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(56) Documents Cited:
GB 2506862 A GB 2487576 A
FR 002743754 A1 US 20090021318 A1
US 20020079908 A1

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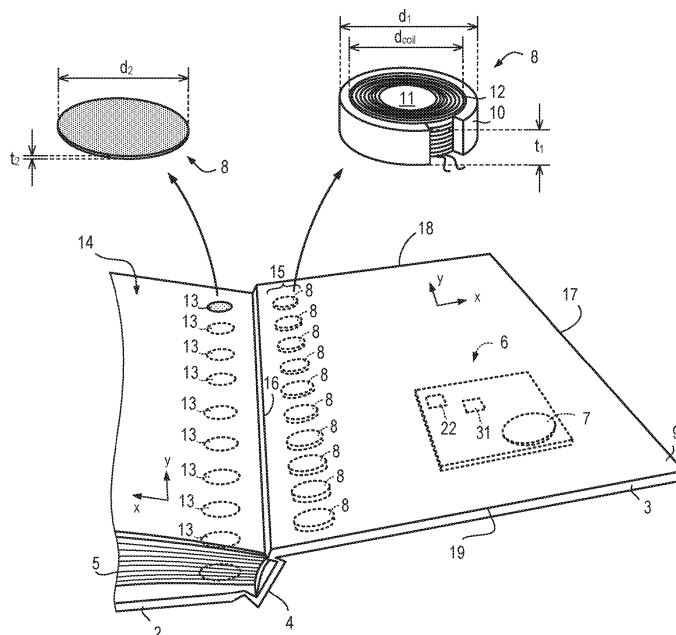
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(54) Title of the Invention: **Book**
Abstract Title: **Book with inductive sensors to detect open page**

(57) The second cover 3 has inductive proximity sensors 8 located adjacent the spine 4 and corresponding with metal pads 13 on the pages 5. The book has a controller 22 to determine using the sensors which page is open. The cover may have further sensors located away from the spine. The metal pads 13 may be circular, non-ferromagnetic or made of copper or aluminium. Preferably, the book has an output device 7 which outputs a signal dependent on the open page. Preferably the book also has a capacitive touch screen element inside of a cover which causes the output device 7 to output a signal dependent on the location of the user's finger on the touch screen. The output device 7 may be a speaker. The output device may comprise a wireless interface. Also disclosed is a method for energising and measuring the response from the sensor, which may be determining frequency or determining oscillation decay, to determine the open page.

Fig. 2



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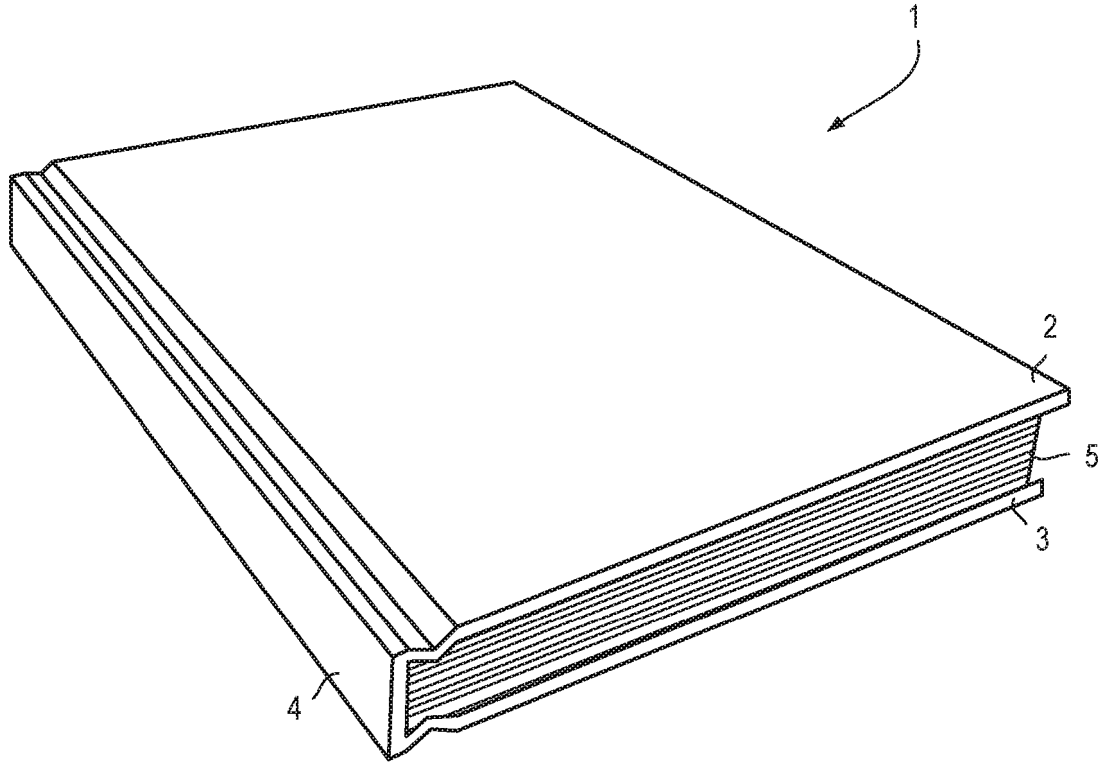


