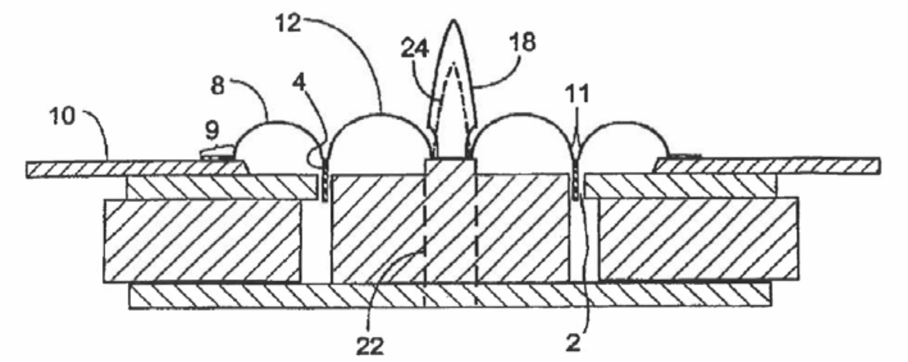
Scan-Speak's Ring Radiator Tweeters

The image below outlines the concept of a typical ring radiator tweeter (Sketch from patent application).

Fig 1



A ring radiator (named a non-dome in the patent) consists of a loudspeaker diaphragm fixed at the center with a phase plug (named a wave guide in the patent). The diaphragm must be sufficiently soft to allow deflection of the rolls.

The basic principle is to increase the speaker's frequency response at high frequencies by mounting a phase plug at the center axis of the tweeter. The phase plug extends the high frequencies by preventing cancellation across the center axis of high frequency waves produced near the center of the diaphragm. This phase plug is the base of the patent application. For all cases the phase plug is fixed to the center of the speaker.

The lowest frequencies of a traditional cone/dome driver are typically generated with a pistonic motion where the shape of the diaphragm is maintained. Above a certain frequency the pistonic behavior changes to a non-pistonic behavior, the diaphragm breaks up in higher order modes and the cone/dome can no longer be considered a stiff and uniform member. This is where the diaphragm starts resonating, contributing an undesirable acoustical signature to the reproduced sound.

The non-dome design changes this entirely by not having a pistonic range and therefore no transition from one mode of operation to the next.

The usual (classical) trouble with managing the transition from pistonic to non-pistonic behavior is frequency response variations in the middle of the speaker's pass band, typically at around 6 kHz for 1" tweeters.

When a traditional soft dome moves at higher frequencies the tip of the dome starts to resonate, it snaps through a wavelike motion where the tip changes from its original dome (convex) shape to a concave one.
This dome resonance is the cause of a cracking sound due to unwanted release of energy as the tip "pops" between these shape stages. Traditional means of solving this problem with domes is to make the dome shape higher and of a softer and more damped material or, alternatively, to make the dome very stiff. In any case these attempts try to control the resonance and move it to a more advantageous frequency region where the effect is less noticeable, but the problem will not be eliminated.

The basic principle is to prevent the ring radiator's center from moving at all so that there is no transition from pistonic behavior. The speaker is, therefore, forced into moving in a non-pistonic way throughout the operating range of the speaker. The speaker radiates acoustical signals from the deflection of the two ring shaped diaphragm sections. Potential resonances (transition effects) are moved to a much higher frequency due to the smaller rolls of the diaphragm.

The lack of transition effect gives the ring radiator a smoother and less resonant sound at higher frequencies and especially at higher power levels.

The benefits are:

1. The speaker radiates sound by deflection of the diaphragm, i.e. it does not have a diaphragm which resonates in the audible frequency range because the transition zone from pistonic to non-pistonic behavior is non-existent. The speaker does not in its non-pistonic range have a transition (resonance) where the tip of the dome snaps from a dome shape to a concave shape.
2. The speakers response at higher frequencies is better controlled and this type of tweeter shows much more consistent behavior from 10 kHz to 20 kHz, where traditional domes can vary to some extent. The ring radiator is insensitive to the variations inherited from the cloth material and the resonances and it can be manufactured with a more consistent result.

The phase plug can have different shapes, most commonly as illustrated in the pictures below:

At Scan-Speak we are using Ring Radiator technology in several of our tweeter lines.

US patent 6,320,972
FR patent 2,790,903
CN patent 1,162,042
GB patent 2,347,044
CA patent 2,299, 151