channel. The noise management system comprises a multi-cell transparent electroactive film speaker comprising a plurality of individually operable electroactive cells, wherein each cell includes a respective series of resonance frequencies such that the multi-cell transparent electroactive film speaker is capable of multiple series of resonance frequencies, and a control unit connected to the multi-cell transparent electroactive film speaker. The control unit is configured to actively detect an incident noise entering the ventilation channel and control at least one cell of the multi-cell transparent electroactive film speaker to generate a corresponding counter noise to substantially cancel the incident noise. The multi-cell transparent electroactive film speaker comprises a layered structure comprising a plurality of transparent patterned top electrodes corresponding to the plurality of cells, a transparent electroactive layer disposed below the transparent top electrodes, a transparent bottom electrode layer disposed below the transparent electroactive layer, a transparent substrate layer disposed below the transparent bottom electrode layer, and a transparent grid configured to mechanically secure the individual cells and separate the cells from each other.

[0011]

[0012]

[0013] The individual transparent top electrodes may be electrically separated from each other.

[0014] Each cell of the multi-cell transparent electroactive film speaker may comprise a respective size corresponding to its series of resonance frequencies.

[0015] Each cell of the multi-cell transparent electroactive film speaker may comprise a respective geometry corresponding to its series of resonance frequencies.

[0016] The transparent electroactive layer may comprise a transparent piezoelectric material.

[0017] The control unit may comprise a first acoustic sensor to actively detect the incident noise and a second acoustic sensor configured to detect a transmitted noise exiting the ventilation channel, and the control unit may be further configured

to adjust the counter noise generated by the at least one cell based on the detected transmitted noise.

[0018] The control unit may comprise a first acoustic sensor to actively detect the incident noise, and the first acoustic sensor may comprise at least one selected cell of the multi-cell transparent electroactive film speaker.

[0019] The window system may further comprise at least one sash, and the at least one sash may be rotationally adjustable to form the ventilation channel.

[0020] The window system may further comprise at least one sash, and the at least one sash may be translationally adjustable to form the ventilation channel.

[0021] The window system may comprise a first sash and a second sash, and the ventilation channel may be in a space between the first and second sashes.

[0022] Another aspect of the present invention provides a method of managing noise. The method comprises providing, on a window having a ventilation channel, a multi-cell transparent electroactive film speaker and a control unit connected to the multi-cell transparent electroactive film speaker, the multi-cell transparent electroactive film speaker comprising a plurality of individually operable electroactive cells, wherein each cell includes a respective series of resonance frequencies such that the multi-cell transparent electroactive film speaker is capable of multiple series of resonance frequencies. The method further comprises actively detecting, by the control unit, an incident noise entering the ventilation channel, and generating a corresponding counter noise to substantially cancel the incident noise by controlling at least one cell of the multi-cell transparent electroactive film speaker based on the detected incident noise. Providing the multi-cell transparent electroactive film speaker comprises providing a layered structure comprising a plurality of transparent patterned top electrodes corresponding to the plurality of cells, a transparent electroactive layer disposed below the transparent top electrodes, a transparent bottom electrode layer disposed below the transparent electroactive layer, a transparent substrate layer disposed below the transparent bottom electrode layer, and a transparent grid configured to mechanically secure the individual cells and separate the cells from each other.

[0023]

[0024] The transparent electroactive layer may comprise a transparent piezoelectric material.

[0025] Actively detecting the incident noise may comprise using a first acoustic sensor.

[0026] The method may further comprise detecting a transmitted noise exiting the ventilation channel using a second acoustic sensor, and adjusting the counter noise generated by the at least one cell based on the detected transmitted noise.

[0027] Actively detecting the incident noise may comprise using a first acoustic sensor, and the first acoustic sensor may comprise at least one selected cell of the multi-cell transparent electroactive film speaker.

