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(54) Title: LOAD-SENSING CARTRIDGE COUNTER

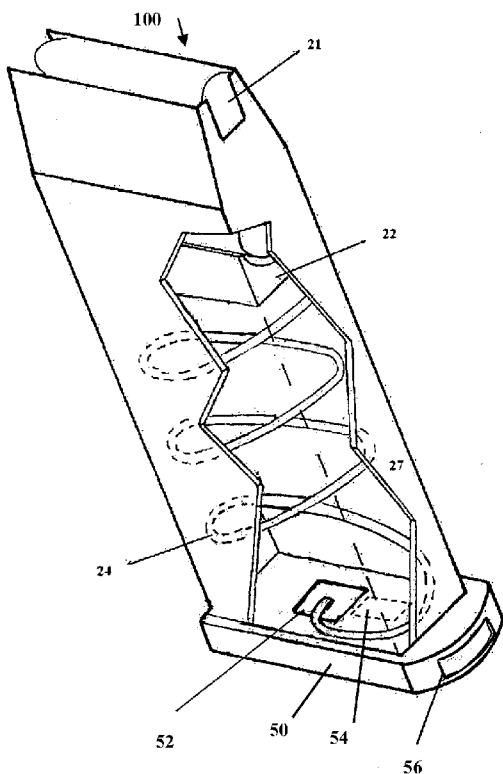


FIG. 4

(57) Abstract: A load-sensing base, cartridge and method are provided for use with a firearm. The cartridge includes a support element that moves a cartridge into a chamber of the firearm. The base includes a load sensor that senses a load applied by the support element and outputs a load sensing signal. The bases also include a cartridge counter, coupled to the load sensor, that uses the load sensing signal to determine a number of cartridges remaining.





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LOAD-SENSING CARTRIDGE COUNTER

FIELD OF INTEREST

[0001] The present inventive concepts relate to the field of firearms, and more particularly to magazines used in firearms.

5

BACKGROUND

[0002] Typical firearms offer no mechanism to communicate to the user a number of cartridges in a magazine of a firearm. For various reasons, this could be extremely useful information for the user.

[0003] Various approaches for determining the number of cartridges remaining in a magazine have been suggested. For example, US Patent Publication 20080276517 entitled Cartridge Counter describes two types of magazines that determine the number of cartridges in a magazine, each uses a distance detector. These magazines are described with respect to FIGS. 1 – 3 provided herein, which also appear in US Patent Publication 20080276517.

15 [0004] In prior art FIGS. 1 and 2, a magazine 29 is shown that can be inserted into a firearm, such as handgun 11 shown in FIG. 3. The firearm 11 includes a handle or grip 12 within which magazine 29 is inserted to load the firearm. The magazine includes cartridges (e.g., bullets, rounds) 21 that are deposited within a chamber of the firearm from the magazine.

20 [0005] Magazine 29 includes a hollow cross section polygonal frame or shell 27, substantially rectangular, suitable for the dimensions of the cartridges 21 that will be stored in the magazine 29.

[0006] The near end of the magazine 29 is fitted into firearm 11, which includes an entry/exit hole for cartridges 21 of magazine 29 (or access aperture); i.e.,
25 a fitting hole located in the upper part of the magazine 29 when it is supported at the opposite end in a substantially vertical position.

[0007] The other end, opposite to the magazine 29 access hole, is closed by a surface or base 28 of the magazine 29 that serves as a seating or support to a first push spring 24 of the magazine 29, and moves an ammunition push means 22, such

as a tile, longitudinally between the empty magazine 29 position where the spring is unstressed and full magazine 29 where the first spring 24 is compressed.

[0008] Consequently, the cartridges 21 stored in the magazine 29 are moved toward the magazine 29 entry each time a cartridge 21 is expelled out of the magazine 29, or towards the base 28 each time a cartridge 21 is added through the magazine 29 access hole.

[0009] As a result of the push effort made by the first spring 24, the tile 22 moves upward or downward depending on if a cartridge 21 is extracted or introduced into the magazine 29.

[0010] A distance detection means (or perceiver) 25 measures the distance between the tile 22 and the base 28. The distance perceiver 25 is located in a place configured for such purpose between the tile 22 and the base 28 of the magazine 29. Thus, when the tile 22 moves longitudinally, the distance perceiver 25 generates an electric signal that indicates the longitudinal movement made by the tile 22, either upward toward to the access hole or downward toward the base 28.

[0011] The distance perceiver 25 includes a first set of electric terminals 26 adapted to make electric contact with a second set of electric terminals 41 located at the tip of the firearm 11. Obviously, both sets of terminals 26, 41 face each other when the magazine 29 is loaded into the firearm 11.

[0012] The first set 26 of electric terminals can be placed, for example, at the entrance of the magazine 29 fitting location in the case of a partially fitted magazine (e.g., sub rifle, assault rifle, lightweight machine gun, etc.), or in the other end of the magazine casing 27 when totally fitted inside the handle of a firearm 11, such as the pistol displayed in FIG. 3.

