

# Exhibit D



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**Williams**

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(54) **PORTABLE COMPUTERS**

(56) **References Cited**

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- (\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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§ 371 (c)(1),  
(2), (4) Date: **Oct. 29, 1998**
- (87) PCT Pub. No.: **WO99/22338**  
PCT Pub. Date: **May 6, 1999**

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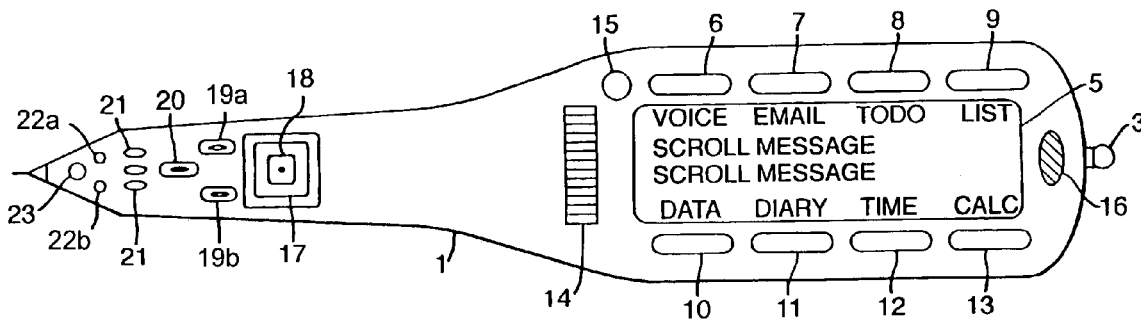
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(74) *Attorney, Agent, or Firm*—Nixon & Vanderhye P.C.

- (30) **Foreign Application Priority Data**  
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- (52) **U.S. Cl.** ..... **345/179; 178/18.01; 178/18.03; 178/18.1; 178/19.01; 178/19.04**
- (58) **Field of Search** ..... **345/156, 157, 345/179, 180, 169; 178/18.01, 18.03, 19.01, 178/19.04, 19.05, 18.1**

(57) **ABSTRACT**

A portable computer arranged to rest comfortably in the hand has a small display screen. Accelerometers capable of detecting movement of the pen with respect to gravity provide input to a microcontroller which selects a response from a number of viewing modes. The pen may be held in either hand and the output message to the screen will be oriented according to the location of the pen. Full personal digital assistance functionality may be incorporated in a relatively small plastics casing and functions, such as calendar, contracts the like may be incorporated.

**36 Claims, 10 Drawing Sheets**



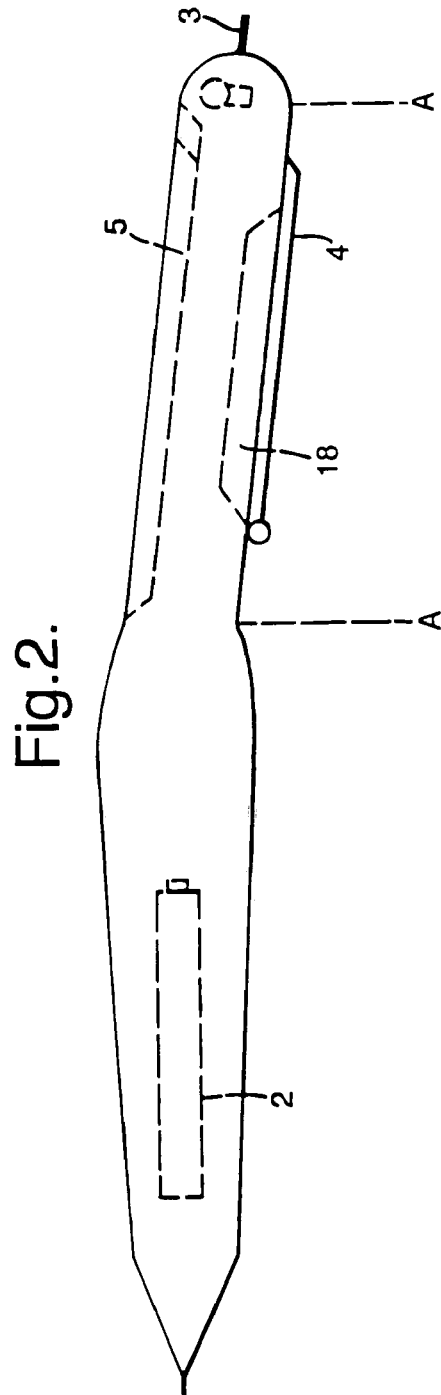
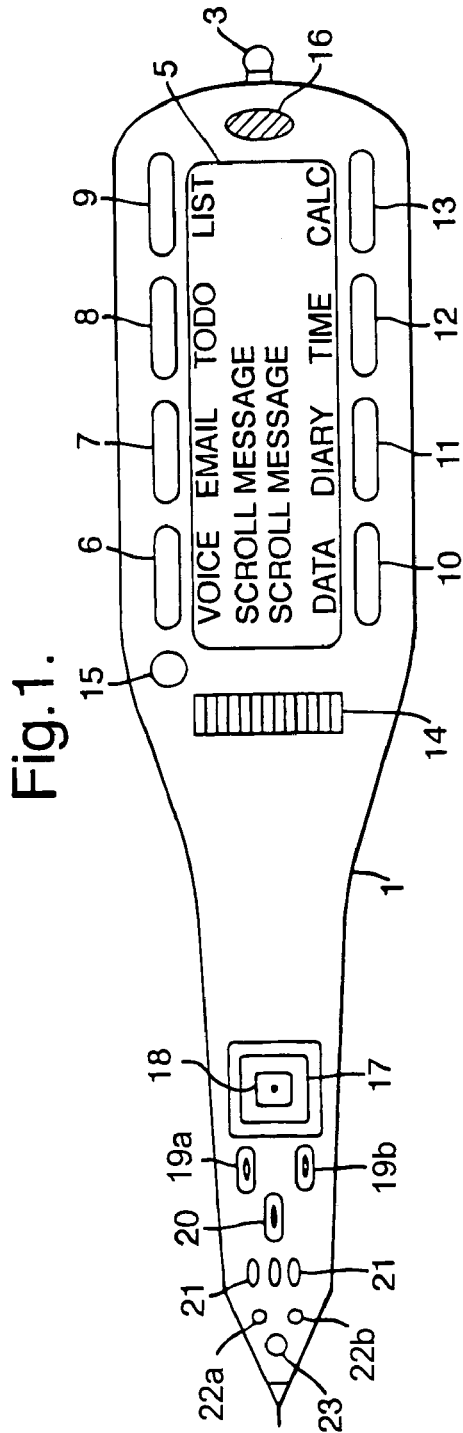
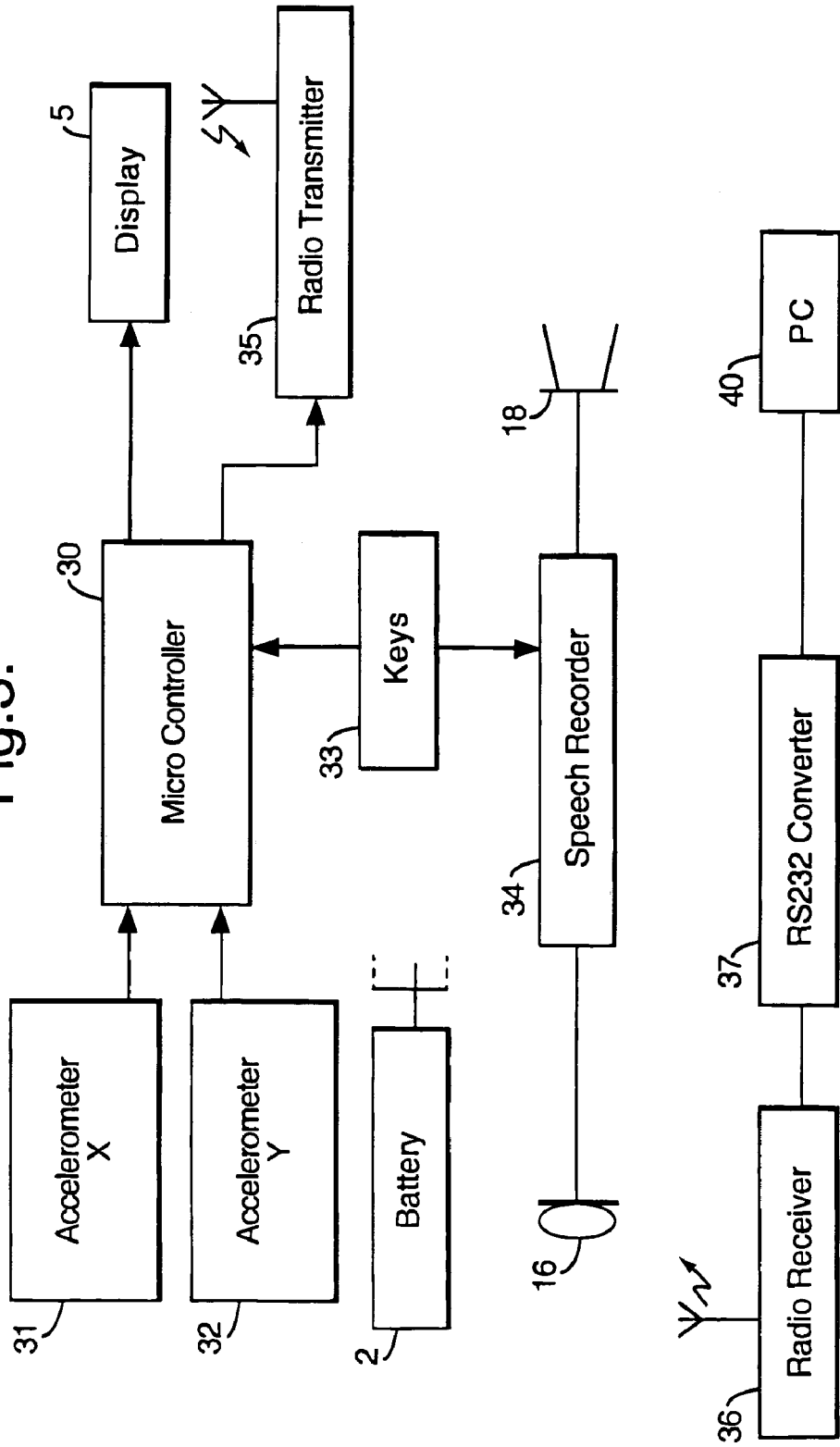