Fig. 1

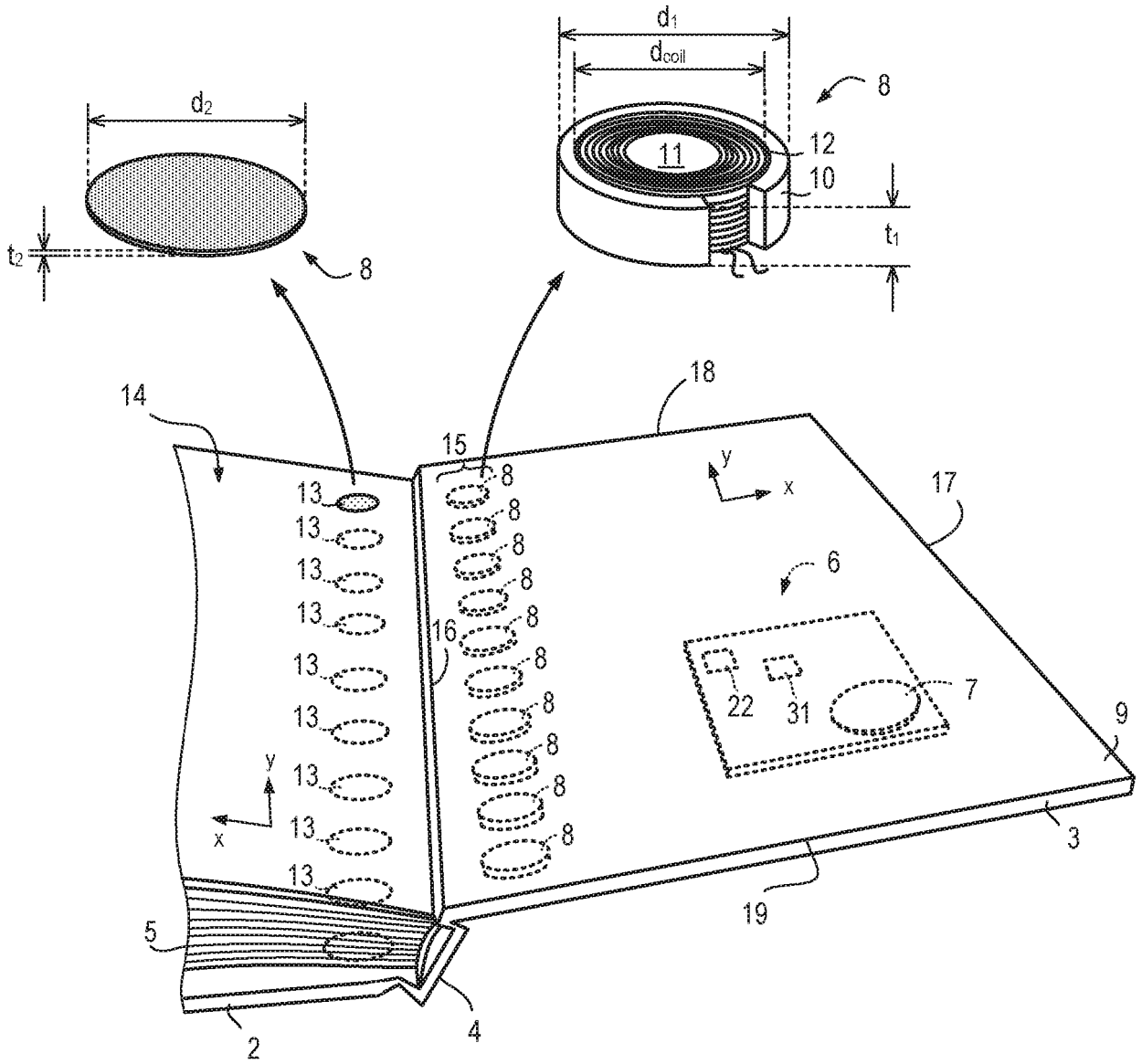


Fig. 2

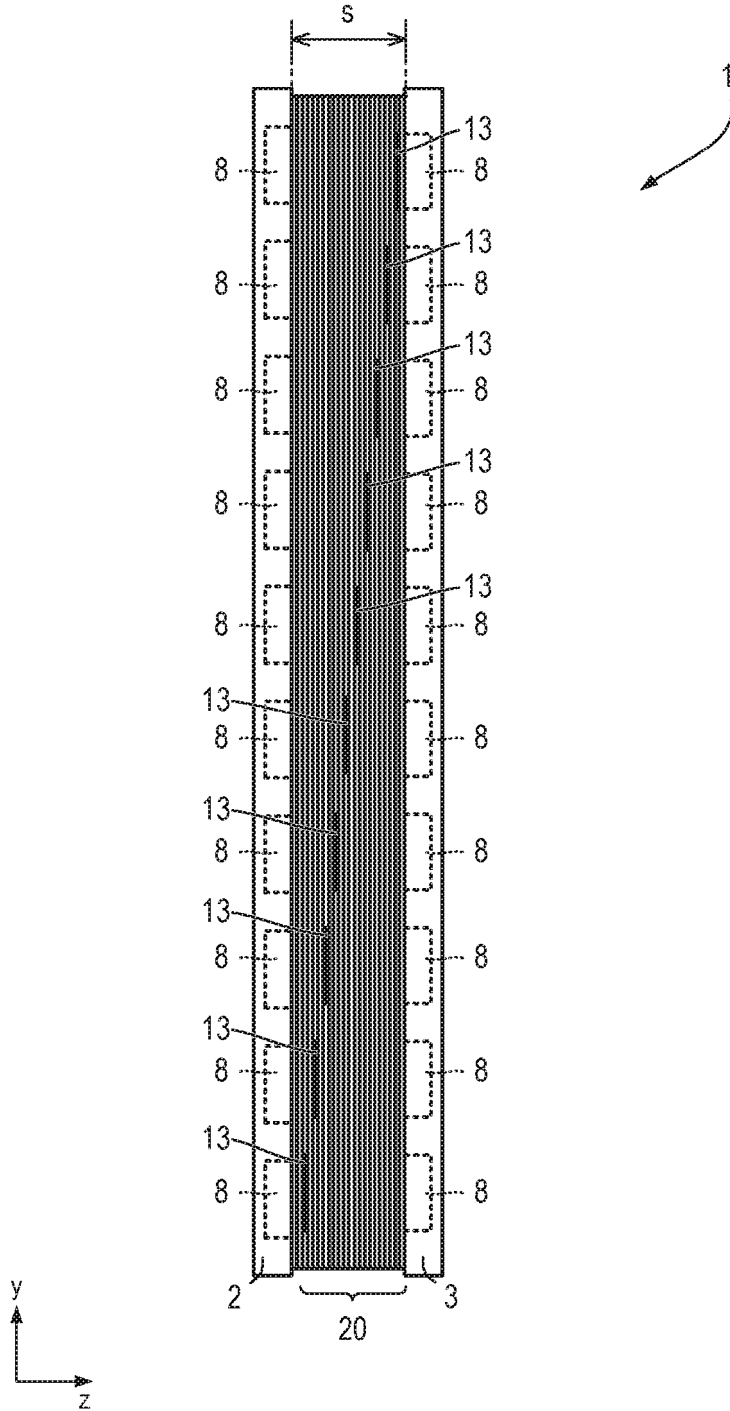


Fig. 3

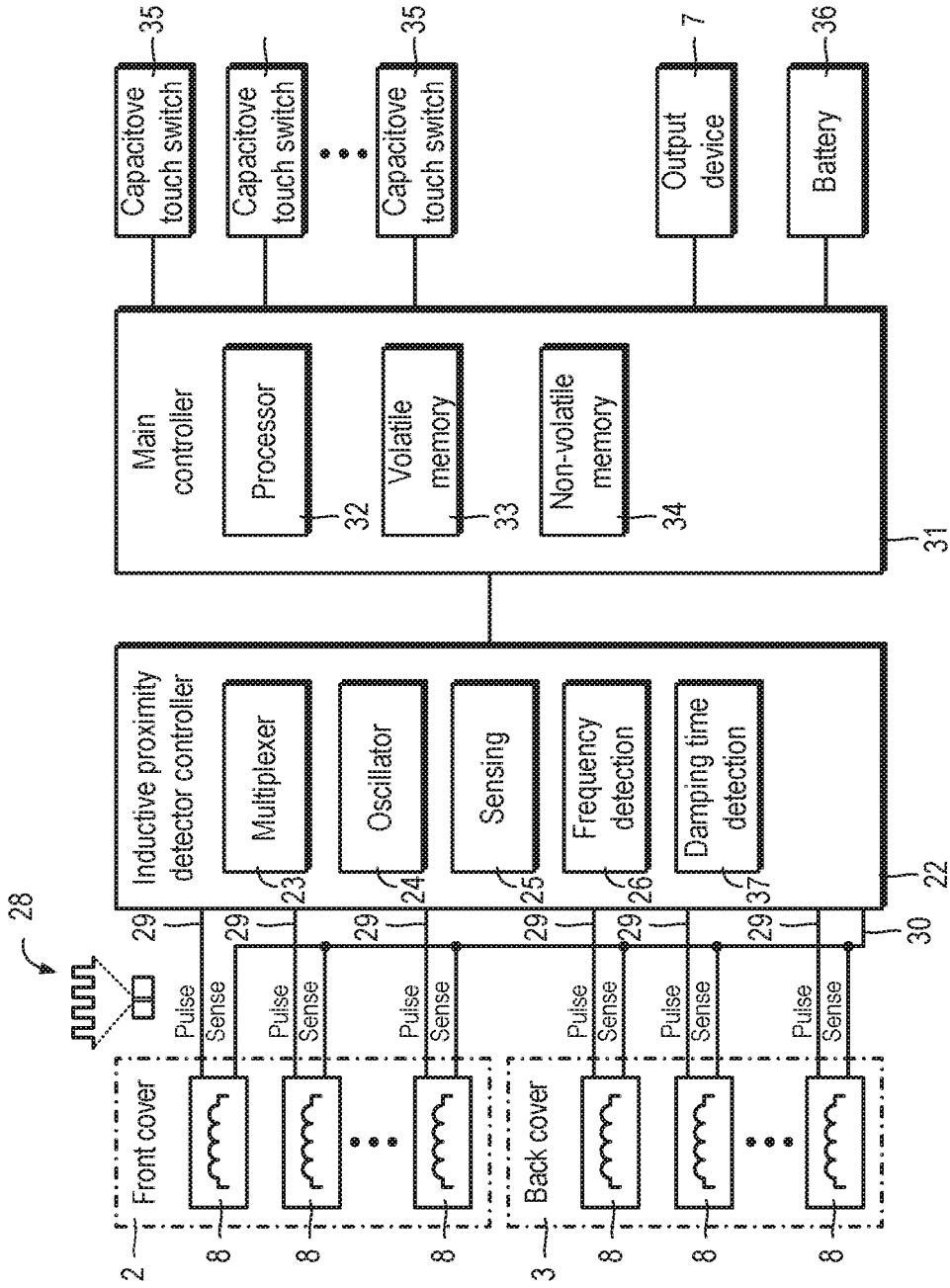


Fig. 4

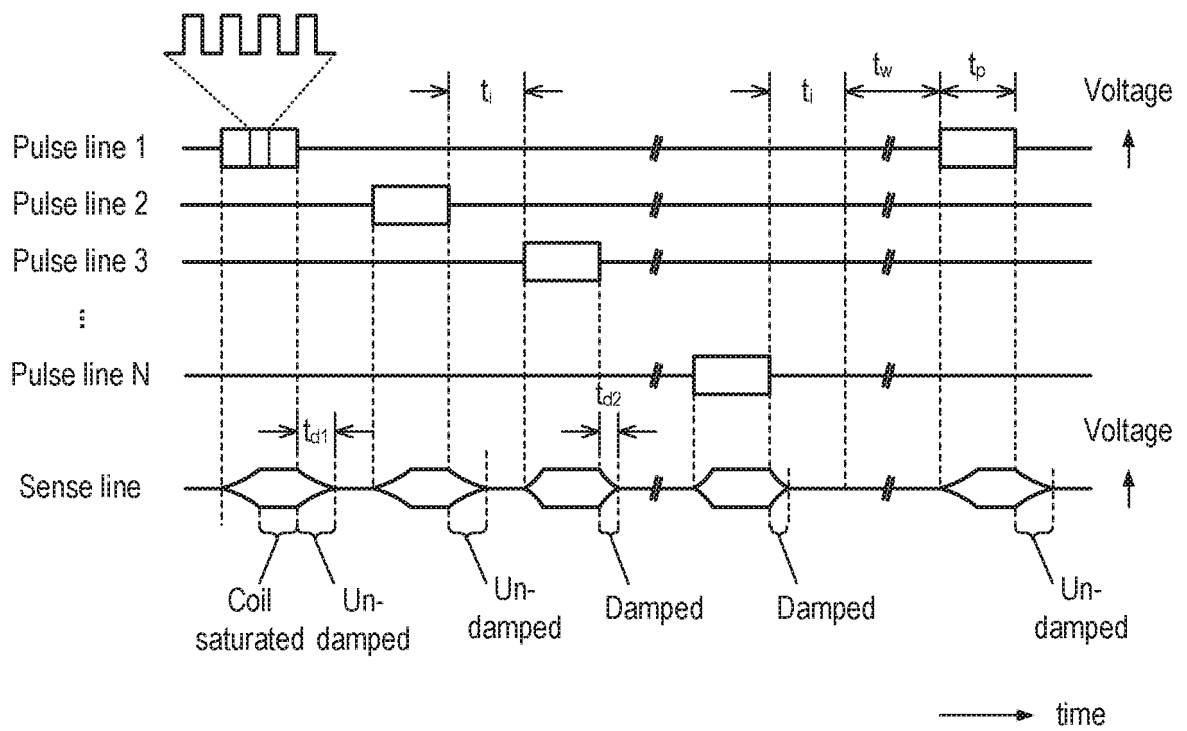


Fig. 5

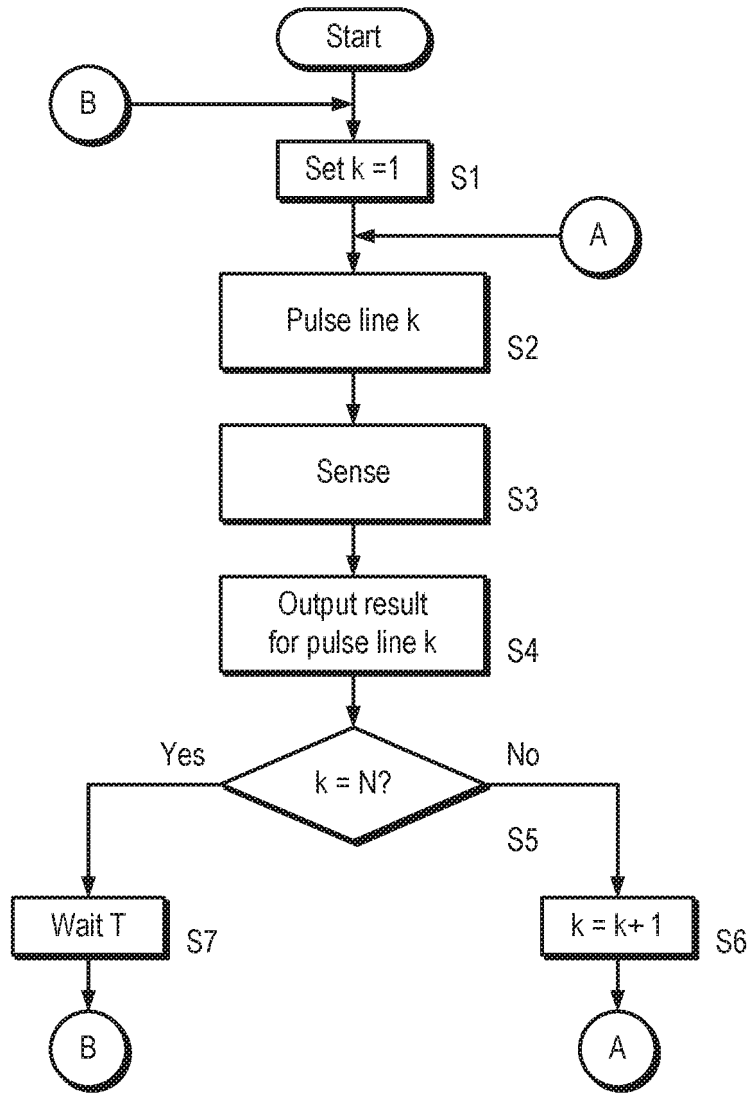


Fig. 6

Book

Field of the Invention

The present invention relates to a book.

5

Background

Electronic printed books, i.e. printed books which include electronic devices, are known.

10 GB 2 506 862 A1 describes a book having capacitive touch elements disposed inside a cover and which is provided with a controller and a loudspeaker. The controller causes the loudspeaker to output a signal in dependence upon position of a user's digit on a page overlying the cover. The position is detected by the capacitive touch elements. This allows the book to become interactive without the need to embed switches or
15 sensors into the pages.

The controller can determine the page being read by providing each page with a conductive pad, strip or pattern and encoding the page number using different respective patterns. The pattern is detected using the capacitive touch elements.

20

Other ways of determining page being read can be used.

For example, EP 0 609 048 A1 describes a book capable of determining the identity of a page using photo sensors provided in a back cover and apertures in pages.

