20 by forming a thin plateau or mesa **22** on a surface of the substrate that is parallel to the plane of the substrate and/or a touch surface **28**. The mesa **22** can be formed on a back surface **24** of the substrate opposite the touch surface **28** of the acoustic cavity as shown in **FIG. 3**. Alternatively, the mesa **22** can be formed on the switch actuation touch surface **28** as shown in **FIG. 12**. A transducer **26** is mounted on a surface **30** of the acoustic wave cavity **20** to generate an acoustic wave that is substantially trapped or localized in the cavity **20**. Although the transducer **26** is shown in **FIG. 3** as mounted on the mesa **22**, if the mesa **22** is formed on the touch surface **28** of the substrate, the transducer **26** is mounted directly on the substrate surface **29** of the acoustic cavity opposite the mesa as shown in **FIG. 12** so that the transducer is on the backside of the substrate.

[**0035**] The acoustic wave switch **12** of the present invention can use any type of acoustic wave capable of being substantially trapped in an acoustic wave cavity. For simplicity, the switch **12** will be described for a preferred embodiment that uses a shear wave in a direction that is in the plane of the substrate, wherein the shear wave energy extends in a direction perpendicular to the substrate plane, i.e. through the thickness of the substrate. A shear wave is advantageous because it is insensitive to liquids and other contaminants on the touch surface **28** of the switch **12**. Because the fundamental or zeroth order mode of a horizontally polarized shear wave cannot be substantially trapped, higher order shear wave modes are used in accordance with the present invention. It should be appreciated that because the acoustic wave used in accordance with the present invention is trapped, the wave is a standing wave. A standing wave has a number of advantages over an acoustic wave that propagates or travels along a path in a substrate. For example, propagating waves are not confined to the main path of propagation but can diffract off of the main path complicating touch detection. This is opposed to a standing wave which by its nature is confined to the area of the cavity. Because the acoustic wave is confined, touch detection is easily accomplished. Further, the wave energy of a propagating wave is not stored at any location along the path. Once the wave passes a point along the path, the wave is gone. this makes timing and control critical for touch detection with propagating waves. There are no timing or control issues with a standing wave because the wave energy is stored in the cavity. Moreover, a propagating wave is not a resonating wave. As such, the wave energy decays at it travels. A standing wave is resonant so that the wave is reinforced and prolonged. As a result, the standing wave has a much greater amplitude than a wave that is not confined.

[**0036**] For a shear wave generated by the transducer **26** and having a harmonic mode, n greater than or equal to 1, the thickness of the cavity b_c should be greater than ½λ, where λ is the wavelength of the fundamental, zeroth order mode. For shear waves having a harmonic mode of $n \geqq 1$, separate cutoff frequencies exist for the acoustic cavity **20** and the adjacent region of the substrate. These cutoff frequencies, designated f_c and f_s respectively, determine the frequency range in which standing waves, and hence resonance, is possible. For wave frequencies below f_c, no waves propagate. For wave frequencies between f_c and f_s, standing waves can form because of reflections at the acoustic cavity boundaries. At wave frequencies above f_s, the waves will not be substantially trapped within the acoustic cavity **20** and will propagate throughout the substrate **14**. Thus, at frequencies above f_s, resonance in the acoustic cavity **20** is suppressed due to substantial leakage of acoustic energy into the surrounding areas in the substrate **14**. The cut-off frequencies f_c and f_s are given by the following formulas.

$$f_c = \frac{nV_s}{2b_c} \quad f_s = \frac{nV_c}{2b_s}$$

[**0037**] Where b_c is the thickness of the acoustic cavity **20**; b_s is the substrate thickness in the area adjacent the acoustic cavity; V_s is the velocity of the zeroth order mode shear wave in the substrate; V_c is the velocity of the zeroth order mode shear wave in the cavity and n is the order of the harmonic mode of the generated shear.

[**0038**] In a preferred embodiment, the cavity **20** is operated in only a single mode. To accomplish this in practice, the geometry of the acoustic cavity **20** is such that the ratio of the length to thickness of the cavity satisfies the following equation where the length is designated as **2***a*.

$$\frac{2a}{b_c} \leq \frac{1}{n}\sqrt{\frac{2b_s}{h_c}}$$

[**0039**] Where h_c is the height of the mesa **22**, i.e. $h_c = b_c - b_s$. Similarly, the width w, of the acoustic cavity should satisfy the same relationship as follows.

$$\frac{w}{b_c} \leq \frac{1}{n}\sqrt{\frac{2b_s}{h_c}}$$

[**0040**] Further, the transducer **26** is positioned along a center line of the cavity.

[**0041**] FIGS. **4**-**7** illustrate the peak displacement of the wave motion in the acoustic cavity for a transducer **26** that is mounted on the acoustic cavity such that the length of the transducer **26** extends along a center line of the acoustic cavity surface in the X direction. In particular, as seen in **FIG. 4** for a shear wave transducer having displacement in the X direction, the shear wave generated in the acoustic cavity propagates in a direction that is in the plane of the substrate (the X-Z plane) as opposed to across the thickness thereof. The shear wave has a displacement component in the y direction designated U_y which is illustrated in **FIG. 5** for the harmonic mode, n=1 and in **FIG. 6** for the harmonic mode n=3. It has been found that a harmonic mode of order n=1 is preferred for thin substrates **14** whereas the harmonic mode $n \geqq 3$ is preferred for thicker substrates. **FIG. 7** illustrates the peak displacement of the wave in the y-z plane for an inharmonic mode of m=0; whereas **FIG. 8** illustrates the peak displacement of the wave in the y-z plane for an inharmonic mode of m=2.

[**0042**] It should be appreciated that the cavity may also be operated in more than one mode in accordance with the present invention. Further, the transducer need not be placed along a centerline of the cavity. For example, the transducer may be placed on the cavity adjacent to an edge thereof. The