Fig.3.





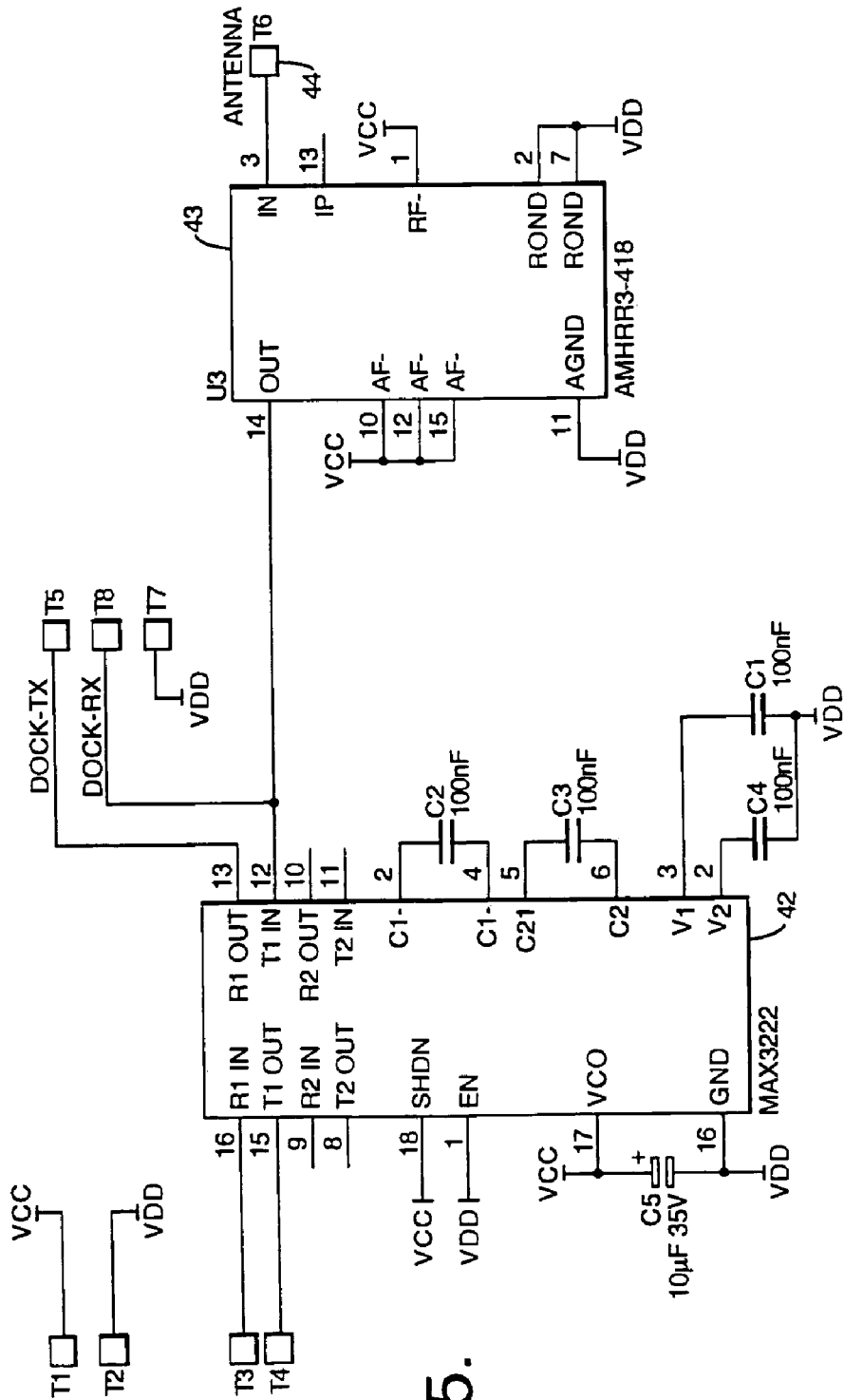


Fig.5.

