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Clifford et al.

[11] **3,772,537**

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[54] **ELECTROSTATICALLY ACTUATED DEVICE**

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[52] **U.S. Cl.** ..... **310/6**, 317/262 E, 200/181

[51] **Int. Cl.** **H02n 1/00**

[58] **Field of Search** ..... 117/93.4 NC, 93.4 R; 317/262 E; 200/181; 310/5, 6, 7, 2; 318/116

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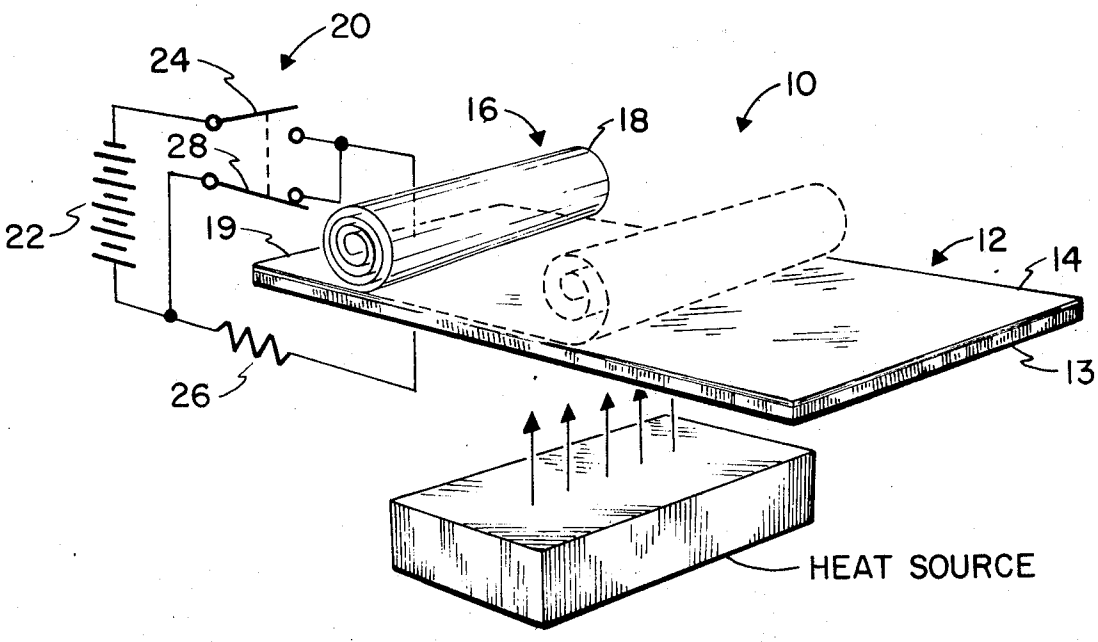
[57] **ABSTRACT**

An electrostatic device having a relatively thin and flexible electrode strip, such as a metal coated plastic film or metal foil, which is secured to and normally curls away from an electrode member and is caused to electrostatically unfurl along the member by impressing a voltage between the member and strip. The device is capable of varied uses and is described in connection with its use as a thermal control louver and a light valve or shutter.

