results in an input power of only P=VI=0.100 J or about a factor of 12 times less than the resistive heating. According to an equation provided by one thermoelectric element manufacturer, the heat produced by the hot side of element **500** (and subsequently available to the spring) is approximately 0.066 Joules (to effect a sufficient movement of the spring). Using 66 millijoules (mJ) as the estimate for the amount of power required to actuate the spring, the efficiency of a thermoelectric heater **500** for heating the spring is on the order of (P_{OUT}/P_{IN}×66 mJ/100 mJ) about 66%, whereas the efficiency of the resistive heating process is on the order of (66 mJ/1.2J) about 6%. Thus element **500** is more efficient than the resistive heating technique.

Use of a thermoelectric heater permits the use of modular braille cells for applications such as ATM machines. Since the currents required by the thermoelectric heater are small, a standard 14-pin integrated circuit multiplex chip can be used to control the actuation of the eight pins, with three leads reserved for data input as a three-digit binary number. This IC braille cell could be plugged in along with other cells into a motherboard, and bad cells could be easily swapped for new ones.

The embodiments of the present invention incorporating thermoelectric heating are useful with the other features of the present invention heretofore described and depicted. Some embodiments of the present invention also contemplate a supporting mechanism similar to those found in ball points pens or similar to those previously described, but modifiying the supporting mechanism so that it can hold any or all of the pins in the up position with no power to the springs. One device is sufficient for all eight of the pins, with a second spring-loaded device for release (reset) of the pins. Although this would increase the total number of springs to nine for the cell, the power would be needed only for switching states. The present invention also contemplates another means for supporting that utilizes a supporting mechanism similar to that found in mechanical pencils. With this alternate means for supporting, the pin is extended to a greater height each time spring **46** is exposed to another heating cycle.

Periodic D.C. signals can be used with a thermoelectric heater like a thermostat to keep a spring in the raised position. Each pin in the cell would be a part of the cycle of signals sent to the IC. As any particular raised spring started to cool, a reinforcement pulse could be sent to heat it again. Pins in the lower state would simply be passed over. For embodiments like this without mechanical ratchet or support, the cooling effect of the thermoelectric element could be used by reversing polarity by use of a polarity inverter, thus snapping the spring back down quickly into its lowered position. Tests with this embodiment have shown that this effect can be utilized to make the spring actuator function like a solenoid.

FIG. **8** depicts a configuration of thermoelectric heater and spring wherein the thermal conductor **510** of element **500** is in contact with the bottom inactive coil **516** of spring **46**. However, the present invention contemplates additional heater configurations in which the thermoelectric element is proximate to the shape memory spring so as to provide improved heat transfer into the spring and improved pacakaging of the spring and heater element combination. FIG. **15** shows a cross-sectional view of a portion of a shape memory spring **46** with portions of the thermoelectric heater. Semiconductors **502** and **504** are configured and adapted to the located proximate to one end of spring **46**. Semiconductors **502** and **504** are in electrical contact with a coil of spring **46** such as inactive coil **516**. Electrical power from a power supply (not shown) is passed by lead wires (not shown) into semiconductors **502** and **504**. A coil spring **46** acts as a conductor between the semiconductors. This configuration provides not only thermoelectric heating of spring **46**, but also resistive heating of spring **46** through the conducting coil.

FIG. **16** shows a cross-sectional view of a portion of a shape memory spring with a thermoelectric element located therein. This configuration is similar to that shown in FIG. **15**, except that thermally conductive layer **510** is located between the semiconductors and the coils of the shape memory spring. Thermally conductive layer **510** is also an electrical insulator, so that no current is passed through the spring. The portion of layer **510** is captured within an inactive coil at one end of the spring.

FIG. **17** shows a diagrammatic cross-section of a thermoelectric heater that surrounds a portion of the outer diameter of the shape memory spring. Semiconductors **502** and **504** are located on either side of spring **46**. Between the semiconductors and the spring is a thermally conductive layer **510**.

FIG. **18** is a top diagrammatic view of portion of a shape memory spring surrounded by a plurality of semiconductor junctions **502** and **504**. Semiconductors **502** and **504** are electrically linked by electrically conductive layers **511**. A thermally conductive layer **510** is placed between the inner diameter of the semiconductors and the spring. Spring **46** is thus heated uniformly circumferentially with or without contacting any coils of the spring.

FIG. **19** is a top diagrammatic view of a spring **46** heated internally by a plurality of semiconductors **502** and **504**. A first thermally conductive layer is placed between the semiconductors and the inner diameter of the spring and may or may not touch the spring. In some embodiments there is a second thermally conductive layer (here shown as a cross section of a thermally conductive post **515**) located within the inner diameter of the semiconductive elements, so as to provide a conductive path for heat being transferred to or from the spring travelling along thermally conductive post **515** into a plate or other heat sink. Although this arrangement of thermoelectric elements may be difficult to fit within a spring **46** as used within a modular braille cell described herein, the present invention also contemplates versions of shape memory spring and pin actuators which are larger and which would accommodate the internal heaters.

The present invention also includes an embodiment in which the thermoelectric element is placed between two shape-memory material springs **46** and **44**. In this embodiment, actuation of the heater heats one shape-memory spring and simultaneously cools the other shape-memory spring.

While the invention has been illustrated and described in detail in the drawings and foregoing description, the same is to be considered as illustrative and not restrictive in character, it being understood that only the preferred embodiments have been shown and described and that all changes and modifications that come within the spirit of the invention are desired to be protected.

What is claimed is:

1. An apparatus comprising:

a first spring made from a shape-memory material;

a first thermoelectric heating element for heating said first spring using the Peltier effect;

a second spring:

a pin urged in a first direction by said first spring after said first spring is heated, said pin being urged in a