[0013] A microprocessor (not shown) is located in a location provided for such purposes in the firearm 11 handle 12. When the magazine 29 is fitted into the firearm 11, both first and second electrical terminals 26,41 are in electrical contact and allow an electric signal, relative to the movement of the push tile 22, to be sent from the distance perceiver 25 through both sets of contacts and electric connections to the microprocessor, which are also connected via electrical connections to a display 13, located in the body or casing of the firearm and in sight of the shooter when pointing the firearm 11 to a potential target.

[0014] In FIG. 1, the distance perceiver 25 is connected to the tile 22 through a second spring 23, so that its near end is connected to the distance perceiver 25 and the other end is connected to the lower part of the push tile 22. The distance perceiver 25 receives from the second spring 23 a signal that is the result of extending the second 23 spring. The signal received varies between a value that corresponds with the maximum number of cartridges 21 that can be stored in a magazine 29 and a value that corresponds to the minimum number of cartridges 21 stored in the magazine 29. The signal received by the distance perceiver 25 is converted into an electric signal that is sent to the microprocessor, which transforms it into a count visible on the display 13 shown in FIG. 3.

[0015] In FIG. 2, the perceiver 25 determines distance using an infrared beam, i.e., the variation of tile 22 position is calculated using an infrared light emitting diode 33 that emits an infrared signal reflected by the underside of the tile 22, and received by a receiving diode 34. Both diodes 33, 34 are connected to the distance perceiver 25. Consequently, the signal received by the distance perceiver 25 from the receiving diode 34 is the result of the distance between tile 22 and the magazine 29 base 28. The signal received varies between a value that corresponds with the maximum number of cartridges 21 that can be stored in the magazine 29 and a value that corresponds with the minimum number of cartridges 21 stored in the magazine 29.

[0016] In FIG. 2, the tile 22 includes a reflecting surface on its underside, suitable to reflect an infrared light beam. Both the projected and reflected beam travel through an empty space between the spirals of the first 24 spring with no elements external to the system interfering in their course. The distance perceiver 25 transforms the signal received into an electric signal that is sent to the microprocessor, which turns it into a count visible on the display 13 shown in FIG. 3.

[0017] In the above embodiments, the design of the firearm must be altered to add the display 13. Requiring such alteration adds to the cost of the firearm. Retrofitting existing firearms with such a display could be difficult, as well as costly, if not impossible.

[0018] Also in the above embodiments, several components of the magazine must be redesigned or new components added. Retrofitting existing magazines, if

possible, would be extensive and costly. It likely that existing magazines would be discarded and completely new magazines required. Such new magazines would have distance measuring and counter parts distributed throughout. Failure of any such parts could cause the counter to fail. Since the parts are distributed throughout the magazine, it is likely the entire magazine would have to be replaced. Reliability can be low in such prior art magazines, as debris can be easily introduced into the magazine and cause failure of mechanical or optical components.

SUMMARY

10 [0019] In accordance with various aspects of the present invention, a load-sensing cartridge counter is provided that does not require alteration or redesign of the firearm. The load sensing cartridge counter is implemented within a magazine base, in a simple design. As a result, if the counter fails, preferably only the base needs replacing. In preferred embodiments, the base fits on existing magazines, so users do not have to discard existing magazines in favor of completely new load-sensing magazines or firearms.

15 [0020] In accordance with one aspect of the present invention, provided is a load-sensing magazine for use with a firearm. The load sensing magazine includes a shell configured to hold a plurality of cartridges, a first end of the shell configured to couple to the firearm; a push tile within the shell and configured to receive a cartridge from the plurality of cartridges; a biasing element that biases the push tile toward the shell first end to load the cartridge into a chamber of the firearm; a base enclosing a second end of the shell, the base comprising a load sensor that senses a load applied by the biasing element and outputs a load sensing signal; and a cartridge counter, coupled to the load sensor, that uses the load sensing signal to determine a number of cartridges in the magazine.

25 [0021] The load-sensing magazine can further include an output device that outputs an indication of the number of cartridges.

[0022] The load sensor can be a strain-gauge load cell.

[0023] In accordance with another aspect of the invention, provided is a load-sensing base for use with a firearm magazine that includes a support element that moves a push tile toward a shell first end to load a cartridge into a chamber of the firearm. The base includes a load sensor that senses a load applied by the support
5 element and outputs a load sensing signal, and also includes a cartridge counter, coupled to the load sensor, that uses the load sensing signal to determine a number of cartridges remaining.

[0024] The base can further include an output device that outputs an indication of the number of cartridges remaining.

10 [0025] The output device can include a display that displays the number of cartridges.

[0026] The display can be a digital number display.

[0027] The brightness and wavelength of illumination of the display can be altered to suit ambient lighting and users requirements.

15 [0028] The variation of display illumination can be made to occur automatically, or in response to user input.

[0029] The output device can include an audio device that outputs the indication of the number of cartridges as an audio output.

20 [0030] The audio device can output the audio output as a number corresponding to the number of cartridges.

[0031] The output device can include an actuator that selectively enables or disables the audio output.

[0032] The output device can be configured to output the indication of the number of cartridges or other signal when the number of cartridges in the firearm or
25 magazine is at or below a threshold number.