5 Claims, 3 Drawing Figures



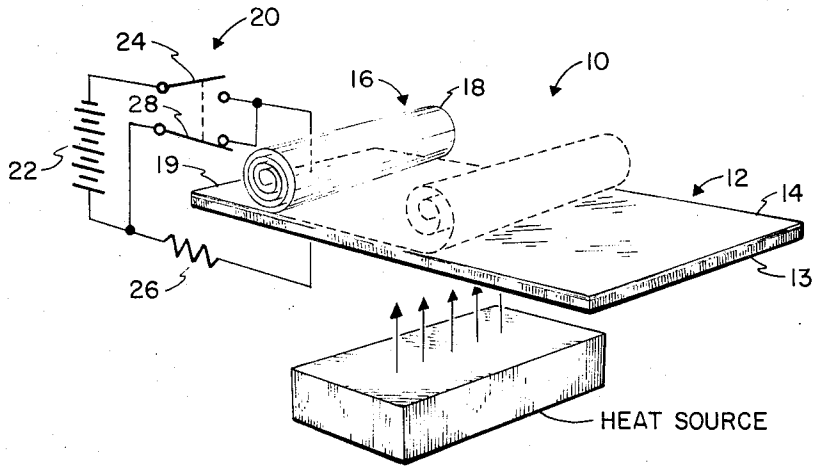


Fig. 1

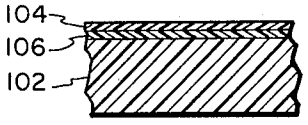


Fig. 3

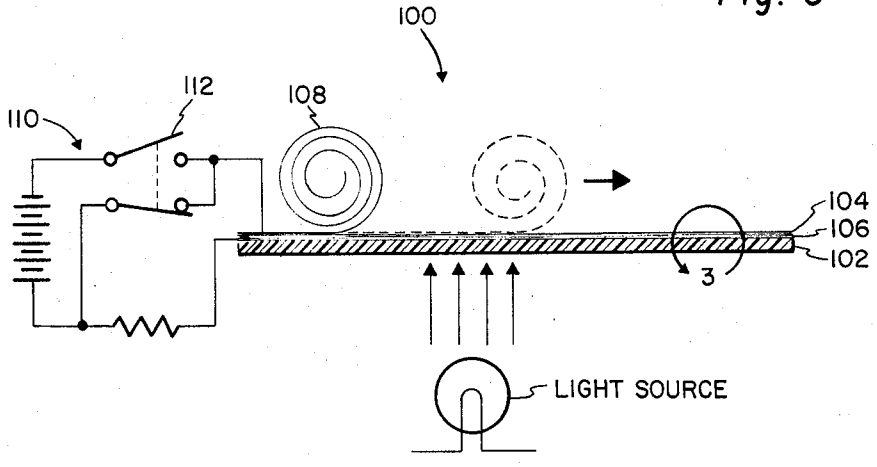


Fig. 2

ELECTROSTATICALLY ACTUATED DEVICE

BACKGROUND OF THE INVENTION

1. Field

This invention relates generally to electrostatically actuated devices, and more particularly to an electrostatic device having a normally curled electrode strip which is caused to unfurl by electrostatic action.

2. Prior Art

A wide variety of devices have been devised which utilize electrostatic forces to move a part from one position to another. A few of the prior art patents disclosing such devices are listed below: U.S. Pat. Nos. 2,568,824; 2,885,509; 2,885,511; 2,927,255; 2,931,954; 2,942,077; 3,553,364.

Most, if not all, of these and other electrostatic devices which have been developed to date are designed for a specific use, such as a relay, light valve, etc.

SUMMARY OF THE INVENTION

The present invention provides a novel electrostatic device capable of many diverse uses. This electrostatic device has a relatively thin and flexible electrode strip which is secured to and normally curls away from an electrode member. A voltage is impressed between the electrode member and strip in such a way that the resulting electrostatic attraction force between the member and strip causes the latter to unfurl along the member.

In the particular electrostatic devices described, the electrode member is a plate and the electrode strip is a metal coated plastic film or a metal foil. This strip is preformed to normally curl into a coil. The outer end of the coiled strip is secured to one side of the electrode plate with electrical insulation between the plate and strip and with the coil curling away from the plate. When the electrode plate and strip are electrified, the strip unfurls across the surface of the plate and then returns to its coiled configuration when the voltage is removed.

This electrostatic device is capable of many diverse uses. Two different devices are described. One is a thermal central louver. The other is a light valve or shutter.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a longitudinal section through a thermal control louver according to the invention;

FIG. 2 is a longitudinal section through a light valve according to the invention; and

FIG. 3 is an enlargement of the area encircled by the arrow 3 in FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The electrostatic device or thermal control louver **10** of FIG. 1 has an electrode member **12** including a flat metal plate **13.** The upper surface of this plate is coated with a dielectric film **14.** Louver **10** has a second electrode **16** in the form of a relatively thin and elastically flexible strip which may comprise metal coated plastic film, such as aluminized Mylar, or a metal foil. This electrode strip is preformed to normally curl into a coil **18,** as shown in full lines. The outer end **19** of the strip is adhesively bonded or otherwise secured to the upper coated surface of the electrode member **12** with the coil **18** curling away from the member.

