4) no additional loose parts/cradles, 5) no significant volume added to the phone when the external display is not in use, 6) people can use the product in either of two configurations.

[0039] Since the external screen will typically be bistable, the cell phone need not buffer data for a complete screen. Instead the cell phone may write out all or a portion of the screen information in a manner similar to outputting to a printer rather than operating a traditional display. Thus, a large image may be created by refreshing discrete portions of the display sequentially. Reducing the buffer memory needs of the cell phone in this manner greatly reduces its cost. The device would not need RAM, a microprocessor, flash memory, or a battery, although it would typically still need a microcontroller. Because the electronic ink external display can update in parts, it can also employ peripheral communications standards like USB rather than high-speed clocked data lines, such as are used by most LCD displays.

[0040] The typical energy draw for portable cell phone screens is based on sizes ranging from 1-4 inch (25 to 101 mm.) diagonals, and consists of 44 J power draw (25 J for the display and 19 J for the backlight) assuming a typical usage model (8 hour day, 5% transmit, 5% receive, 90% standby, backlight times out 10 seconds after last key press, total use 60 minutes/day for 6 calls of 10 minutes each; shows only time, date and signal strength in standby). Since the total energy budget for the cell phone is 26855 J, this is a tiny fraction of the energy budget. The display may draw 1.2 mW/0.9 mW during talk/standby, but while the buttons are being pressed the backlight is on and draws 108 mW. (Source: R. Akins "Displays for Hand-held Portable Electronic Products", SID (Society for Information Display) Invited Paper, SID Digest, May 2000).

[0041] An external screen using an electronic ink display medium need draw very little power. It is estimated that a USB external cell phone display would use about 20 mA during an update (most of which goes to powering the microcontroller), which might last 1 second. If an update took place once every 10 seconds this would be a steady state power draw of 20 mA*5V (USB power)*1 sec/10 sec=10 mW. Over one hour, this would use 36 J, an almost negligible amount of power. Thus, while there could be batteries in the display, preferably the external display is powered by the phone, thus reducing the cost of the external display and maximizing its portability.

[0042] The visual indicator cell phone of the present invention will now be discussed in detail. As already mentioned, this cell phone uses a visual indicator comprising an electro-optic medium of variable optical appearance to provide a visual indication when a call is received by the phone. Although the visual indicator could simply change from one state to another (say from black to white) when a call is received, the human eye is far more sensitive to changes in optical appearance than to optical appearance itself. Accordingly, it is desirable that the visual indicator be arranged to "flash" (i.e., to change repeatedly between its two display states) when a call is received by the phone.

[0043] Electro-optic visual displays are well suited to act as a visual indicator for a cell phone. To enable the cell phone to be used with services such as caller ID and call waiting, desirably the electro-optic medium has at least two modes of changing repeatedly between it two or more display states. Different colors, frequencies, intensities or other visual cues may be used in combination with caller ID or call waiting to indicate information about the call. Other visual states such as voice mail or E-mail waiting may also be visually indicated.

[0044] The electronic ink visual indicator may be attached to the surface of the cell phone or be present in an external cellphone case or other peripheral attachment. (In saying that the visual indicator is present on an external surface of the cell phone or other object, we do not exclude the possibility that the visual indicator may be overlain by one or more substantial transparent layers, provided only that the visual indicator is readily visible to a user of the cell phone or other object. Most electro-optic media require electrodes on both sides of the medium, so the visual indicator will usually have a substantially transparent electrode overlying the electro-optic medium itself. In addition it may be desirable to cover the electro-optic medium with one or more protective layers to protect the medium itself against any combination of moisture, ultra-violet radiation, and the sweat or skin oils of a user holding the cell phone.) The visual indicator may be curved, flexed or conformed to the surface. In order that it may be conspicuous, the visual indicator desirably covers a large portion of the surface on which it is provided. Typically, the visual indicator should cover an area of at least about 1 cm^2 ; when provided on the external surface of the cell phone, it desirably covers at least about 5 percent of the external surface of the cell phone.

[0045] The thin, flexible nature of certain electro-optic media allows them to cover a surface in an ergonomic, lightweight way while still achieving a large display area, which is a critical requirement for a visual indicator. The visual indicator may be wrapped around multiple sides of the cell phone, so that it is visible regardless of the orientation of the phone. Typically, the external surface of a cell phone will comprise at least three separate surfaces, and the visual indicator should be present on at least two of these surfaces. Many cell phones have a substantially cuboidal form with a front surface bearing a key pad, an opposed rear surface, and at least two side opposed surfaces and two opposed end surfaces extending between the front and rear surfaces, and in such phones it is desirable that the visual indicator be present on the rear surface and an opposed pair of the side and rear surfaces, so that when the cell phone is placed face down on a surface, the visual indicator will be visible from almost any direction.

[0046] In certain special situations, for example cell phones intended for noisy industrial environments, the visual indicator may be the only ring indicator present on the cell phone. However, most users will prefer a choice between audible and visual "ringing" and thus desirable the cell phone comprises an audible indicator means for indicating when a call is received by the phone, and selector means whereby a user may select operation of either the visual indicator means or the audible indicator means when a call is received.

[0047] As already indicated, the low power requirement of many electro-optic media permits the visual indicator to function with minimal battery drain. The bistability of such media allows persistent "flags", such as E-mail or voice mail flags, to remain visible without drawing power. The light weight of an electro-optic visual indicator achieves its functionality with minimal reduction of portability.