[0033] A tactile transducer, such as a vibrating device can be included to alert the user silently that the number of cartridges in the firearm or magazine is at or below a threshold number.

[0034] The number of cartridges can include one or more cartridges in the chamber and cartridges in the magazine.

[0035] The cartridge counter can be configured to count a number of cartridges fired from the firearm.

5 [0036] The cartridge counter can use a predetermined load-to-cartridge relationship to determine the number of cartridges.

[0037] The cartridge counter can use a combination of a count of cartridges loaded and/or fired and a predetermined load-to-cartridge relationship to determine the number of cartridges.

10 [0038] In accordance with another aspect of the present invention, provided is a method of determining a number of cartridges in a firearm. The method includes sensing a load applied by an element supporting cartridges within a magazine; generating a load sensing signal in response to the sensed load; determining a number of cartridges remaining from the load sensing signal; and outputting an
15 indication of the number of cartridges.

[0039] A predetermined load-to-cartridge relationship can be used to determine the number of cartridges.

[0040] A combination of a predetermined load-to-cartridge relationship and a count of cartridges loaded and/or fired can be used to determine the number of
20 cartridges.

[0041] The method can further include outputting the indication via an output device.

[0042] Outputting the indication can include generating a display representing the indication.

25 [0043] Outputting the indication can include generating an audio output representing the indication.

[0044] The method can further include selectively enabling and disabling the outputting.

[0045] The method can include providing the output or other signal when the number of cartridges in the magazine is at or below a threshold number.

[0046] The signal provided when the number of cartridges in the magazine is at or below a threshold number may be a silent tactile signal, such as a vibration.

5 [0047] Determining the number of cartridges remaining can include determining one or more cartridges in the chamber and cartridges in the magazine.

[0048] The method can further include determining a number of cartridges fired.

[0049] The method can include a calibration sequence performed during
10 loading, unloading, or firing of the firearm, at a time chosen automatically, or in response to specific user input.

BRIEF DESCRIPTION OF THE DRAWINGS

[0050] The present invention will become more apparent in view of the
15 attached drawings and accompanying detailed description. The embodiments depicted therein are provided by way of example, not by way of limitation, wherein like reference numerals refer to the same or similar elements. The drawings are not necessarily to scale, emphasis instead being placed upon illustrating aspects of the invention. In the drawings:

20 [0051] FIG. 1 shows a section perspective view of a prior art magazine from US Pat. Pub. 20080276517;

[0052] FIG. 2 shows a section perspective view of another prior art magazine from US Pat. Pub. 20080276517,

[0053] FIG. 3 is a perspective view of a prior art handgun, as an example of a
25 firearm specially designed to use the magazines of FIGS. 1 and 2;

[0054] FIG. 4 is a perspective view of an embodiment of magazine in accordance with aspects of the present invention; and

[0055] FIG. 5 is a perspective view of a handgun, as an example of a firearm, with which the magazine of FIG. 4 can be used.

[0056] FIG. 6 is a block diagram of the functional elements of an embodiment of the base (50) of FIG. 4.

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DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0057] Hereinafter, aspects of the present invention will be described by explaining illustrative embodiments in accordance therewith, with reference to the attached drawings. While describing these embodiments, detailed descriptions of well-known items, functions, or configurations are typically omitted for conciseness.

[0058] It will be understood that, although the terms first, second, etc. are used herein to describe various elements, these elements should not be limited by these terms. These terms are used to distinguish one element from another, but not to imply a required sequence of elements. For example, a first element can be termed a second element, and, similarly, a second element can be termed a first element, without departing from the scope of the present invention. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

[0059] It will be understood that when an element is referred to as being "on" or "connected" or "coupled" to another element, it can be directly on or connected or coupled to the other element or intervening elements can be present. In contrast, when an element is referred to as being "directly on" or "directly connected" or "directly coupled" to another element, there are no intervening elements present. Other words used to describe the relationship between elements should be interpreted in a like fashion (e.g., "between" versus "directly between," "adjacent" versus "directly adjacent," etc.).

[0060] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the invention. As used herein, the singular forms "a," "an" and "the" are intended to include the plural forms as well,

unless the context clearly indicates otherwise. It will be further understood that the terms "comprises," "comprising," "includes" and/or "including," when used herein, specify the presence of stated features, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other
5 features, steps, operations, elements, components, and/or groups thereof.

[0061] Spatially relative terms, such as "beneath," "below," "lower," "above," "upper" and the like may be used to describe an element and/or feature's relationship to another element(s) and/or feature(s) as, for example, illustrated in the figures. It will be understood that the spatially relative terms are intended to
10 encompass different orientations of the device in use and/or operation in addition to the orientation depicted in the figures. For example, if the device in the figures is turned over, elements described as "below" and/or "beneath" other elements or features would then be oriented "above" the other elements or features. The device may be otherwise oriented (e.g., rotated 90 degrees or at other orientations) and the
15 spatially relative descriptors used herein interpreted accordingly.