Fig.6.

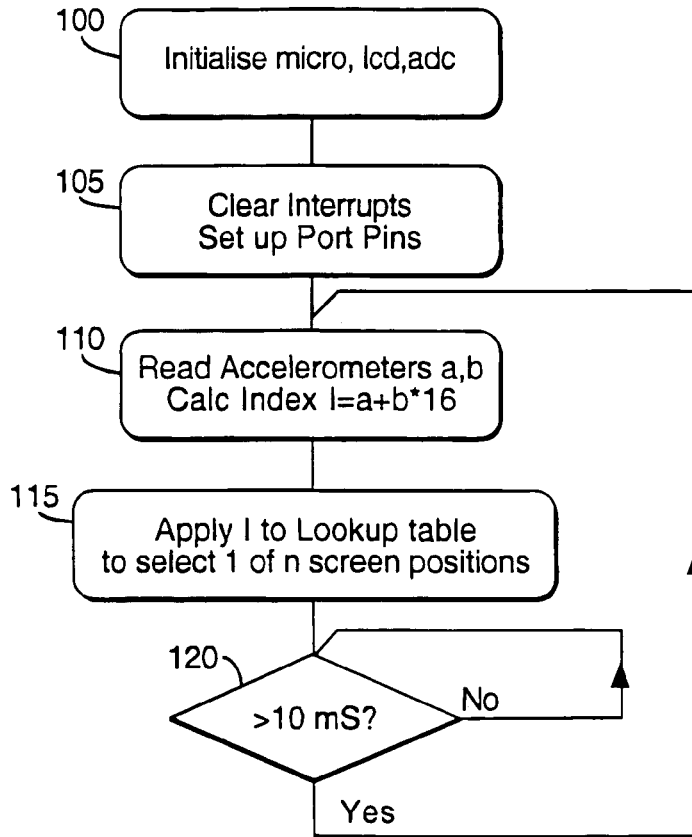


Fig.7a.

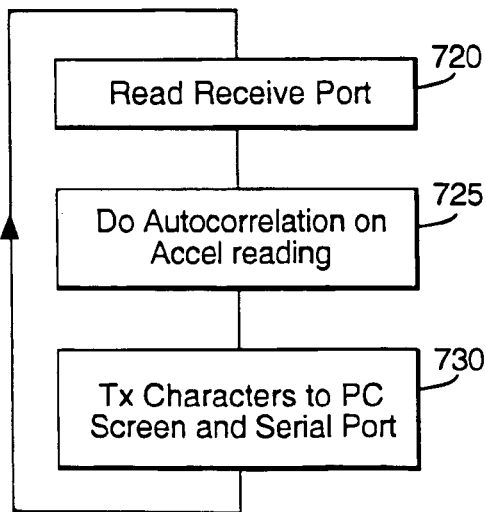


Fig.7b.

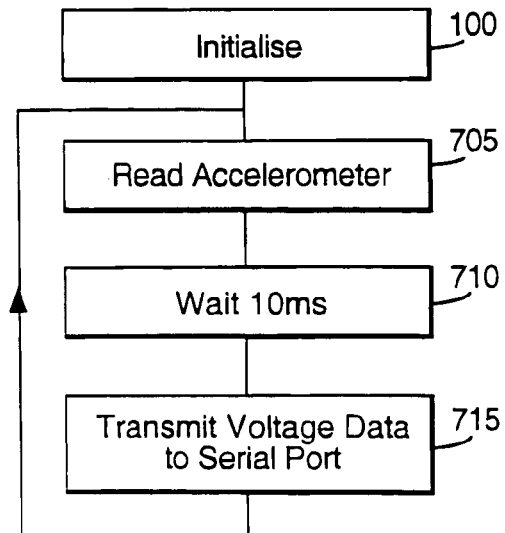


Fig. 8.

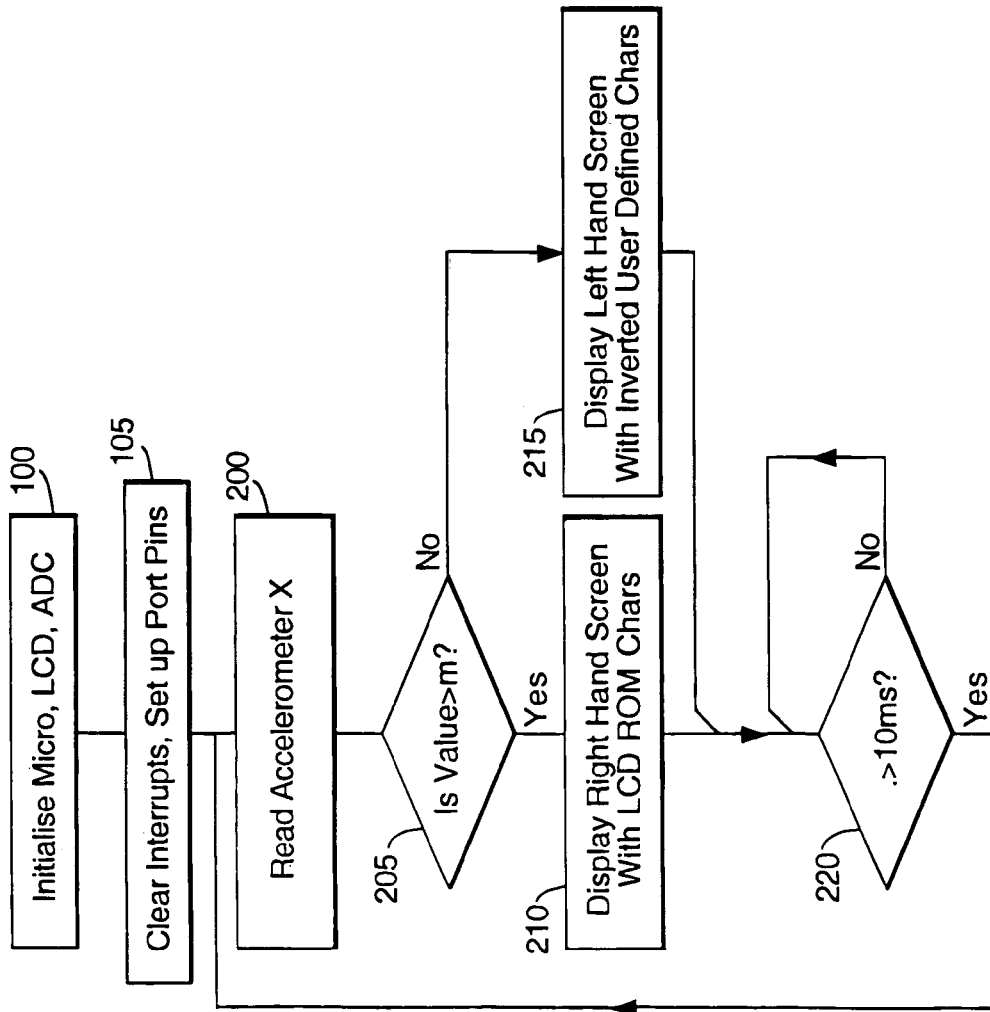
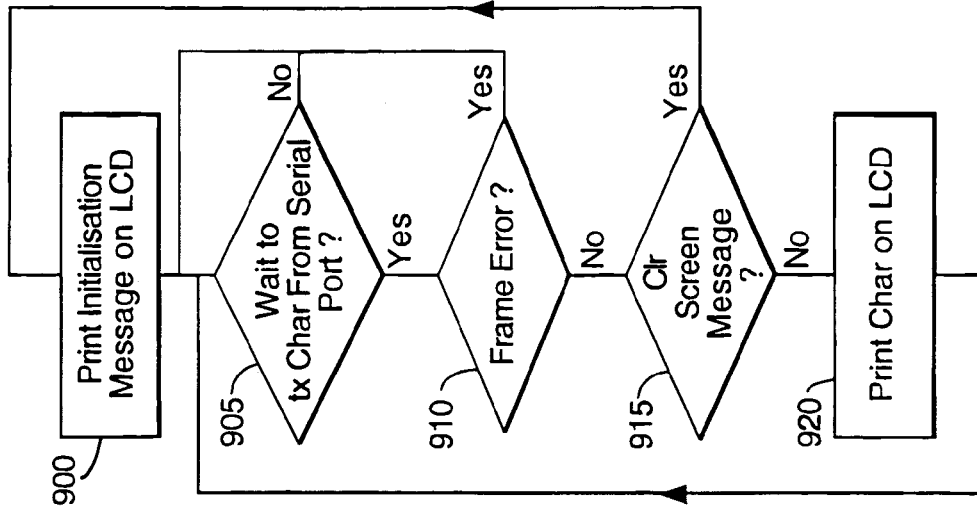