Louver **10** may be utilized as either a controllable thermal energy radiator for regulating radiant heat transfer from a heat source below the electrode member **12** to a heat sink above the member, as shown in FIG. **1,** or as a controllable thermal energy absorber for regulating radiant heat transfer from a heat source above the electrode member to a heat sink below the member. In the case of the radiator, the electrode member **12** has a high thermal emittance and the electrode strip **16** has a low thermal emittance. This low thermal emittance of the strip may be attained by making the strip from a material which has low thermal emittance or by coating the strip with a low emittance material. In the case of the thermal energy absorber, the electrode member **12** has a high thermal absorbance and the electrode strip **16** has a low thermal absorbance.

Louver **10** has an electrifying circuit **20.** This circuit includes a d-c voltage source **22** having one terminal connected to the electrode plate **13** and its other terminal connected to the electrode strip **16.** A switch **24** is provided for interrupting the circuit and a current-limiting resistor **26** is connected in series with the battery.

When the switch **24** is open, the electrode strip **16** remains in its solid line coiled configuration. Under these conditions, the strip uncovers the upper thermal radiating surface of the electrode member **12** and maximum radiant heat transfer occurs between the heat source and heat sink through the plate.

When the switch **24** is closed, the terminal voltage of the d-c source **22** is impressed between the electrode plate **13** and strip **16.** This voltage electrifies the plate and strip with opposite electrical polarity. The resulting electrostatic attraction force between the plate and strip causes the strip to unfurl across the electrode member, as indicated in broken lines in FIG. **1.** The strip then covers the electrode member to reduce heat transfer between the heat source and heat sink. Reopening the switch **24** removes the impressed voltage and hence the electrostatic attraction force. The elastic strain energy stored in the electrode strip in its unfurled condition causes the strip to recurl itself to its coiled configuration and thereby restore the radiant heat transfer to its original high value. If desired, the switch **24,** when opened to interrupt the electrifying circuit **20,** may complete a short circuit path **28** for short-circuiting the electrode plate and strip to rapidly dissipate the charges on the plate and strip. Also, the d-c source **22** may be adjustable to permit unfurling of the strip to and retention of the strip in any selected partially unfurled position, so as to permit finer control of the radiant heat transfer between the heat source and sink.

The electrostatic light valve or shutter **100** of FIGS. **2** and **3** is similar to the thermal control louver just described except for replacement of the metal electrode plate **13** and dielectric film **14** of the louver by an electrode plate **102,** dielectric film **104,** and intervening electrically conductive film **106** which are transparent to the wavelength of the light to be controlled, and use of an electrode strip **108** which is opaque to such light. The terminals of the electrifying circuit **110** are connected to the electrode strip **108** and the conductive film **106.**

When the circuit switch **112** is closed, the electrode strip **108** unfurls across the electrode plate **102** to

block passage of light through the plate. Opening the switch permits the strip to recurl to its coiled configuration and permit light passage through the plate. It will be understood that the strip **108** may not be totally opaque to light but only to those wavelengths to the controlled.

What is claimed as new in support of Letters Patent is:

1. An electrostatic device comprising:

an electrode member;

a relatively thin and resiliently flexible electrode strip secured at one end to said electrode member and having its opposite end portion preformed to normally curl away from said electrode member into a coil;

means electrically insulating said electrode member and strip from one another; and

means for impressing a voltage between said electrode member and strip to cause said coiled end portion of said strip to unfurl along said member.

2. An electrostatic device according to claim **1** wherein:

said electrode member comprises a plate and said electrode strip comprises a thin sheet material such as metal coated plastic film, metal foil or the like.

3. An electrostatic device according to claim **1** wherein:

said device is a thermal control louver;

said electrode member comprises a thermal energy radiator having high thermal emittance; and

said electrode strip has low thermal emittance.

4. An electrostatic device according to claim **1** wherein:

said device is a thermal control louver;

said electrode member comprises a thermal energy absorber having high thermal absorbance; and

said electrode strip has low thermal absorbance.

5. An electrostatic device according to claim **1** wherein:

said device is a light valve;

said electrode member is transparent to light; and

said electrode strip is opaque to light.

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