[0062] FIG. 4 shows an embodiment of a magazine 100 in accordance with aspects of the present invention. Like magazine 29 of FIGS 1 and 2, magazine 100 is configured to hold cartridges 21 that are pushed upward away from a base by a spring 24 and push tile 22. A shell 27 encases the cartridges 21, spring 24, and
20 push tile 22 – which are all part of a conventional magazine.

[0063] However, unlike conventional magazines, magazine 100 includes a base 50 that has a load sensor 52. The load sensor can be, as an example, a strain gauge load cell. In other embodiments, the load sensor can be or include a piezoelectric load sensor. Load sensor 52 is disposed within the base 50 to have a
25 bottom end of the spring 24, opposite the push tile 22, apply a force thereto. The amount of force exerted on load sensor 52 is related to the number of cartridges 21 in the magazine 100. The more cartridges 21 in magazine 100, the greater the force exerted by spring 24 on load sensor 52.

[0064] A cartridge counter 54 is also included in base 50. The cartridge counter 54, which includes a processor or microprocessor 60 and memory 61, is configured to receive a load sensing signal from load sensor 52 and to translate that
30

signal into a number of cartridges 21 remaining in the magazine 29. Translating the load sensing signal into a number of cartridges can include using a predetermined load-to-cartridge relationship stored in the memory of the cartridge counter. The relationship can be the same for magazines of the same type, and different for magazines of different types.

[0065] Suitable circuitry, according to known principles, may be used to couple the load sensor 52 to the processor 60. This may include an amplifier/signal conditioner 57, and an analog to digital converter 58.

[0066] The processor 60 may use known principles to improve the accuracy of the translation of sensed load into cartridge count. For example, the processor 60 may be programmed to average a succession of counts, to implement digital filtering of the sensed data, or to employ stochastic or "fuzzy logic" principles.

[0067] The loading or firing of a cartridge may also be detected by a change of the signal from the load sensor 52. The processor 60 may also use this information in determining the the cartridge count.

[0068] As the mechanical force exerted by the spring 24 may be altered by large variations in temperature, a temperature sensor 65 can be included to introduce a compensation factor into the determination of the cartridge count.

[0069] The cartridge counter 54 can also be configured to keep a history of shots fired, which may or may not include a time and a date of the firing of each cartridge. Cartridge counter 54 can keep this history for magazines on an individual basis, for the gun across multiple magazines, or both.

[0070] The base 50 can output the number of cartridges, or other data or information that cartridge counter 54 stores or generates, to a memory, a graphical display, an audio output, a wireless transmitter, a data port, or some combination thereof. One or more of these output types can be represented by output device 56.

[0071] The output device 56 can be or include a display 62, for example, an LCD display or LED display. The output device 56 can be or include an audio device, for example, a speaker. As a data port, the output device could include a

USB port or Firewire, as examples. As a wireless transmitter, the output device could include a radio frequency (RF) transmitter, Wi-Fi transmitter (e.g., Bluetooth), cellular transmitter, or other wireless transmitter.

[0072] The output device 56 can include a sensor 64 to determine the level of ambient lighting, so that the processor 60 can adjust the illumination level of the display 62 to a suitable level. The sensor 64 can, for example, be a phototransistor or light-dependant-resistor. The brightness may be adjusted continuously, or in discrete steps. User input from the user input actuator 59 may also be used in determining or adjusting the brightness level.

[0073] The illumination device 66 of the display 62 can be made to selectively provide a choice of colors or wavelengths of light. This may be done according to well-known principles by selectively illuminating LED light sources used to illuminate the display. For example, a first LED 67 may illuminate the display at 600nm for use by the unaided eye. A second LED 68 may illuminate the display at 800nm for use with night-vision equipment. The selection of wavelength may be made through the user input actuator 59.

[0074] As an example, a numeric display can output a number indicating the number of cartridges remaining in the firearm or magazine. Also as an example, an audio output can output a number indicating the number of cartridges remaining in the firearm or magazine. If the output device 56 includes a display or audio output, in various embodiments the base can include an actuator 59 that selectively enables or disables the display output, audio output, or both - such as a switch or button. In some embodiments, the actuator can be, for example, a button that causes output of the number of cartridges remaining when it is pressed. Such a button could also be used to calibrate the cartridge counter, e.g., when the magazine is refilled with cartridges, or to select user options such as display brightness or threshold counts.

[0075] The output device can be configured to output the number of cartridges or other signal via display, audio output, or both when the number of cartridges in the firearm or magazine is at or below a threshold number, e.g., 25% of the cartridges remain. For example, the display could flash when the number of remaining cartridges is at or below the threshold. As another example, a low tone can be

output from an audio output when the number of remaining cartridges is at or below the threshold. In some embodiments, there can be multiple thresholds, and there can be a different graphical, audio, or both output for each threshold. For example, there could also be a threshold for the situation where there is one cartridge remaining.

[0076] The output device 56 may also include a tactile transducer 63, such as a small motor with an eccentric weight, which can silently produce a vibration or other tactile sensation to alert the user when the remaining cartridge threshold is reached.