Fig. 9.





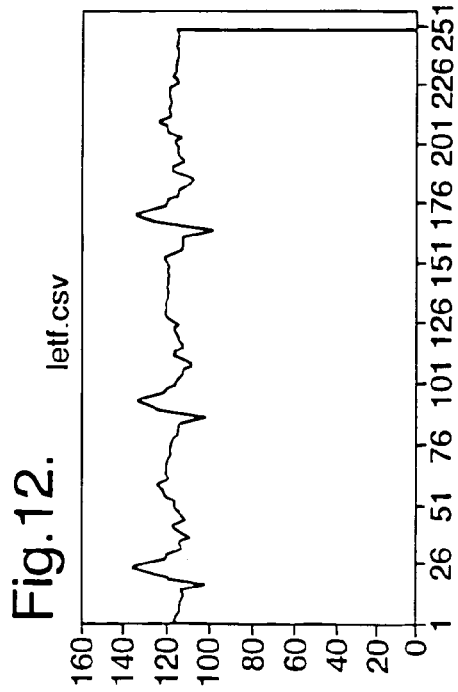
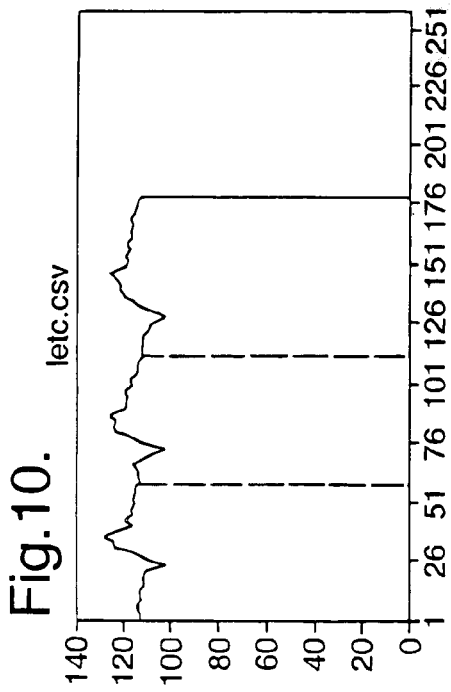
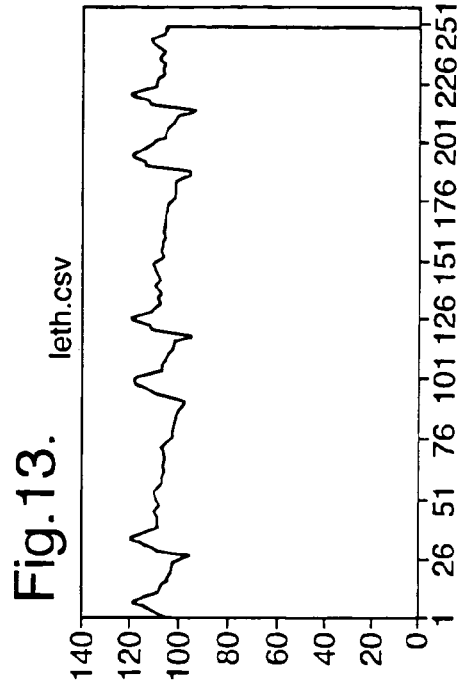
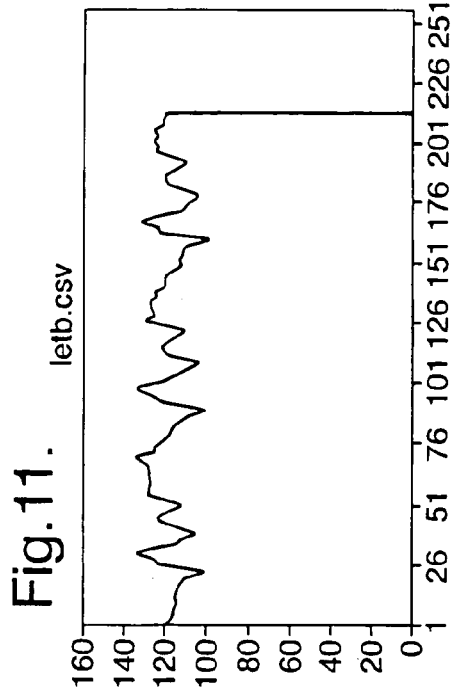


Fig. 14.