25

FR 2 743 754 A1 describes a book which uses inductive detectors and conductive chips positioned on the pages.

Summary

According to a first aspect of the present invention there is provided a book. The book comprises first and second covers, a spine and a plurality of pages between the covers. The book also comprises inductive proximity sensors disposed in the second cover (for
5 example, the back cover) adjacent to the spine. The book further comprises a plurality of metal pads. A metal pad is provided on each respective page and is positioned so as to be aligned with a corresponding inductive proximity sensor when the page lies over the second cover. The book includes a controller configured to determine on which
10 page the book is open in dependence on response signals from the inductive proximity sensors.

The term “book” is intended to include any book-like printed matter including a booklet, notebook, exercise book etc. The pages may be fixed (or “bound”) between the covers. Thus, the book may be a typical paperback or hardback book. The pages may
15 be replaceable (or “loose leaf”). Thus, the book may be a ring binder or other form of file having a temporary paper-retaining mechanism.

The book can be a children’s book. The book may include images, such as line art, colour pictures, and/or photos. The book may include a significant number of images
20 and few words, i.e. be a picture book. The book may include musical notation.

The inductive proximity sensors may have a thickness no more than 4 mm. The inductive proximity sensors may have a diameter no more than 10 mm. The inductive proximity sensors may lie within 20 mm of the spine. The inductive proximity sensors
25 may have a pitch (i.e. centre-to-centre spacing) of at least 10 mm. The inductive proximity sensors may have a pitch of no more than 50 mm.

The book may further comprise inductive proximity sensors disposed away from the spine, for example, along an edge of the cover. The inductive proximity sensors may be
30 disposed as an array across the cover.

The metal pads may have a thickness of at least 50 µm. The metal pads may have a width or diameter of at least 5 mm. The metal pads may have a width or diameter of no more than 20 mm. The metal pads may be circular. The metal pads may comprise
35 a non-ferromagnetic material, such as aluminium or copper. The metal pads may be attached to the page by an adhesive or tape. The metal pads preferably do not comprise

a conductive ink. The metal pads may be embedded in the pages. For example, each page may comprise a laminate of two or more sheets and a metal page may be sandwiched between two sheets.

5 The pages may comprise a fibre-based material, such as paper, card or board. The pages may comprise a plastic material. The pages may comprise a laminate. The laminate may comprise first and second sheets. The first sheet may comprise a fibre-based material. The second sheet may comprise a plastic material.

10 The book has a text block (i.e. comprising the pages) having thickness no more than a detection range of the inductive proximity sensors, for example, no more than 5 mm, no more than 4 mm or no more than 3 mm thick. The text block may have a thickness no more than twice the detection range of the inductive proximity sensors, for example, no more than 10 mm, no more than 8 mm or no more than 6 mm.

15

The book may include an array of capacitive touch elements disposed on the inside of a cover (for example, the back cover) and at least one output device (such as a loudspeaker. The controller is operatively connected to the array and the output device(s). The controller is configured to cause the output device or at least one of the
20 output devices to output a signal in dependence upon position of a user's digit on a page overlying the cover. The position is detected by the capacitive touch elements.