[0077] In order to conserve battery power, the cartridge counter 54 can be configured to turn off the output device 56, and to employ other well known power-saving measures, such as processor "sleeping," when the magazine is idle (not in the process of being loaded or fired). The cartridge counter 54 may furthermore be configured to restore power to the display and return to normal operation on a sudden change of reading from the load sensor 52, such as from loading a cartridge 21, discharging the firearm, or striking the base 50 with the hand. The cartridge counter may also be configured to restore power through detection of biometric information, such as reading a thumb print of an authorized user, e.g., using a known thumb print reader.

[0078] The output device 56 may be configured to display some indication other than "0" when the magazine is empty, so that the user will not be deceived into thinking the firearm itself is empty when a cartridge 21 may still be present in the firing chamber. The indication "Ch", for "Chamber" may be shown, for example.

[0079] While the foregoing has described what are considered to be the best mode and/or other preferred embodiments, it is understood that various modifications can be made therein and that the invention or inventions may be implemented in various forms and embodiments, and that they may be applied in numerous applications, only some of which have been described herein. It is intended by the following claims to claim that which is literally described and all equivalents thereto, including all modifications and variations that fall within the scope of each claim.

CLAIMS

What is claimed is:

1. A load-sensing magazine for use with a firearm, comprising:
 - 5 a shell configured to hold a plurality of cartridges, a first end of the shell configured to couple to the firearm;
 - a push tile within the shell and configured to receive a cartridge from the plurality of cartridges;
 - a biasing element that biases the push tile toward the shell first end to load
10 the cartridge into a chamber of the firearm;
 - a base enclosing a second end of the shell, the base comprising a load sensor that senses a load applied by the biasing element and outputs a load sensing signal; and
 - a cartridge counter, coupled to the load sensor, that uses the load sensing
15 signal to determine a number of cartridges in the magazine.
2. The load-sensing magazine of claim 1, further comprising:
 - an output device that outputs an indication of the number of cartridges.
- 20 3. The load-sensing magazine of claim 2, wherein the output device is configured to alter the brightness and wavelength of illumination of the display.
4. The load-sensing magazine of claim 3, wherein the output device is
25 configured to automatically alter the brightness and wavelength of illumination of the display.
5. The load-sensing magazine of claim 3, wherein the output device is
configured to alter the brightness and wavelength of illumination of the display in
response to a user input.
- 30 6. The load-sensing magazine of claim 1, wherein the output device includes:
 - a tactile transducer that causes a vibration to alert the user silently that the
number of cartridges is at or below a threshold number.

7. The load-sensing magazine of claim 1, wherein the load sensor is a strain-gauge load cell.
8. A load-sensing base for use with a firearm magazine that includes a support element that moves a push tile toward a shell first end to load a cartridge into a chamber of the firearm, the base comprising:
a load sensor that senses a load applied by the support element and outputs a load sensing signal; and
a cartridge counter, coupled to the load sensor, that uses the load sensing signal to determine a number of cartridges remaining.
9. The base of claim 8, further comprising:
an output device that outputs an indication of the number of cartridges remaining.
10. The base of claim 9, wherein the output device includes a display that displays the number of cartridges.
11. The base of claim 10, wherein the display is a digital number display.
12. The base of claim 9, wherein the output device includes an audio device that outputs the indication of the number of cartridges as an audio output.
13. The base of claim 12, wherein the audio device outputs the audio output as a number corresponding to the number of cartridges.
14. The base of claim 9, wherein the output device includes an actuator that selectively enables or disables the audio output.
15. The base of claim 9, wherein the output device is configured to output the indication of the number of cartridges or other signal when the number of cartridges in the firearm or magazine is at or below a threshold number.
16. The base of claim 15, wherein the output device includes:

a tactile transducer that causes a vibration to alert the user silently that the number of cartridges is at or below the threshold number.

- 5 17. The base of claim 9, wherein the output device is configured to alter the brightness and wavelength of illumination of the display.
18. The base of claim 17, wherein the output device is configured to automatically alter the brightness and wavelength of illumination of the display.
- 10 19. The base of claim 17, wherein the output device is configured to alter the brightness and wavelength of illumination of the display in response to a user input.
20. The base of claim 8, wherein the load sensor is a strain-gauge load cell.
- 15 21. The base of claim 8, wherein the number of cartridges includes one or more cartridges in the chamber and cartridges in the magazine.
22. The base of claim 8, wherein the cartridge counter is configured to count a number of cartridges fired from the firearm.
- 20 23. The base of claim 8, wherein the cartridge counter uses a predetermined load-to-cartridge relationship to determine the number of cartridges.
24. A method of determining a number of cartridges in a firearm, comprising:
25 sensing a load applied by an element supporting cartridges within a magazine;
generating a load sensing signal in response to the sensed load;
determining a number of cartridges remaining from the load sensing signal;
and
30 outputting an indication of the number of cartridges.
25. The method of claim 24, wherein a predetermined load-to-cartridge relationship is used to determine the number of cartridges.

