structures **314***a*, **31***b* allow for the thickness mode bulging of the inactive portions and the compressing of the active portions of the actuator strip **318**. Fluid is caused to linearly move between diaphragm **316** and top cover **312***b* by sequential activation and deactivation of the various active portions of actuator **318**. The flow rate may be varied by controlling the on-off rate of the active portions. Optionally, a fixed diaphragm **322** may be mounted to the underside of top cover **312***b* to facilitate fluid-flow dynamics through the passageway **320** defined between the two diaphragms or to provide a disposable fluid path (with the actuator and housing being non-disposable).

[0067] FIG. **15**B illustrates another peristaltic pump **330** with a simplified design in that the diaphragm(s) and top output structures of the peristaltic pump of FIG. **15**A have been eliminated. As such, the top passive layer **324** of actuator **318** takes the function of previous diaphragm **316**, with fluid passing through the spacing **326** between the passive layer and the top cover or **312***b*.

[0068] The subject thickness mode actuators are also very useful in brake/clutch applications. FIGS. **16**A and **16**B illustrate a proportional linear braking system **330** in which a moveable member **332** (such as those used for commonly known rod bearing arrangement) is linearly translatable within the spacing between a grounded structure **338** and a brake mechanism **334**. The brake includes thickness mode actuator mechanism **336** positioned within housing **334**, which is also grounded. Actuator **336** may have one or more active areas (i.e., two active areas are employed here) depending on the surface area of member **332** and the breaking force required to stop its movement. For maximum breaking force (as well as for maximum clearance), all of the active areas are activated/deactivated simultaneously. In the passive state, as illustrated in FIG. **16**A, the output plate **342** of the actuators is in a closed or extended position, thereby clamping member **332** against grounding pad **338**. In the active state, as illustrated in FIG. **16**B, output plate **342** is open or receded within housing **334**, providing clearance for the linear movement of member **332**.

[0069] FIGS. **17**A and **17**B illustrate a rotary braking system **350** having a rotary disc **352** having a disc element **352***a* and an axial shaft **352***b*. The braking actuators **356***a*, **356***b* are mounted in stacked relationship within a housing **354**. Disc **352** is positioned within the spacing between inwardly facing output members or braking or clutch pads **358***a*, **35***b*, respectively. When actuators **356***a*, **356***b* are inactive and in their highest profile, as illustrated in FIG. **17**A, they are caused to clamp down and stop the rotation of disc **352**. When the actuators are active and in a compressed state, disc **352** is unclamped and allowed to move therethrough. The amount of braking force applied to disc **352***a* can be proportioned by either activating one of the two actuators or activating them both in tandem but at a decreased voltage to reduce their respective output displacement.

[0070] The transducer/actuator embodiments described thus far have the passive layer(s) coupled to both the active (i.e., areas including overlapping electrodes) and inactive regions of the EAP transducer film. Where the transducer/actuator has also employed a rigid output structure, that structure has been positioned over areas of the passive layers that reside above the active regions. Further, the active/activatable regions of these embodiments have been positioned centrally relative to the inactive regions. The present invention also includes other transducer/actuator configurations. For example, the passive layer(s) may cover only the active regions or only the inactive regions. Additionally, the inactive regions of the EAP film may be positioned centrally to the active regions.

[0071] FIGS. **18**A and **18**B illustrate one such variation in which the inactive area is positioned internally or centrally to the active region(s), i.e., the central portion of the EAP film is devoid of overlapping electrodes. Thickness mode actuator **360** includes EAP transducer film comprising dielectric layer **362** sandwiched between electrode layers **364***a*, **354***b* in which a central portion **365** of the film is passive and devoid of electrode material. The EAP film is held in a taut or stretched condition by at least one of top and bottom frame members **366***a*, **366***b*, collectively providing a cartridge configuration. Covering at least one of the top and bottom sides of the passive portion **365** of the film are passive layers **368***a*, **368***b* with optional rigid constraints or output members **370***a*, **370***b* mounted thereon, respectively. With the EAP film constrained at its perimeter by cartridge frame **366**, when activated (see FIG. **18**B), the compression of the EAP film causes the film material to retract inward, as shown by arrows **367***a*, **367***b*, rather than outward as with the above-described actuator embodiments. The compressed EAP film impinges on the passive material **368***a*, **368***b* causing its diameter to decrease and its height to increase. This change in configuration applies outward forces on output members **370***a*, **370***b*, respectively. As with the previously described actuator embodiments, the passively coupled film actuators may be provided in multiples in stacked or planar relationships to provide multi-phase actuation and/or to increase the output force and/or stroke of the actuator.

[0072] Performance may be enhanced by prestraining the dielectric film and/or the passive material. The actuator may be used as a key or button device and may be stacked or integrated with sensor devices such as membrane switches. The bottom output member or bottom electrode can be used to to provide sufficient pressure to a membrane switch to complete the circuit or can complete the circuit directly if the bottom output member has a conductive layer. Multiple actuators can be used in arrays for applications such as keypads or keyboards.

[0073] The various dielectric elastomer and electrode materials disclosed in U.S. Patent Application Publication No. 2005/0157893 are suitable for use with the thickness mode transducers of the present invention. Generally, the dielectric elastomers include any substantially insulating, compliant polymer, such as silicone rubber and acrylic, that deforms in response to an electrostatic force or whose deformation results in a change in electric field. In designing or choosing an appropriate polymer, one may consider the optimal material, physical, and chemical properties. Such properties can be tailored by judicious selection of monomer (including any side chains), additives, degree of cross-linking, crystallinity, molecular weight, etc.

[0074] Electrodes described therein and suitable for use include structured electrodes comprising metal traces and charge distribution layers, textured electrodes, conductive greases such as carbon greases or silver greases, colloidal suspensions, high aspect ratio conductive materials such as conductive carbon black, carbon fibrils, carbon nanotubes, graphene and metal nanowires, and mixtures of ionically conductive materials. The electrodes may be made of a compliant material such as elastomer matrix containing carbon or other conductive particles. The present invention may also employ metal and semi-inflexible electrodes.

[0075] Exemplary passive layer materials for use in the subject transducers include but are not limited to silicone, styrenic or olefinic copolymer, polyurethane, acrylate, rub-