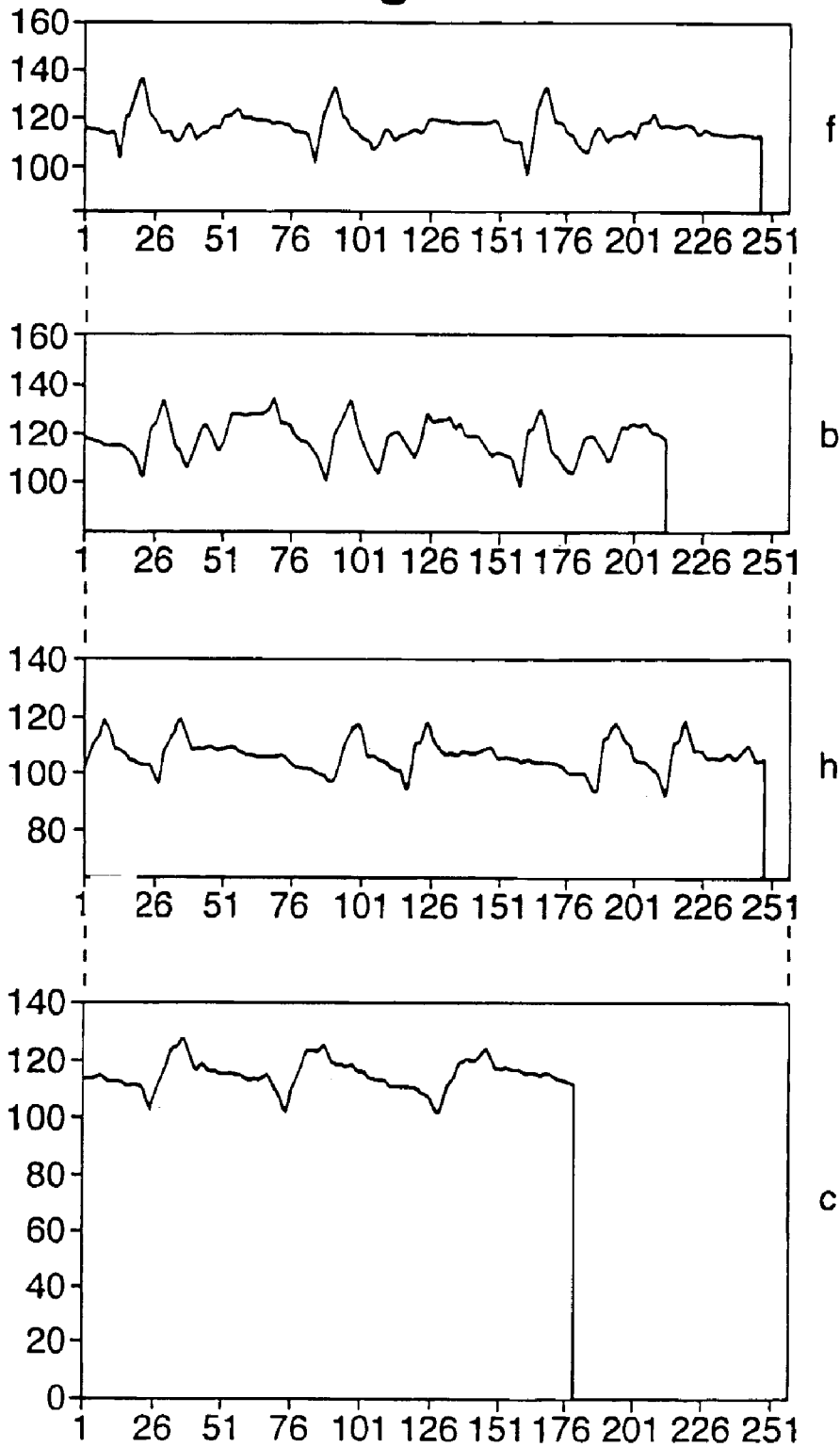


Fig.15.

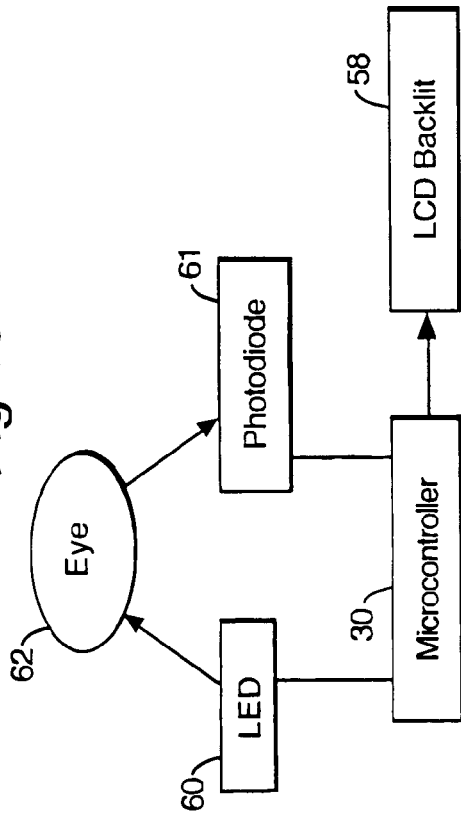


Fig.16.

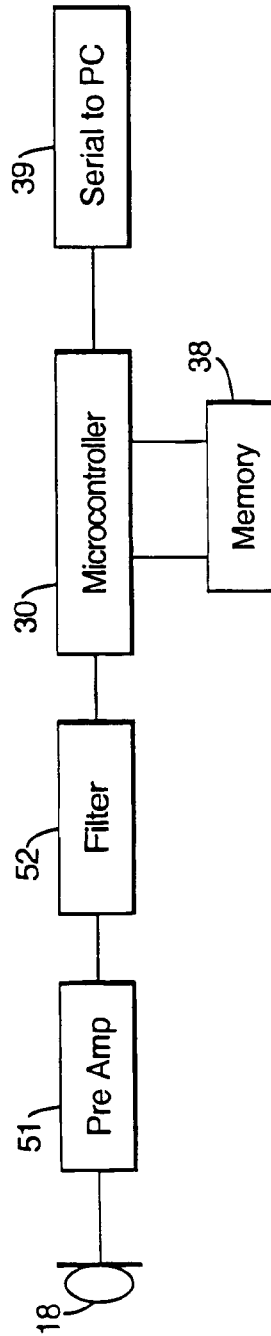


Fig.17.

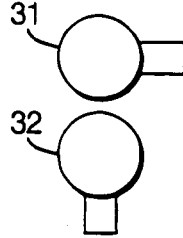


Fig.18.

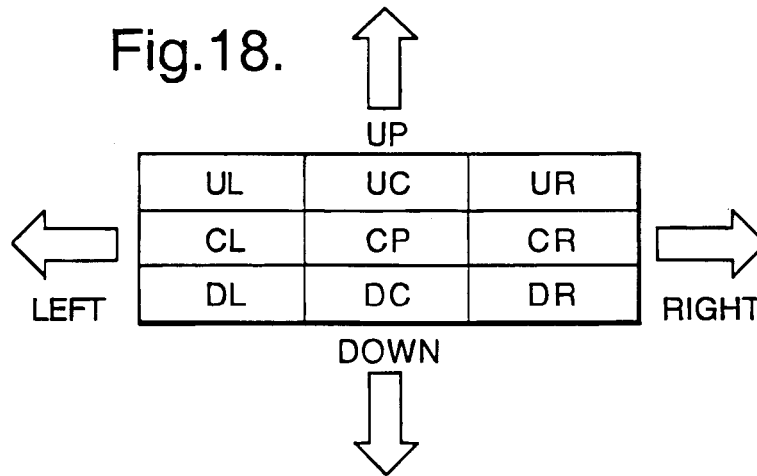
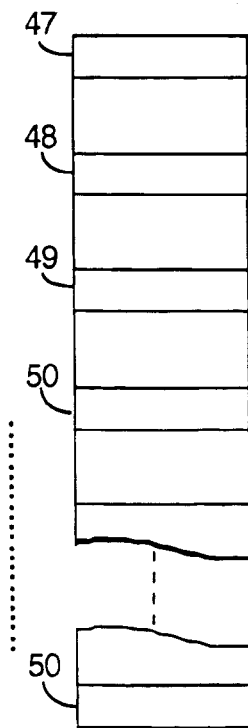


Fig.19.