- 26 The method of claim 24, further comprising:
 outputting the indication via an output device.
27. The method of claim 26, wherein outputting the indication includes generating
5 a display representing the indication.
28. The method of claim 27, wherein the display includes a number of cartridges.
29. The method of claim 26, wherein the display brightness is variable.
- 10 30. The method of claim 26, wherein outputting the indication includes causing a
 vibration of the firearm.
- 15 31. The method of claim 26, wherein outputting the indication includes generating
 an audio output representing the indication.
- 20 32. The method of claim 26, wherein the method includes providing the output or
 other signal when the number of cartridges in the shell is at or below a threshold
 number.
- 25 33. The method of claim 24, wherein determining the number of cartridges
 remaining includes determining one or more cartridges in the chamber and
 cartridges in the magazine.
34. The method of claim 24, further comprising:
 determining a number of cartridges fired.

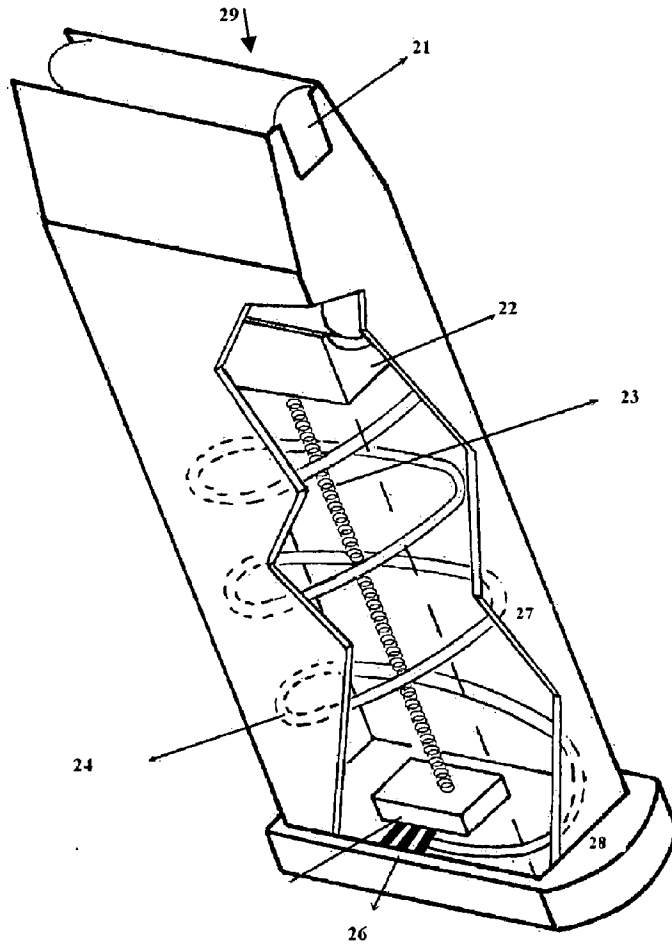


FIG. 1 (Prior Art)

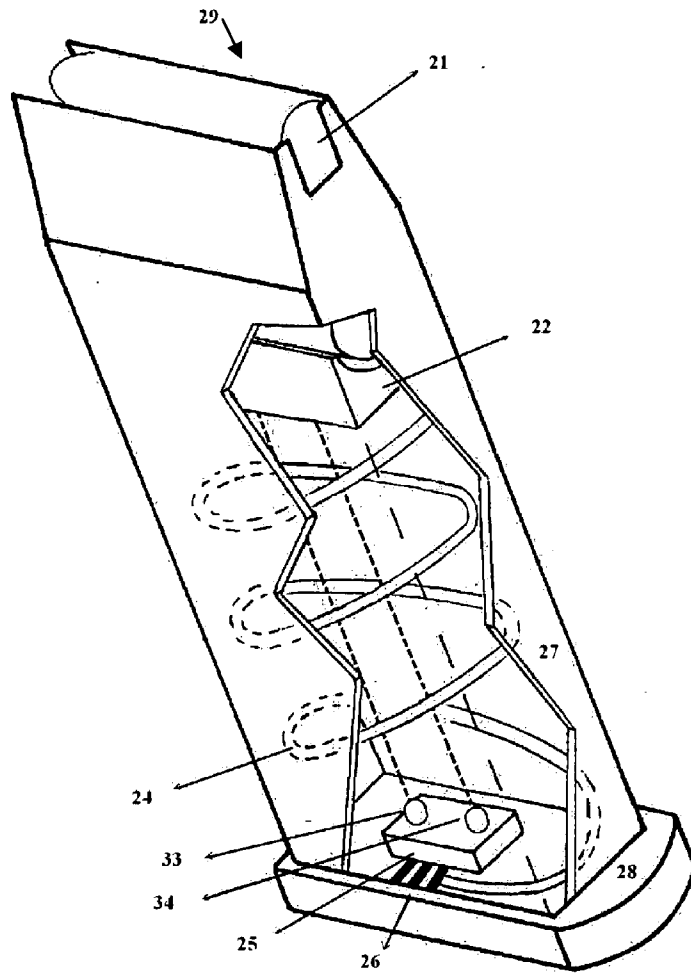


FIG. 2 (Prior Art)