[0028] Another aspect of the present invention provides a method of installing a noise management system on a window. The method comprises mounting a multi-cell transparent electroactive film speaker in or adjacent a ventilation channel of the window, the multi-cell transparent electroactive film speaker comprising a plurality of individually operable electroactive cells, wherein each cell includes a respective series of resonance frequencies such that the multi-cell transparent electroactive film speaker is capable of multiple series of resonance frequencies. The method further comprises connecting a control unit to the multi-cell transparent electroactive film speaker, the control unit being configured to actively detect an incident noise entering the ventilation channel and control at least one cell of the multi-cell transparent electroactive film speaker to generate a corresponding counter noise to substantially cancel the incident noise. Mounting the multi-cell transparent electroactive film speaker comprises mounting a layered structure comprising a plurality of transparent patterned top electrodes corresponding to the plurality of cells, a transparent electroactive layer disposed below the transparent top electrodes, a transparent bottom electrode layer disposed below the transparent electroactive layer, a transparent substrate layer disposed below the transparent bottom electrode layer, and a transparent grid configured to mechanically secure the individual cells and separate the cells from each other.

[0029] Another aspect of the present invention provides a window system comprising a ventilation channel and a noise management system in or adjacent the ventilation channel. The noise management system comprises a multi-cell transparent electroactive film speaker comprising a plurality of individually operable electroactive cells, wherein each cell includes a respective series of resonance frequencies such that the multi-cell transparent electroactive film speaker is capable of multiple series of resonance frequencies, and a control unit connected to the multi-cell transparent electroactive film speaker. The control unit comprises a first acoustic sensor to actively detect an incident noise entering the ventilation channel, the control unit being configured to control the multi-cell transparent electroactive film speaker to generate a corresponding counter noise to substantially cancel the incident noise. The first acoustic sensor comprises at least one selected cell of the multi-cell transparent electroactive film speaker.

CLAIMS

1. A window system comprising:

a ventilation channel; and

a noise management system in or adjacent the ventilation channel, the noise management system comprising:

a multi-cell transparent electroactive film speaker comprising a plurality of individually operable electroactive cells, wherein each cell includes a respective series of resonance frequencies such that the multi-cell transparent electroactive film speaker is capable of multiple series of resonance frequencies; and

a control unit connected to the multi-cell transparent electroactive film speaker,

wherein the control unit is configured to actively detect an incident noise entering the ventilation channel and control at least one cell of the multi-cell transparent electroactive film speaker to generate a corresponding counter noise to substantially cancel the incident noise; and

wherein the multi-cell transparent electroactive film speaker comprises a layered structure comprising:

a plurality of transparent patterned top electrodes corresponding to the plurality of cells;

a transparent electroactive layer disposed below the transparent top electrodes;

a transparent bottom electrode layer disposed below the transparent electroactive layer;

a transparent substrate layer disposed below the transparent bottom electrode layer; and

a transparent grid configured to mechanically secure the individual cells and separate the cells from each other.

2. The window system as claimed in claim 1, wherein the individual transparent top electrodes are electrically separated from each other.

3. The window system as claimed in claim 2, wherein each cell of the multi-cell transparent electroactive film speaker comprises a respective size corresponding to its series of resonance frequencies.

4. The window system as claimed in claim 2, wherein each cell of the multi-cell transparent electroactive film speaker comprises a respective geometry corresponding to its series of resonance frequencies.

5. The window system as claimed in any one of claims 1 to 4, wherein the transparent electroactive layer comprises a transparent piezoelectric material.

6. The window system as claimed in claim 1, wherein the control unit comprises a first acoustic sensor to actively detect the incident noise and a second acoustic sensor configured to detect a transmitted noise exiting the ventilation channel, and wherein the control unit is further configured to adjust the counter noise generated by the at least one cell based on the detected transmitted noise.

7. The window system as claimed in claim 1, wherein the control unit comprises a first acoustic sensor to actively detect the incident noise, and wherein the first acoustic sensor comprises at least one selected cell of the multi-cell transparent electroactive film speaker.

8. The window system as claimed in any one of the preceding claims, further comprising at least one sash, wherein the at least one sash is rotationally adjustable to form the ventilation channel.

9. The window system as claimed in any one of claims 1 to 7, further comprising at least one sash, wherein the at least one sash is translationally adjustable to form the ventilation channel.

