[0057] An optional electronic controller circuit **35** may be provided which varies the modulation, voltage output and/or selects the appropriate electrodes to energize **20**A, **20**B in accordance with the needs to produce a desired dynamic effect. The electronic controller circuit **35** may be a general purpose computer programmed to provide the desired control or an application specific integrated circuit (ASIC.)

[0058] The electronic controller **35** may also be hardwired analog electronics or an embedded microprocessor. If an embedded microprocessor is used, a variety of waveforms (**FIGS. 3A-3F** for example) can be generated to modulate the voltage applied to the electrodes **20**A, **20**B.

[0059] Application of the output voltage from the EMF generator **25** causes deformation of the polymeric material **15** sandwiched between the electrodes **20**A, **20**B. In this exemplary embodiment of the invention, application of the output voltage from the EMF generator **25** causes the electroactive polymeric material **15** and the graphical image **10** to deform uniformly to a larger area **5'** and graphical image **10'**. Removal of the output voltage allows the electroactive polymeric material **15** and the graphical image **10** to return to their original shapes.

[0060] The graphical image **10** may be affixed to the surface of the dynamic graphical imagery display device **5** by several methods. For example, a dry film lamination process may be used to affix a composite structure of photopolymer and polyester film to one of the electrodes **20**A, **20**B, the electroactive polymeric material **15**, and/or the intervening resilient material layer affixed over the electrodes and/or polymer material. Alternately, a thermal dye sublimation process may be used to transfer ink directly onto at least one of the electrodes **20**A, **20**B and/or electroactive polymeric material **15**. Likewise, a simple silk screening process may be used to transfer or paint the graphical image **10** onto one of the electrodes **20**A, **20**B and/or the electroactive polymeric material **15**.

[0061] Lastly, an adhesive process may be used where the graphical image **10** is affixed to a thin elastomeric or otherwise compliant material and affixed to one of the electrodes **20**A, **20**B and/or electroactive polymeric material **15** using an adhesive. Affixing of the graphical image **10** usually is performed when the electroactive polymeric material **15** is expanded (i.e., voltage applied) to allow for higher resolution images.

[0062] **FIGS. 2A and 2B** depict selected non-uniform deformations by placing the graphical image **10** over areas of the electroactive polymeric material **15** having different amounts of pre-strain. Pre-strain can be used to provide graphical images **10**A, **10**B having differences in horizontal and vertical stretch, thus providing desirable non-uniform image deformations.

[0063] In non-uniform deformation, a given area of electroactive polymer material **15** may be prepared such that the amount of stretch achieved for a given voltage change is not identical in the vertical dimension as shown in **FIG. 2A**. The graphical image **10** and electroactive polymeric material **15** expands considerably more in the vertical dimension **15**A than in the horizontal dimension **15**B due to the pre-stress. Analogously, as shown in **FIG. 2B**, pre-stressing the electroactive polymeric material **15** in the horizontal dimension allows considerably greater expansion in the horizontal dimension **15**B than in the vertical dimension **15**A. The affixed graphical image **10** likewise **10**A, **10**B expands in conformance with the underlying electroactive polymeric material **15** to which the image is affixed. Pre-stress is accomplished during the manufacturing process by pre-stretching the material more in the horizontal dimension **15**A than in the vertical direction **15**B (or vice versa).

[0064] By having significantly different amounts of pre-stretch, the amount of deformation can be substantially different in these two directions when a voltage is applied. For example, an area of electroactive polymer material **15** could be prepared such that when a voltage of about 500V is applied, the stretch in the horizontal axis is 400% while the stretch in the vertical axis is only 50% based on the specific values selected during the manufacturing process.

[0065] **FIGS. 3A-3F** depict exemplary wave forms which may be generated by the EMF generator **25**. The Y axis indicates the amount of electromotive force in volts Vy being applied to the dynamic graphical display device **5**. The X axis is time t.

[0066] Each of the varying wave forms will have a different effect on the dynamic graphical display device **5** and the graphical image **15** affixed thereto. The wave forms depicted are only intended as examples of common wave forms. Other wave forms such as increasing and decreasing voltage ramps, complex modulations and other wave forms are envisioned as well.

[0067] **FIG. 3A** depicts a constant DC voltage being applied to the electrodes **20**A, **20**B of the dynamic graphical display device **5**. A constant DC voltage causes the electroactive polymer material **15** to remain in a deformed (compressed and elongated) steady state until the voltage is removed.

[0068] **FIG. 3B** depicts a sinusoidally varying wave form superimposed over a constant DC voltage being applied to the electrodes **20**A, **20**B of the dynamic graphical display device **5**. The addition of a varying wave form causes the electroactive polymer material **15** to partially deform in response to the applied DC voltage and dynamically vary the deformations in concert with the frequency of the superimposed sinusoidal wave form.

[0069] **FIG. 3C** depicts a sinusoidal wave form (AC signal source) being applied to the electrodes **20**A, **20**B of the dynamic graphical display device **5**. The application of a varying wave form causes the electroactive polymer material **15** to deform in concert with the frequency of the sinusoidal wave form.

[0070] **FIG. 3D** depicts a square wave form (pulse signal source) being applied to the electrodes **20**A, **20**B of the dynamic graphical display device **5**. The application of a square wave form causes the electroactive polymer material **15** to deform in concert with the pulse width (time variable) and height (voltage variable) of the square wave form.

[0071] **FIG. 3E** depicts an increasing DC voltage ramp function being applied to the electrodes **20**A, **20**B of the dynamic graphical display device **5**. The application of an increasing DC voltage ramp function causes the electroactive polymer material **15** to deform in concert with the increasing voltage applied until a maximum applied voltage has been applied. Once the maximum applied voltage has