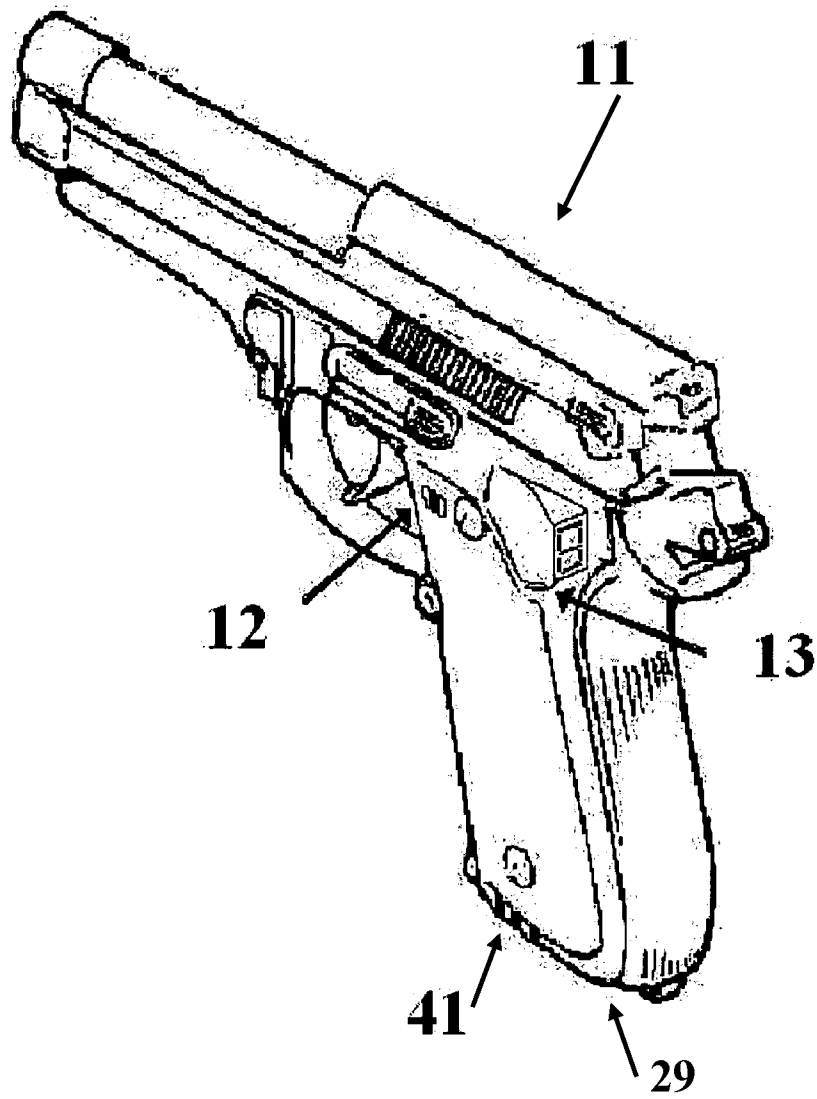


FIG. 3 (Prior Art)