The at least one output device may include a speaker. The speaker may be piezoelectric speaker or other form of low-profile speaker. Thus, the signal can be speech and/or
25 other form of sound. The at least one output device may include an interface for outputting an audio signal. The interface may be a wireless interface, such as Bluetooth (RTM) transmitter or transceiver. Thus, sound or image can be transmitted to a remote device, such as headset, mobile communication device (for example, a smart phone), computer (for example, a tablet computer), television set or smart board.

30

According to a second aspect of the present invention there is provided a method of determining on which page a book is open, the method comprising applying an energising signal to a coil of an inductive proximity sensor, measuring a response signal from the coil and determining whether a metal pad is within range of the sensor.

35

The method may comprise measuring a response signal after applying the energising signal.

5 Determining whether a metal pad is within range of the sensor may comprise determining a frequency or period of an oscillation. Determining whether a metal pad is within range of the sensor may comprise determining a time or number of oscillations for the oscillations to decay.

10 The method may comprise applying an energising signal to each one of a plurality of coils of respective inductive proximity sensors in turn.

The method may further comprise receiving signals indicative of position of a user's digit on a page of book and causing at least one output device to output a signal in dependence upon the position of the user's digit on a page overlying the cover. The
15 method may be performed by a microcontroller.

According to a third aspect of the present invention there is provided a computer program which, when executed by a playback device comprising an output device, causes the playback device to perform the method.

20

According to a fourth aspect of the present invention there is provided a computer readable medium storing the computer program.

Brief Description of the Drawings

Certain embodiments of the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a perspective view of a book;

5 Figure 2 is a perspective view of an inside back cover of the book shown in Figure 1 which include metal page markers and inductive proximity sensors;

Figure 3 is a side view of the book shown in Figure 1;

Figure 4 is a schematic block diagram of a page detecting circuit;

Figure 5 illustrates scanning sensors in sequence; and

10 Figure 6 is a process flow diagram of a method of page detection.

Detailed Description of Certain Embodiments

Referring to Figures 1, 2 and 3, a printed book 1 is shown.

15 The printed book 1 is in the form of a hardcover (also known as a “hardback” or “hardbound”) book having rigid front and back covers 2, 3 and a spine 4. The book 1 contains leaves (or “pages”) 5 bound between the covers 2, 3.

Referring in particular to Figure 2, a playback device 6 (which may also be referred to
20 as a “feedback device” or “rendering device”) is housed in the back cover 3 for providing audio and/or visual content via an output device 7. In this example, the output device 7 takes the form of a piezoelectric speaker. However, other forms of output device 7 can be used. The playback device 6 is incorporated into the back cover 3. However, the playback device 6 may be built into the front cover 2 or into the spine 4, or may be
25 distributed between two or all three of the front cover 2, back cover 3 and spine 4.

Inductive proximity sensors 8 are incorporated into the front and back covers 2, 3 under a pastedown endpaper 9 or other protective cover. For clarity, only back cover 3
30 is shown. Each sensor 8 is generally disk-shaped and has a low profile (i.e. is thin) so as to fit into the cover 3. A sensor 8 preferably has an outer diameter, d_1 , which is no more than 10 mm and a thickness, t_1 , which is no more than 4 mm.

Each inductive proximity sensor 8 comprises a half-pot ferrite core 10 having a central column 11 and a coil 12 wound around the column 11. The coil 12 may be wound onto a
35 bobbin or coil former (not shown) which is dropped into the half-pot ferrite core 10. The coil 12 has an outer diameter, t_{coil} . The outer diameter, t_{coil} , is preferably no more

than 5 mm. The outer diameter, t_{coil} , may be greater than 5 mm, for example, up to 10 mm or more. The coil 12 may comprise 30 to 60 or more turns.

5 Metal pads 13 (herein also referred to as “metal page markers” or simply “page markers”) are provided on the pages 5. Each page marker 13 takes the form of a disk of aluminium foil attached, e.g. using adhesive, to a page 5. Each page marker 13 has a diameter, d_2 , which is about the same as the coil diameter, d_1 . Each page marker 13 has a thickness, t_2 , such that the page marker 13 is thick enough to be detectable by the inductive proximity sensor 8. Preferably, the page marker 13 has a thickness, t_2 , of at
10 least 50 μm . The page markers 13 need not be circular, but can be, for example, rectangular (e.g. a strip). The page markers 13 may be formed from other non-magnetic metal (such as copper) or alloy or from a magnetic metal or alloy.

15 A metal page marker 13 is provided on each respective page 5 that needs to be identifiable. In this case, all pages 5 are provided with a respective page marker 13, i.e. all the pages 5 are identifiable. However, not all the pages 5 need be provided with a page marker 13. The page markers 13 are provided on the verso 14 of the page 5 and are arranged in a column adjacent to the spine 4.