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**PORTABLE COMPUTERS****BACKGROUND OF THE INVENTION**

## 1. Field of the Invention

The present invention relates to portable computers and more particularly but not exclusively to hand-held computers of the kind sometimes referred to as personal digital assistants.

## 2. Related Art

A personal digital assistant includes data files defining such items as an electronic diary, address book and other applications such as word processing software, calculators and the like. As more powerful memories and processors have been developed in smaller packages it has become possible to provide quite powerful computers in relatively small portable cases. However, the limitation of miniaturisation occurs when a viewing screen and keyboard are needed for data input and read out. Thus, so called palm top personal computers (PPC) are usually of the order of 15 cm by 7 cm in order to provide a readable screen and a usable keyboard. Such palm top computers are known, for example Psion Corporation have produced a Psion Series 5 (trade mark) PPC having an 8 megabyte RAM and processor while Hewlett Packard similarly produce PPCs as e.g. the HP320LX (trade mark). The capabilities of such PPCs may be enhanced by incorporating so called flash cards enabling the expansion of the RAM by up to 10 megabytes or more while PCMCIA cards may be provided to enable connection of the PPC to telephone networks by way of cellular phones or telephony sockets for communication with other computers and the so called Internet and Intranets.

Most PPCs incorporate a docking arrangement to enable them to be connected with a desktop computer or other main frame for the purposes of synchronisation of data files and the like.

However, generally speaking PPCs are not robust and are prone to damage mainly because of the clam shell design requiring a hinge that opens to reveal the incorporated keyboard and screen. Thus PPCs are more usually used on a desk top or table or may be held in one hand while typing with the other.

**SUMMARY OF THE INVENTION**

According to the present invention there is provided a portable computer including movement detection means responsive to movement of the computer to produce an electrical output signal representative of such movement, processing means responsive to the output of said position detection means to determine detected movement data defining a user's intention, the processing means using said data to provide a mode response selected from a multiplicity of stored possible modes.

Preferably the movement detection means includes at least one acceleration or tilt detection means responsive to movement of the computer to produce the output electrical signal. There may be a plurality of acceleration detection means each producing a respective electrical output signal representative of movement components in respective directions, the detectors generally being mounted to detect X and Y movement components at a ninety degree angle.

The processing means may include a data input mode in which detected movement data is used to generate alphanumeric or graphical data. The alphanumeric or graphical data may be stored in data storage of the portable computer or

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may be output by transmitting means to receiving means connected to another processing device.

The processing means may include a screen output mode in which detected movement data is used to modify output to display means of the computer whereby scrolling of displayed information is effected. In the screen output mode the processing means may be responsive to relative lateral tilting movement to cause the display of information stored as to one or other side of currently displayed information. Relative rolling movement may cause the display of information stored as above or below the currently displayed information.

In the screen output mode the processing means may be responsive to detected movement data to determine a most likely orientation of the computer display means with respect to a user's eye line whereby the signals output to the display means may cause inversion of the displayed information such that the computer may be held and used in either hand.

The computer may include proximity detection means arranged to provide signals indicative of the proximity of the display screen to a user's view, the processing means being responsive to changes in the relative proximity to increase or decrease density of displayed information.

In a further development, security data derived from movement of the computer defining an authorised user's password is stored, the processing means being locked in a secure mode until detected movement data corresponding to the security data is received.

The computer may include a sound input device, the processing means having a second data input mode in which alphanumeric data is derived from input speech signals. A sound output device may also be included to permit the output of speech derived from stored data. Alternatively the sound input and output devices may be combined with a radio transceiver whereby cellular or other radio telephony networks may be used.

The computer may be housed in a casing shaped to facilitate a user holding the computer as if holding a writing stylus. The casing is preferably of substantially radiused triangular cross section along a substantial portion of its length and may include a flattened section incorporating a display screen. The casing may include angular shaping between a forward holding area and a rearward screen area the shaping being such as to provide a natural viewing angle of an incorporated display screen while the casing is held as a writing stylus. The shaping may also be such as to facilitate support of the rearward screen area by the dorsal aspect of a user's hand between the root of the thumb and index finger and the wrist.

**BRIEF DESCRIPTION OF THE DRAWINGS**

A portable computer in accordance with the invention will now be described by way of example only with reference to the accompanying drawings of which:

FIG. 1 shows a plan view of the computer;

FIG. 2 shows a side view of the computer of FIG. 1;

FIG. 3 is a block schematic diagram of the circuits of the computer of FIG. 1;

FIGS. 4a and 4b provide a circuit diagram showing details of the circuitry described with respect to FIG. 3;

FIG. 5 is a circuit diagram of a docking station to enable the computer of FIG. 1 to be connected to a desktop or other device;

FIGS. 6 to 9 are flow charts showing some of the programs incorporated in the microprocessor of FIG. 4;

FIGS. 10 to 13 are graphical representations of the outputs of the accelerometers of FIG. 4 as analysed by the micro-processor;

FIGS. 14a and 14b provide a graphical comparison of the representations of the outputs of the accelerometers as shown in FIGS. 10 to 13;

FIG. 15 is a schematic diagram of a power saving arrangement of the portable computer of FIG. 1;

FIG. 16 is a schematic diagram of a voice input arrangement of the portable computer of FIG. 1;

FIG. 17 shows mounting positions of the accelerometers of FIG. 4 with respect to each other;

FIG. 18 is a table showing a program response to movement of the accelerometers of FIG. 16 in a particular mode of operation; and

FIG. 19 is a schematic diagram of a part of a scroll detector of the portable computer of FIG. 1

#### DETAILED DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

Referring to FIGS. 1 and 2, the hand-held computer of the present invention has a case 1 of a moulded plastics material having a triangular barrel cross section towards the forward end, that is towards the point, with radiused sides providing a diameter of approximately 15 mm. The case is shaped to have a curve so that when the forward part of the barrel of the casing is held as a writing stylus using the thumb, index finger and second finger of the user, the screen area A—A rests comfortably on the dorsal area at the back of the hand between the root of the thumb and index finger of the hand and the user's wrist. This provides some additional support to allow the entire computer to be operated using one hand only. After assembly the case is sealed using an O-ring seal much in the manner of sealing watch parts. Coating the casing with wax polythene completes the sealing of the unit so that to all intents and purposes the case is waterproofed.

The casing is weighted at one end (for example by including a rechargeable battery 2) at the forward end so that if the item is dropped on to a surface it tends to fall in a specified manner such that the tip which may include some impact protection, for example by being rubber cased, prevents any significant damage to internal components. The weighting also assists balancing of the unit in a user's hand.

