CLAIMS

1. An acoustic matching structure for a transducer, the structure comprising:
a cavity which, in use, contains a fluid, the cavity having a substantially planar shape;
two end walls bounding the substantially planar shape of the cavity;
a side wall bounding the cavity and substantially perpendicular to the end walls;
the structure defining an area A_{cavity} given by the average cross-sectional area in the planar dimension in the cavity between the end walls,
wherein the cavity has an effective side wall radius r_{cavity} defined as:
$r_{cavity} = (A_{cavity} /\pi)^{½}$; and
at least one aperture placed in at least one of the end walls and side walls, wherein the at least one aperture is located in an end wall within a distance less than $r_{cavity}/2$ from the side wall;
wherein the cavity height h_{cavity} is defined as the average separation of the end walls;
wherein r_{cavity} and h_{cavity}, satisfy the inequality:
r_{cavity} is greater than h_{cavity};
wherein, in operation, a transducing element acting on one of the cavity end walls generates acoustic oscillations in the fluid in the cavity;
and whereby, in use, the acoustic oscillations in the fluid in the cavity cause pressure waves to propagate into a surrounding acoustic medium.

2. An acoustic matching structure according to claim 1,
wherein, in operation, the cavity supports a resonant frequency of acoustic oscillation in the fluid, wherein: the resonant frequency determines a wavelength defined by $\lambda = \frac{c}{f}$, where c is the speed of sound in the fluid; where h_{cavity} is substantially less than half of said wavelength and
where r_{cavity} is substantially equal to or greater than half of said wavelength;
at least one aperture is placed in at least one of the end walls and side walls; and
at least one acoustic transducing element is located on at least one of the end walls and side walls;
such that the resulting acoustic cavity constrains the acoustic medium in the cavity to induce a resonant mode that substantially improves the transfer of acoustic energy from the transducing element to the medium outside the aperture.

3. An acoustic matching structure according to claim 1, wherein the transducer contains an actuator that causes oscillatory motion of at least one of the end walls in a direction substantially perpendicular to the planes of the end walls.

~~4. An acoustic matching structure according to claim 1, wherein at least one aperture is located in an end wall within a distance less than r_{cavity}/2 from the side wall.~~

~~5.~~4. An acoustic matching structure according to claim 1, wherein the shape is one of: circular, elliptical, square, polygonal shape, with an aspect ratio of less than 2.

~~6.~~5. An acoustic matching structure according to claim 1, wherein the sum of the areas of the aperture(s), $A_{aperture}$, and A_{cavity} satisfy the inequality:
A_{cavity} /$A_{aperture}$ is greater than 2.

~~7.~~6. An acoustic matching structure according to claim 1, wherein r_{cavity} /h_{cavity} is greater than 5.

~~8.~~7. An acoustic matching structure according to claim 1, wherein the fluid contained in the cavity is air and the speed of sound is between 300m/s and 400m/s.

~~9.~~8. An acoustic matching structure according to claim 1, wherein h_{cavity}^2/r_{cavity} is greater than 10^{-8} meters.

~~10.~~9. An acoustic matching structure according to claim 1, wherein, in use, lowest resonant frequency of radial pressure oscillations in the cavity is in the range 200Hz – 2MHz.

~~11.~~10. An acoustic transducer comprising:
1) an acoustic matching structure for a transducer, the structure comprising:
a cavity which, in use, contains a fluid, the cavity having a substantially planar shape;
two end walls bounding the substantially planar shape of the cavity;
a side wall bounding the cavity and substantially perpendicular to the end walls;

the structure defining an area A_{cavity} given by the average cross-sectional area in the planar dimension in the cavity between the end walls,

wherein the cavity has an effective side wall radius r_{cavity} defined as:

$r_{cavity} = (A_{cavity} /\pi)^{½}$; and

at least one aperture placed in at least one of the end walls and side walls, wherein the at least one aperture is located in an end wall within a distance less than $r_{cavity}/2$ from the side wall;

wherein the cavity height h_{cavity} is defined as the average separation of the end walls;

wherein r_{cavity} and h_{cavity}, satisfy the inequality:

r_{cavity} is greater than h_{cavity};

wherein, in operation, a transducing element acting on one of the cavity end walls generates acoustic oscillations in the fluid in the cavity;

and whereby, in use, the acoustic oscillations in the fluid in the cavity cause pressure waves to propagate into a surrounding acoustic medium; and

2) an actuator, wherein, in use, the frequency of oscillatory motion of the actuator is within 30% of the lowest resonant frequency of radial acoustic oscillations in the cavity.

~~12.~~11. An acoustic transducer according to claim ~~11~~ 10, wherein the end wall motion of the actuator is mode-shape matched to the pressure oscillation in the cavity.

~~13.~~12. An acoustic transducer according to claim ~~11~~ 10, wherein the actuator causes motion of an end-wall with a displacement profile approximating a Bessel function.

~~14.~~13. An acoustic transducer according to claim ~~11~~ 10, wherein, in use, the acoustic pressure oscillations in the cavity have a pressure antinode located within a distance of $r_{cavity}/4$ of the center of the cavity.

~~15.~~14. An acoustic transducer according to claim ~~11~~ 10, wherein aperture(s) in the cavity wall connect, in use, the internal cavity volume to a surrounding acoustic medium.

~~16.~~15. An acoustic transducer according to claim ~~11~~ 10, wherein the aperture(s) are located in an end wall formed by a blocking plate supported at its edge and spaced away from

the transducing element by the side wall and located between the cavity and a surrounding acoustic medium.

~~17.~~16. An acoustic transducer according to claim ~~11~~ 10, wherein the actuator is located between the cavity and a surrounding acoustic medium and the aperture(s) are located in an end wall formed by one face of the actuator.

~~18.~~17. An acoustic transducer according to claim ~~11~~ 10, wherein the displacement of the actuator follows a bending shape when actuated.

~~19.~~18. An acoustic transducer according to claim ~~11~~ 10, wherein motion of edge of the actuator is constrained by the actuator support.

~~20.~~19. An acoustic transducer according to claim ~~11~~ 10, wherein motion of the center of the actuator is unconstrained.

~~21.~~20. An acoustic transducer according to claim ~~11~~ 10, wherein the transducing element is one of: a piezoelectric actuator, an electromagnetic actuator, an electrostatic actuator, a magnetostrictive actuator, a thermoacoustic transducing element.

~~22.~~21. An acoustic transducer according to claim ~~11~~ 10, wherein motion of the actuator support is constrained by a blocking plate.

~~23.~~22. An acoustic transducer according to claim ~~22~~ 21, further comprising a thin film matching structure positioned between the transducing element and the blocking plate.

~~24.~~23. An acoustic transducer according to claim ~~22~~ 21, further comprising a thin film matching structure positioned between the blocking plate and the external acoustic medium.

~~25.~~24. An acoustic transducer according to claim ~~22~~ 21, further comprising a perforated plate matching structure containing apertures of approximately λ/4 height positioned between the transducing element and the blocking plate.

~~26.~~25. An acoustic according to claim ~~22~~ 21, further comprising a perforated plate matching structure containing apertures of approximately λ/4 height positioned between the blocking plate and the external acoustic medium.