20 The metal page markers 13 have different positions (i.e. x-y coordinates) on each page 3. Thus, when the book 1 is closed, no two page markers 13 are aligned (i.e. have the same x-y coordinate) so as to lie over each other. However, page markers 13 on two different pages 3 may share the same position if they are separated by a sufficiently large number of pages 5. Using this arrangement and inductive proximity sensors 8 in
25 both the front and back covers 2, 3 allows the same area on a page to be re-used for page marking and, thus, permit a larger number of pages 5 to be identified.

30 The metal page markers 13 can be provided on the recto (not shown) of the page 5. The page markers 13 can be embedded into a page 5 or laminated between two sheets forming a page 5 so as to hide the marker 13. Hiding a page marker 13 can allow a greater area of the page to be used for page detection (i.e. allow areas which support text and/or images to be used for page markers) as well as improve appearance.

35 Each page marker 13 cooperates with a respective inductive proximity sensor 8 to identify whether the book 1 is open on a given page.

The inductive proximity sensors 8 are arranged in a column 15 along the hinge 16, adjacent to the spine 4. An inner edge of a sensor 8 may lie within 20 mm of the hinge 16. Each page marker 13 is aligned with a single respective inductive proximity sensor 8 in the cover 3. Thus, when the book 1 is closed, one page marker 13 and one sensor 8
5 in the cover 3 are aligned, i.e. the page marker lies over the sensor 8.

If inductive proximity sensors 8 are included in the front cover 2, two page markers 13 may be aligned with two inductive proximity sensors 8 provided that the two page markers 13 are sufficiently separated in a text block 20. For example, if the text block
10 20 has a thickness, s , and the inductive proximity sensor 8 has a range, r , if $s > 2r$ and only one marker 13 is within range of one of the two proximity sensors 8, then two page markers 13 can share the same position. An inductive proximity sensor 8 may have a range, r , of 3 or 4 mm.

15 Placing the page markers 13 and the inductive proximity sensors 8 next to the spine 4 (i.e. in the book gutter) can help to reduce misalignment of a page marker 13 and sensor 8. It also means that the pages markers 12 are placed in a less prominent position. Nevertheless, inductive proximity sensors 8 may also be arranged along the (outer) edge 17 of the cover 3. Sensors 8 may be arranged in a row, or rows, along the
20 head 18 (i.e. top edge) and/or tail 19, (i.e. bottom edge) of the cover 3. The sensors 8 can be equally spaced. The sensors 8 can be set out in a rectangular two-dimensional array across the cover. However, the sensors 8 need not be set out in a periodic pattern.

25 Figure 4 is a schematic diagram of a page detection circuit 21.

Referring to Figure 4, the page detection circuit 21 includes the inductive proximity sensors 8 disposed in the front and back covers 2, 3 and an inductive proximity sensor controller 22. The inductive proximity sensor controller 22 includes a multiplexer 23,
30 oscillator 24, sensing circuit 25, frequency detection circuit 26 and a damping time detection circuit 27.

The inductive proximity sensor controller 22 is arranged such that each inductive proximity sensor 8 can be selectively excited with a pulse 28 of square waves using
35 respective pulse lines 29. An excitation frequency, f_e , is about 160 kHz. Other

excitation frequencies can be used. The inductive proximity sensors 8 share a common sense line 30.

The inductive proximity sensors 8 form part of an LC circuit (not shown). In this
5 example, L is 22 μ H and C is 47 nF. However, L and C can have other values.

The page detection circuit 21 is connected to a main controller 31, e.g. a
microcontroller, which includes a processor 32, volatile and non-volatile memory 33,
34. The main controller 31 is used to provide output content, e.g. sound, via the output
10 device 7. Content output may depend on user input, for example, provided by
capacitive touch switches 35, as described, for example, in GB 2 506 862 A. The circuit
is powered by a battery 36.

The inductive proximity sensor controller 22 and main controller 31 can be provided by
15 separate integrated circuits. However, the controllers 22, 31 can be implemented in a
single, general purpose microcontroller, application-specific integrated circuit (ASIC)
or field programmable gate array (FPGA).

Referring to Figure 2, 4, 5 and 6, a method of page detection will now be described.
20

Starting with a first inductive proximity sensor 8 (step S1), the inductive proximity
sensor controller 22 excites each coil 12 in turn for a period, t_p , which sets up an
oscillation in an LC circuit of which the coil 12 forms a part (step S2). The pulse period
 t_p is long enough for the coil 12 to saturate. The pulse period t_p may have an order of
25 magnitude of 10 μ s. For example, the pulse period t_p may be about 50 μ s. The
presence of a metal object in range of the sensor 8 affects the response of the sensor. In
particular, it affects the resonant frequency of the LC circuit and also the degree of
damping. The controller 22 senses the current in the sense line 29 (step S3).

30 For a sufficiently long pulse of sufficient magnitude, a coil 12 becomes saturated and so
there are no oscillations. After the drive current is turned off, the current in the coil
oscillates at a frequency $f = f_1$. If no page marker is present, the current in the coil 12
oscillates, for example, about eight to 12 times before the oscillations decay. If a page
marker is present, then the current in the coil oscillates at a frequency $f = f_2$ and decays
35 more quickly. For example, the oscillations can be damped in less than five oscillations
or even in less than one oscillation. The first and second oscillation frequencies f_1, f_2 are

about 160 kHz and differ $(f_2 - f_1 / f_1)$ by about 10 to 100 parts per million. However, other oscillation frequencies may be used and the frequency shift may differ by larger or smaller amounts.