10. The window system as claimed in claim 8 or 9, comprising a first sash and a second sash, wherein the ventilation channel is in a space between the first and second sashes.

11. A method of managing noise, the method comprising:

providing, on a window having a ventilation channel, a multi-cell transparent electroactive film speaker and a control unit connected to the multi-cell transparent electroactive film speaker, the multi-cell transparent electroactive film speaker comprising a plurality of individually operable electroactive cells, wherein each cell includes a respective series of resonance frequencies such that the multi-cell transparent electroactive film speaker is capable of multiple series of resonance frequencies;

actively detecting, by the control unit, an incident noise entering the ventilation channel; and

generating a corresponding counter noise to substantially cancel the incident noise by controlling at least one cell of the multi-cell transparent electroactive film speaker based on the detected incident noise,

wherein providing the multi-cell transparent electroactive film speaker comprises providing a layered structure comprising:

a plurality of transparent patterned top electrodes corresponding to the plurality of cells;

a transparent electroactive layer disposed below the transparent top electrodes;

a transparent bottom electrode layer disposed below the transparent electroactive layer;

a transparent substrate layer disposed below the transparent bottom electrode layer; and

a transparent grid configured to mechanically secure the individual cells and separate the cells from each other.

12. The method as claimed in claim 11, wherein the transparent electroactive layer comprises a transparent piezoelectric material.

13. The method as claimed in claim 12, wherein actively detecting the incident noise comprises using a first acoustic sensor.

14. The method as claimed in claim 13, further comprising:

detecting a transmitted noise exiting the ventilation channel using a second acoustic sensor; and

adjusting the counter noise generated by the at least one cell based on the detected transmitted noise.

15. The method as claimed in claim 12, wherein actively detecting the incident noise comprises using a first acoustic sensor, the first acoustic sensor comprising at least one selected cell of the multi-cell transparent electroactive film speaker.

16. A method of installing a noise management system on a window, the method comprising:

mounting a multi-cell transparent electroactive film speaker in or adjacent a ventilation channel of the window, the multi-cell transparent electroactive film speaker comprising a plurality of individually operable electroactive cells, wherein each cell includes a respective series of resonance frequencies such that the multi-cell transparent electroactive film speaker is capable of multiple series of resonance frequencies; and

connecting a control unit to the multi-cell transparent electroactive film speaker, the control unit being configured to actively detect an incident noise entering the ventilation channel and control at least one cell of the multi-cell transparent electroactive film speaker to generate a corresponding counter noise to substantially cancel the incident noise,

wherein mounting the multi-cell transparent electroactive film speaker comprises mounting a layered structure comprising:

a plurality of transparent patterned top electrodes corresponding to the plurality of cells;

a transparent electroactive layer disposed below the transparent top electrodes;

a transparent bottom electrode layer disposed below the transparent electroactive layer;

a transparent substrate layer disposed below the transparent bottom electrode layer; and

a transparent grid configured to mechanically secure the individual cells and separate the cells from each other.

17. The method as claimed in claim 16, wherein the control unit comprises a first acoustic sensor, a second acoustic sensor, and a control circuit communicatively coupled to the first and second acoustic sensors.

18. The method as claimed in claim 17, wherein the first acoustic sensor comprises at least one selected cell of the multi-cell transparent electroactive film speaker.

19. A window system comprising:

a ventilation channel; and

a noise management system in or adjacent the ventilation channel, the noise management system comprising:

a multi-cell transparent electroactive film speaker comprising a plurality of individually operable electroactive cells, wherein each cell includes a respective series

of resonance frequencies such that the multi-cell transparent electroactive film speaker is capable of multiple series of resonance frequencies; and

a control unit connected to the multi-cell transparent electroactive film speaker,

wherein the control unit comprises a first acoustic sensor to actively detect an incident noise entering the ventilation channel, the control unit being configured to control the multi-cell transparent electroactive film speaker to generate a corresponding counter noise to substantially cancel the incident noise, and wherein the first acoustic sensor comprises at least one selected cell of the multi-cell transparent electroactive film speaker.