The case may incorporate a hook 3 for attachment of a strap or key ring (not shown) and may have a pocket clip 4. The hook is preferably recessed within the casing.

Externally mounted a small liquid crystal diode screen which may be of the kind manufactured by Batron and supplied under type number BT42003STYC is included. To either side of the LCD 5 touch or pressure sensitive switches 6 to 13 are provided. These switches may be soft programmed to provide functions as hereinafter described. A touch scroll strip 14 (hereinafter described) is provided in front of the screen 5 and the system includes a pyroelectric detector 15 used in determining the proximity of the computer to a user's eye.

Audio input and output devices are also provided together with an alerting device. For example, a microphone 16, annunciator 17 and speaker 18 may be included. Finger switches 19a, 19b, 20 are provided forward of the annunciator 17 and again may be soft programmed for functionality. Also visible are gold docking pins 21 used for connecting the hand-held computer for recharging of the battery 2 and transfer of data by way of a docking device to other computers, for example desk mounted personal computers.

As an alternative means of transferring data from the computer of the invention to another processing device or to enable the computer of the invention to be used as an input device for a PC, an infrared transceiver 22a, 22b is mounted towards the front of the casing 1.

Also included is a light emitting diode 23 which may be of the kind having three or more colours. Individual colours allow for a small amount of illumination or may be used to provide indication or alarm functions. Alternatively, a single coloured red light emitting diode part TL5H180P from Toshiba may be used. This ultrabright LED aids human night sight viewing and whilst only being of low power may in a dark environment assist the user.

Turning now to FIG. 3, a block schematic diagram of the component parts of the computer is shown. It will be noted that the display 5 receives inputs from a microcontroller 30 which may be of the type supplied by Microchip under the reference PIC16C74. The PIC16C74 includes on board read only memory (ROM) but in a preferred embodiment an ARM processor with a larger memory is used. Also mounted within the casing 1 are two accelerometers 31, 32 which may be of the kind known as ADXL05 from Analog Devices Limited and which are buffered by operational amplifiers, for example National Semiconductor type LPC662. The keys 6 to 13 and 18 to 20 are here represented as a keypad 33. Some of the keys may be used to control a speech recorder 34 which is also used as an interface between the microcontroller 30, and microphone 16 and the speaker 18. A radio transmitter 35, which may be a radio transceiver, is also incorporated.

One function of the radio transmitter may be to allow use of the hand-held computer of the invention as an input device for a desk mounted or other PC 40 having corresponding receiver 36 and an appropriate converter without physical interconnection. Other functions of the transceivers 35, 36 may be apparent from the description hereinafter.

Referring now to FIGS. 4a, 4b the microcontroller 30 is connected to the display 5 using standard control inputs of the display to provide a visual output of the result of program activities requested by the user. It will be noted that the accelerometers 31 and 32 have associated buffer circuits which each include an operational amplifier to buffer the input to the microcontroller. The operational amplifiers 41 may be type LPC662 from National semiconductor.

Power to the accelerometers 31 is by way of a transistor TR2 so that if the microcontroller 30 determines that no movement of the computer is occurring or that the present program does not require use of the accelerometers 31 and 32, output RB1 may be set to stop current being drawn to minimise battery usage. The microcontroller may allow periodic sampling during dormant periods so that if the computer is picked up the sensors may again be activated.

An EEPROM integrated circuit chip type X24F064 8 Kbyte from Xicor providing 8 Kbytes of memory is also provided accessible from the microcontroller 30 in known manner. Switches S1 to S8 (keys 33 in FIG. 3) are wired to respective inputs of the microcontroller 30.

Note that TR1 controls power input to the back lighting circuitry of the LCD display 5. Again, the microcontroller 30 will normally bias TR1 off when the computer is dormant and will maintain TR1 biased off unless back lighting is requested by operation of one of the keys of the keyboard 33.

For the avoidance of doubt it is here noted that the microcontroller 30 includes a program which uses position outputs from the accelerometers 31, 32 to determine from the orientation of the computer whether the hand-held computer is in the left hand or right hand of the user. It is

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here noted that accelerometer output may depend upon the tilt angle of the included accelerometers to the earth's gravitational field. The keys **S1** to **S8** are then swapped over in soft programming mode such that functionality is determined by the apparent top of the display **5** to the user in its current position. Similarly, determination of orientation of alphanumeric or other display information on the screen **5** will be determined from the orientation of the computer itself. Thus, data output to the screen from the controller **30** arranged to provide an appropriately oriented display.

The speech recorder **34** is implemented using Sequoia technology sound recording integrated circuit type ISD2560. The Sequoia technology chip is capable of recording 60 seconds of speech message in digital form and is connected so that the microphone **16** can be used to provide an input. The three switches **SW1**, **SW2** and **SW3** may correspond to the fingertip switches **18** to **20** of FIG. **1** or may be selected in software from keys **6** to **13**.

In speech recording mode **SW1** provides a start and pause control function for the user, **SW2** is a stop or reset function while **SW3** switches between the record and play modes.

Short messages are played back by way of the loud speaker **18**. As currently implemented the microphone **16** is a Maplin type QY62S, the speaker is from Hosiden type HDR9941. "Speech notes" recorded by this method may be down loaded to a PC for sorting and categorising.

Turning briefly to FIG. **5**, the hand-held computer of FIG. **1** can be inserted in a corresponding docking port shaped to align the contact **21** with **T5** to **T7** of FIG. **5**. The contact **T5** and **T8** provide serial receive and transmit paths for synchronising databases between a PC and the portable computer and also provide battery charging. Contact **T7** provides an earth contact. Speech samples and other data may be up loaded from a PC to the portable computer.

A Maxim integrated circuit **42**, which may be type MAX232IC, converts RS232 level serial output and input required by current PCs to the voltage level required by the microcontroller **30** of FIG. **4**. Note also the ability to receive radio input by way of an antenna connected to the radio receiver chip type AMHRR3-418.

Having discussed the hardware of the portable computer of the invention we shall now consider various uses to which the writing stylus input, voice input and screen may be used. Exemplary flow charts for some aspects of the use of the portable computer are attached. While functions are individually discussed in respect of the flow charts of FIGS. **6** to **9**, it will be appreciated that combinations of programs may be used in the implementation of features described hereinafter.

Turning now to FIG. **6**, the tilt sensor software uses inputs from the accelerometers **31**, **32** which, as shown in FIG. **17** to which reference is additionally made, are mounted with their respective sensitive axes at right angles to each other. As will have been seen from FIG. **4**, the output from each accelerometer is filtered by a resistor capacitance network to remote high frequency noise for example, and the outputs are then read by an analogue to digital converter included within the microcontroller **30**. Thus, referring to FIG. **6**, for special sensing the microcontroller **30**, display **5** and analogue to digital conversion circuits are initialised at **100** and the interrupts and port pins of the microcontroller **30** are reset or cleared at **105**. The output of the accelerometers **31**, **32** is read from respective analogue input pins **AN0** and **AN1** of the microcontroller **30** and an index to a look up table is calculated at step **110** using the formula  $I=a+(b1 \times 16)$ . In this case  $a$  is a calibration constant and  $b1$  is the digitised output of the accelerometer **31**. This allows for a look up table

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allowing a  $16$  by  $16$  matrix of left to right position to be determined. For vertical tilt position the formula  $I=a+(b2 \times 16)$  where  $b2$  is the output of the accelerometer **32** may be used to address a further matrix to determine the relative up/down position. By applying one or more of the indices to the look up table, it is possible to select one of  $n$  screen positions or to determine the amount of movement since the last reading at step **115**. The system then waits for 10 ms as indicated at step **120** before repeating the reading of the accelerometer output.

