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Integrated wireless slot antenna and piezo buzzer

Jerry W. Kuo

David W. Poole

Andrew J. Sutter

Wei Li

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ABSTRACT

Home security products such as smoke detectors, intrusion detectors, etc. are often wirelessly connected, and also feature buzzers that produce audio alarms. This disclosure describes techniques to integrate the buzzer and the wireless antenna, thereby enabling more compact security products.

KEYWORDS

- Home security
- Security camera
- Smoke detector
- Internet-of-Things (IoT)
- Piezo buzzer
- Slot antenna
- Piezo disk

BACKGROUND

Home security products such as smoke detectors, intrusion detectors, etc., internet-of-things (IoT) products, and health-monitoring products are often wirelessly connected, and also feature buzzers that produce audio alarms. To achieve compactness, the buzzers are made using piezo disks, e.g., disks that vibrate to produce sound when electrically excited. Wireless connectivity is provided by a wireless modem connected to an antenna, e.g., using Wi-Fi. The antenna typically takes up a separate volume which can limit the compactness of the home security product.

DESCRIPTION

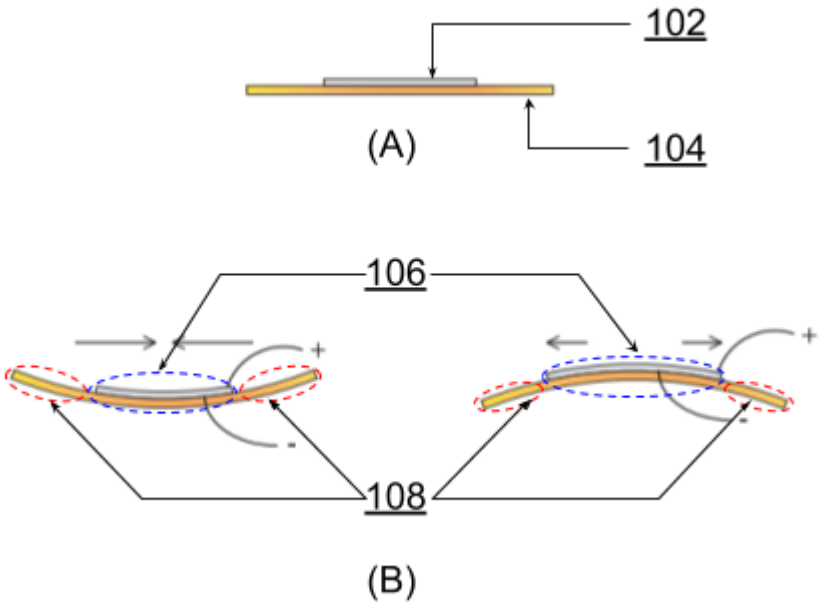

Fig. 1: Operation of a piezo buzzer, and proper placement of a slotted antenna therein

Fig. 1 illustrates the operation of a piezo buzzer. Fig. 1(A) illustrates a side view of a quiescent piezo buzzer. An electrical element (102) is coupled to a piezo disk (104). Fig. 1(B) illustrates the generation of sound waves from a piezo disk. The electrical element impresses an alternating voltage onto the piezo disk, causing the piezo disk to vibrate and produce sound waves. The central section of the piezo disk (106), marked in blue, is of importance to the production of sound. The peripheral regions of the disk (108), marked in red, are of lesser importance to the production of sound. The techniques of this disclosure leverage the peripheral regions to place a slotted antenna therein for wireless communication.

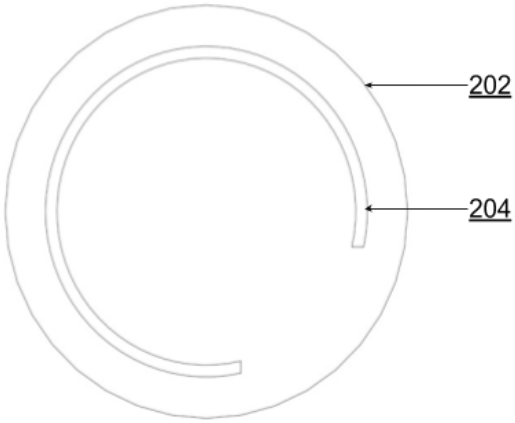

Fig. 2: A slotted antenna integrated onto a piezo disk

Fig. 2 illustrates the integration of a slotted antenna onto a piezo disk, per techniques of this disclosure. A C-shaped slot (204) is cut through the periphery of the piezo disk (202). The C-shaped slot acts as a radio-frequency slotted antenna. Since the piezo buzzer has no coil and no magnetic field (unlike a conventional speaker) and is not a significant emitter of radio-frequency energy, it does not interfere with the operations of the slotted antenna. Further, the width of the slot can be adjusted to achieve changes in resonant (audio) frequency. For example, wider widths correspond to slightly higher resonant frequencies (as compared to slot-less piezo disks).