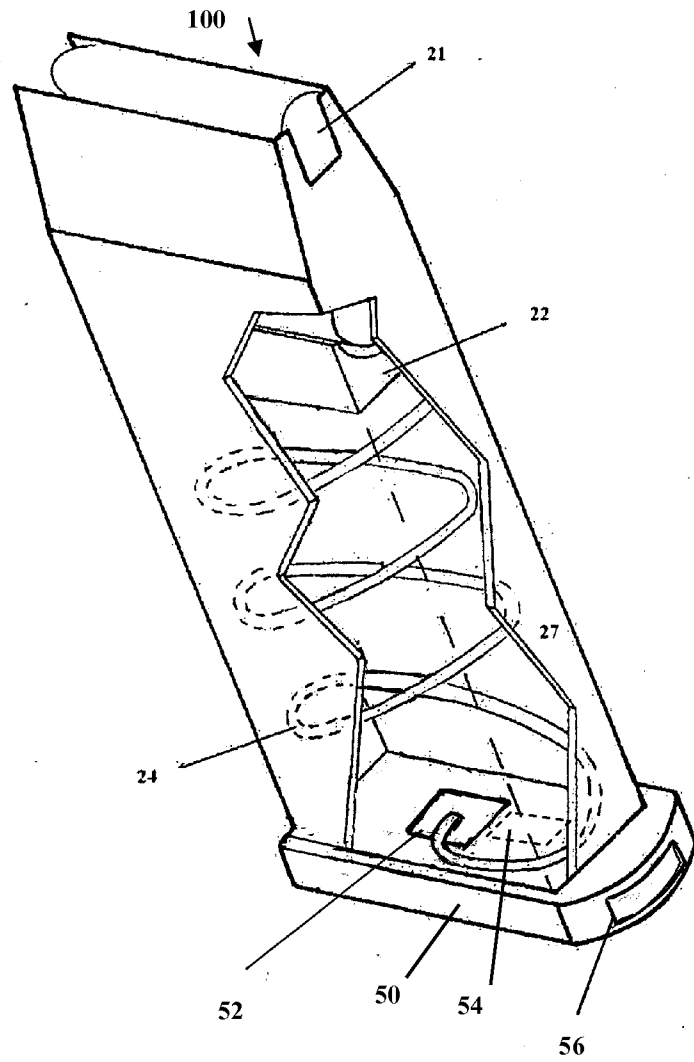


FIG. 4

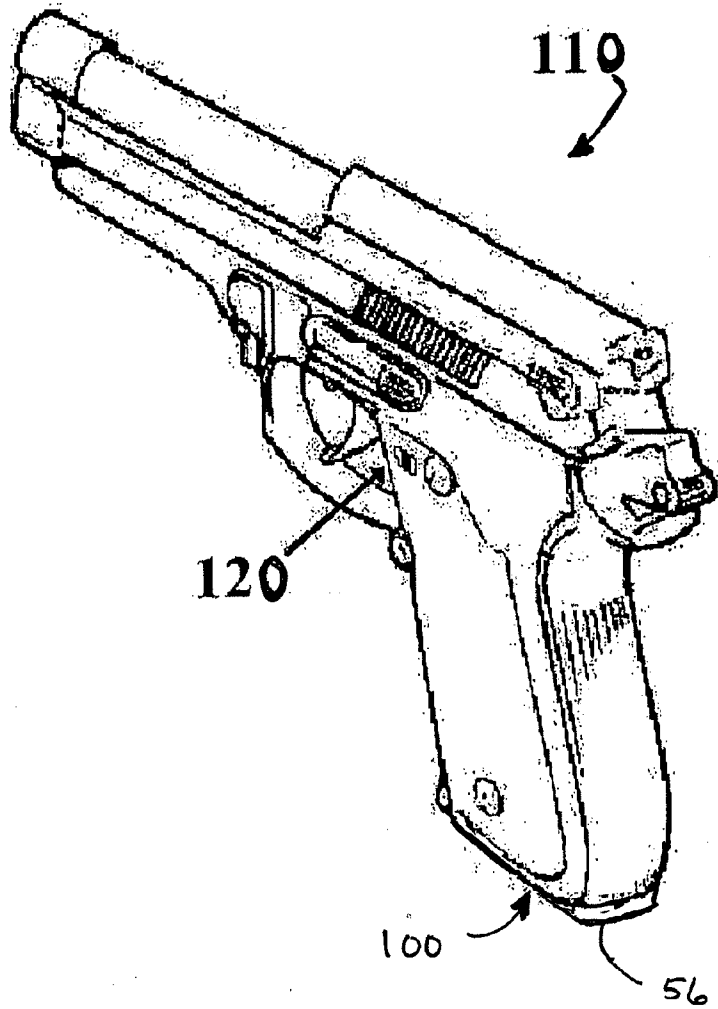


FIG. 5

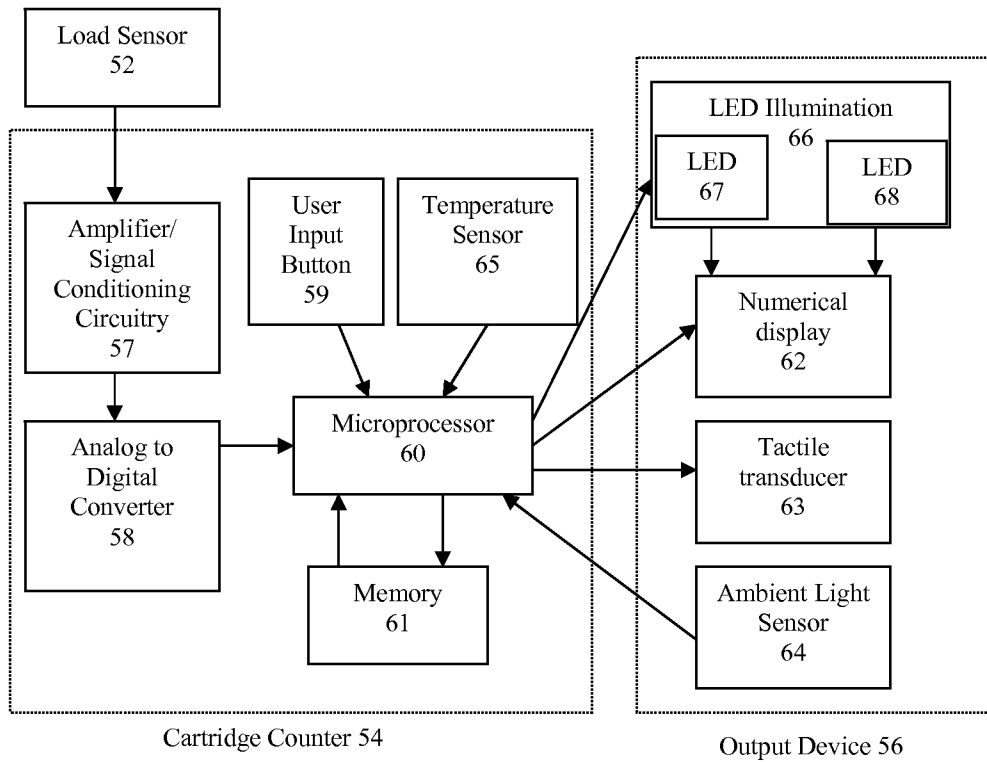


FIG. 6