- 5 The inductive proximity sensor controller 22 can measure the frequency, f , of oscillation (step S4). This can be done by counting the number of zero crossings to identify a given number of periods and measuring the aggregated wave period.

The inductive proximity sensor controller 22 can measure the damping time (step S5).

- 10 If a metal object, such as page marker, is sufficiently close to an excited coil 12, then eddy currents are induced the metal object. Counting the number of zero crossings can be used to identify a given number of periods and measuring the aggregated wave period.

- 15 It will be appreciated that many modifications may be made to the embodiments hereinbefore described.

- For example, instead of driving each coil separately with separate pulse lines and sensing the coils using a common sense line, all the coils could be pulsed at once using
20 a common pulse line (not shown) and sensing each coil separately with respective sensing lines.

Claims

1. A book comprising:
first and second covers;
5 a spine;
a plurality of pages between the covers;
a plurality of inductive proximity sensors disposed in the second cover adjacent to the spine;
a plurality of metal pads, wherein a metal pad is provided on each respective page
10 and arranged to correspond to a respective inductive proximity sensor; and
a controller configured to determine on which page the book is open in dependence upon signals from the inductive proximity sensors.
2. A book according to claim 1, wherein the inductive proximity sensors have a
15 thickness no more than 4 mm.
3. A book according to any claim 1 or 2, wherein the inductive proximity sensors have a diameter no more than 10 mm.
- 20 4. A book according to any preceding claim, wherein the inductive proximity sensors lie within 20 mm of the spine.
5. A book according to any preceding claim, wherein the inductive proximity sensors have a pitch of at least 10 mm.
- 25 6. A book according to any preceding claim, wherein the inductive proximity sensors have a pitch of no more than 50 mm.
7. A book according to any preceding claim, further comprising inductive proximity
30 sensors disposed away from the spine.
8. A book according to any preceding claim, wherein the metal pads have a thickness of at least 50 μm .
- 35 9. A book according to any preceding claim, wherein the metal pads have a width or diameter of at least 5 mm.

10. A book according to any preceding claim, wherein the metal pads have a width or diameter of no more than 20 mm.
- 5 11. A book according to any preceding claim, wherein the metal pads are circular.
12. A book according to any preceding claim, wherein the metal pads comprise a non-ferromagnetic material.
- 10 13. A book according to any preceding claim, wherein the metal pads comprise aluminium or copper.
14. A book according to any preceding claim, further comprising:
at least one output device; and
- 15 the controller or a further controller configured to cause the or at least one of the output devices to output a signal in dependence upon the page on which the book is open.
15. A book according to claim 14, further comprising:
20 capacitive touch elements disposed on the inside of a cover;
wherein the controller or further controller is configured to cause the or at least one of the output devices to output the signal in dependence upon the position of a user's digit on a page overlying the cover.
- 25 16. A book according to claim 14 or 15, wherein the at least one output device comprises a speaker.
17. A book according to any preceding claim, wherein the at least one output device comprises a wireless interface.
- 30 18. A method comprising:
applying an energising signal to a coil of an inductive proximity sensor disposed in a cover of the book;
measuring a response signal from the coil; and
- 35 determining whether a metal pad is within range of the sensor so as to determine on which page a book is open.

19. A method according to claim 18, comprising measuring the response signal after applying the energising signal.
- 5 20. A method according to claim 18 or 19, wherein determining whether a metal pad is within range of the sensor comprises determining a frequency or period of an oscillation.
21. A method according to any one of claims 18 to 20, wherein determining whether a
10 metal pad is within range of the sensor comprises determining a time or number of oscillations for the oscillations to decay.
22. A method according to any one of claims 18 to 21, comprising:
applying an energising signal to each one of a plurality of coils of respective
15 inductive proximity sensors in turn.
23. A method according to any one of claims 18 to 22, further comprising:
causing an output device to output a signal in dependence upon the page on
which the book is open.
20
24. A method according to any one of claims 18 to 23, further comprising:
causing an output devices to output the signal in dependence upon the position of
a user's digit on a page overlying the cover.
- 25 25. A computer program which, when executed by a playback device comprising an output device, causes the playback device to perform a method according to any one of claims 18 to 24.
26. A computer readable medium storing the computer program according to claim
30 25.



Application No: GB1413311.0

Examiner: Ms Lucy Stratton

Claims searched: 1-26

Date of search: 8 January 2015

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1-26	US2009/021318 A1 (HOLYLIFE) Figures 1, 2 and 4
X	1-26	US2002/079908 A1 (HOHL) Figures 1 and 3
X	1-11, 14-17	FR2743754 A1 (MICROBJET) All figures and abstract
A	-	GB2487576 A (NOVALIA) Figure 2
A	-	GB2506862 A (NOVALIA) Figures 2 and 5

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^X :

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Worldwide search of patent documents classified in the following areas of the IPC

A63F; A63H; B42D; G09B

The following online and other databases have been used in the preparation of this search report

WPI, EPODOC



International Classification:

Subclass	Subgroup	Valid From
B42D	0003/12	01/01/2006
G09B	0005/06	01/01/2006
A63H	0033/38	01/01/2006