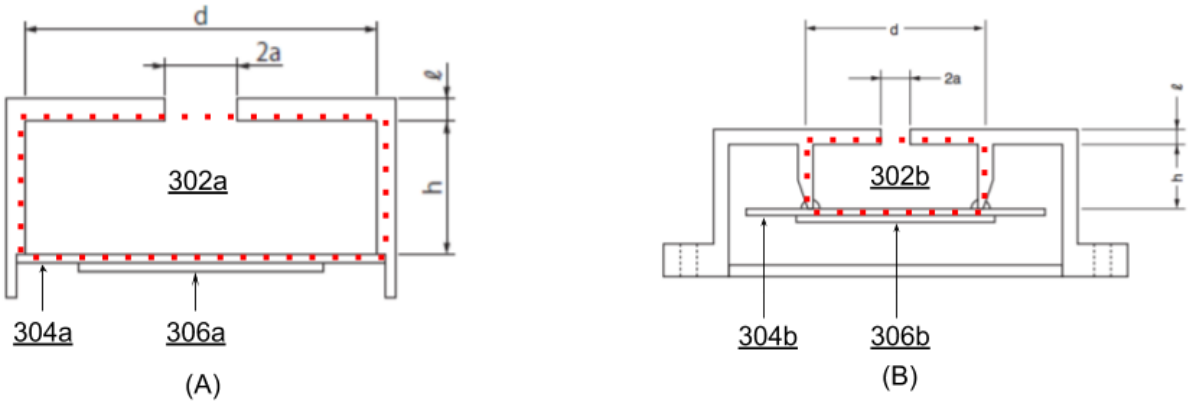

Fig. 3: Piezo buzzers within their cavity resonators, and proper placement of the slot antenna

Fig. 3 illustrates types of cavity resonators used to house piezo buzzers. Fig. 3(A) illustrates in cross-section an edge-supported piezo buzzer, in which the piezo disk (304a) is supported at its edges while being coupled to an electrical element (306a) and housed in a resonant cavity (302a). Fig. 2(B) illustrates in cross-section a nodal-supported piezo buzzer, in which the piezo disk (304b) is suspended within a resonant cavity (302b) while being coupled to an electrical element (306b). In either case, the boundaries of the cavity, marked in red, are left undisturbed, so as to resonate properly at the frequency of the piezo disk.

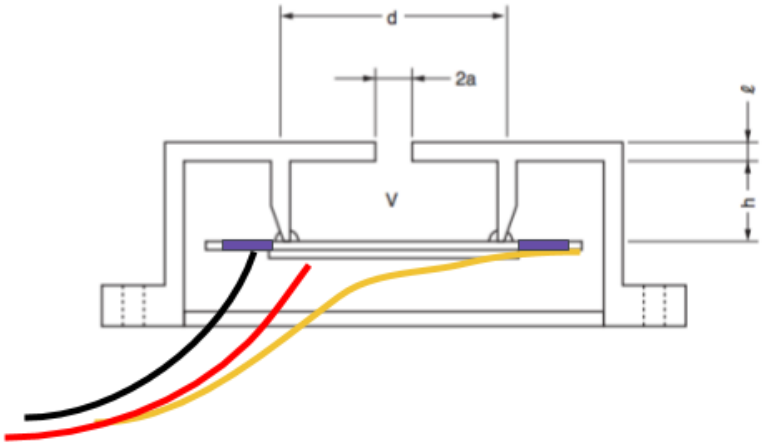

Fig. 4: Placement of the slotted antenna within a nodal-supported piezo buzzer

Thus, as illustrated for example in Fig. 4, the slot antenna can be placed in the purple region of the piezo disk of nodal-supported type, with the antenna pigtail (a cable connecting the source of the radio-frequency energy to the antenna), shown in yellow, being connected as illustrated. The black and red cables are electric inputs to the piezo disk for the purpose of producing sound.

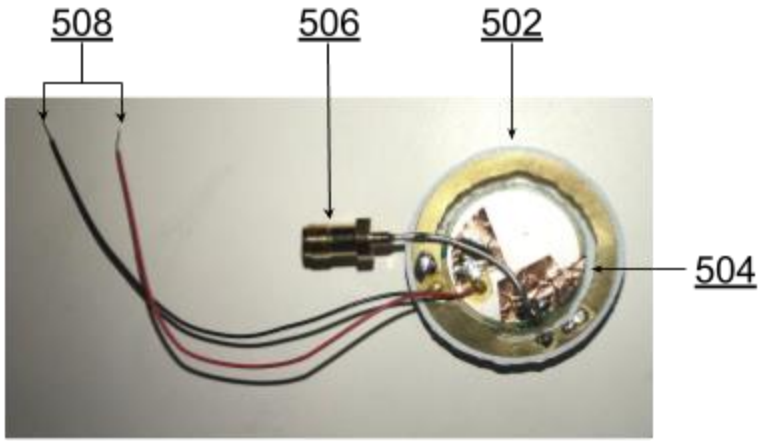

Fig. 5: A wireless antenna integrated with a piezo buzzer

Fig. 5 illustrates a wireless antenna integrated with a piezo buzzer. Cut through the piezo disk (502) is a wireless slot antenna (504). The antenna is fed by radio-frequency energy routed via an antenna pigtail (506), while the piezo buzzer is electrically excited via electrical leads (508).

CONCLUSION

This disclosure describes techniques to integrate a piezo buzzer with a wireless antenna, enabling more compact Internet-of-Things products, including, e.g., security camera, intrusion detection device, etc.