The program allows for the screen **5** to be scrolled in accordance with the user's requirements. The mounting of these sensors, as shown in FIG. **17**, allows positional movement such as up, down, left and right to resolved to fractions of a degree.

Using software the microcontroller **30** may use the output from the accelerometers **31**, **32** to determine a user's requirement for a different view to be displayed on the screen **5**. Thus a virtual hinge is created such that if the user moves the stylus whilst it is in viewing position the screen information may be changed to respond to a natural reaction for looking up or down or to the left or right. Thus, as shown in FIG. **18** in a simplified arrangement, if the display on the screen at any time is designated as current page (CP) then tilting the stylus towards the left will cause the display of a page stored as to the right of CP (CR). The page which was formerly CR (as represented by data held within the storage of the microcontroller **30** or an associated data store) is now CP. Tilting the stylus to the right will cause a page of information (CL) to the left of CP to be displayed. For the avoidance of doubt the term page is used here as for a screen for information. Thus the action of tilting the stylus to the left or right is analogous to the natural inclination to look through a window towards the right or left to obtain additional information from a scene.

Similarly, if the stylus is turned towards the user information stored at UC will be displayed and tilting the stylus away results in the information DC being displayed. It will be appreciated that combining tilt angles may result in the display of information up and to the left (UL), up and to the right (UR), down and to the left (DL) and down and to the right (DR). This simplified description of a multiple line screen moving as if a jump is occurring should be considered as allowing single line scrolling in which CP defines the top line of the screen, DC the line below and further lines to the limit of screen viewability also being displayed with CP such that single line scroll movement or smooth scrolling appears to occur. Finer scrolling modes such as single pixel movements are also possible. The user may select the rate of response using keys **6** to **13** or fingertip switches **18** to **20**. It should also be noted that the tilt sensor arrangement **31**, **32** allows the microcontroller **30** to determine the most likely viewing angle and to adjust pixel mapping to the screen accordingly so that if a user holds the stylus in the left hand the display is inverted to that shown in FIG. **1** so that the bottom right corner, as viewed by a right handed user, becomes the top left corner as viewed by a left handed user. It should be noted that the microcontroller does not require an input from the user to determine whether the stylus is being held in the left or right hand and, if a user changes hands during the course of viewing the screen output will be inverted accordingly.

It is also possible, particularly if pictorial rather than alphanumeric display is required, for the screen to enter a "portrait" mode if the stylus is held vertically. In this case the orientation will be appropriate to the stylus being held with its tip above or below the waist of the stylus.

To prevent scrolling or orientation change the user may use a soft key **6** to **13** or fingertip switch **18** to **20** to lock and unlock display movement.

Further, while as described with reference to FIG. 3, the display screen is a Batron, in a preferred embodiment a Kopin Cyberdisplay **320** having  $\frac{1}{4}$  VGA colour resolution may be used. Using the Kopin display and the associated monocular viewing lens mounted end on to the body allows clear viewing of some 15 lines of normal text. The Kopin Monocular lens is approximately 20 mm by 18 mm which gives an acceptable size to a pen body incorporating movement sensing means as herein described.

In a still further development the pyroelectric detector (Murata type IRA- E700STO) **15** may be used to detect the presence of the user and the proximity of the user to the viewing screen **5**. Using the Kopin  $\frac{1}{4}$  VGA display it is possible to decrease the size of character displayed. Thus the microcontroller **30** uses the output of the pyroelectric detector **15** to determine how close to a user's eye the stylus is held and may adjust the size of print so that more characters are fitted on the screen **5**. In this way large areas of text may be read by holding the screen close to the user's eye. A further use of the pyroelectric detector for power saving purposes it discussed hereinafter. As has been mentioned detection of the position of the screen with respect to the user's left or right side is possible.

Referring to FIG. 8, clearing of interrupt and set port pins and initialisation as previously mentioned with regard to FIG. 6 is carried out. One of the accelerometers, for example the accelerometer **31**, is read at step **200** and its value compared with a predetermined value *m*. Values greater than *m* indicate that the display is most likely in the user's left hand so that as indicated at **215** inverted characters are displayed on the screen **5**. If the value read from accelerometer **31** is less than *m* then it may be assumed that the stylus is in the user's right hand and normal ROM LCD characters are displayed. As indicated at **220**, a check may be carried every 10 ms to determine the whereabouts for the screen.

It is envisaged that input to the computer system either for use as a PDA or for word processing purposes, will be carried out either by hand writing recognition (HR) or by voice input using the microphone **16**. Handwriting recognition does not require the user to write on a surface, although some users may find this a preferable method of operation, but requires the user merely to move the stylus (that is the whole computer) as if writing letters and numbers. Katakana or Cyrillic texts may also be entered as may symbols.

Thus using one of the two accelerometers **31**, **32** and referring to FIGS. 10 to 14, the output of one of the accelerometers **31**, **32** is read at a simple rate of 100 times per second. The received data is stored in a random access memory (RAM) buffer as a set of acceleration values against unit time. Using a software process of autocorrelation the microcontroller **30** may determine the character entered. Thus, referring to the Figures, FIG. 10 shows three entries of the letter C, FIGS. 11 shows three entries of letter B, FIG. 123 entries of letter F and FIG. 13 three entries of letter H for exemplary purposes only. Feedback to the user either on the display or by character speech output or simply by an acoustic beep indication may be used to note acceptance of a character. The validity indication may be user selectable.

It will be noted from FIG. 14 that a single accelerometer output is distinct for each of the input characters and therefore the microcontroller can determine the entry made. The entry may be of text which can be reflected to the viewing screen **5** or maybe instructions couched in appro-

priate terms such as "get Monday diary". Once the diary has been recovered from the store the appropriate entries may be displayed on the screen **5** with appropriate soft key indications for the keys **6** to **13**.

Note that predefined user gestures such as drawing an "envelope" to request e-mail mode or a table for diary mode, for example, may be used. The instructions may be user selectable or teachable so that on initialisation the user draws and selects the mode. Subsequently drawing the same symbol will cause the microcontroller **30** to enter the appropriate selected mode.

Again sensing may be used to move around the displayed area (as discussed with reference to FIG. 6 and FIG. 18) or the touch strip controller **14** may be used in combination with the keys **6** to **13** to select appropriate areas.

Entry of information to the diary may also be by handwriting input. It is convenient here to consider the construction of the touch strip **14** which as shown in FIG. 19 comprises a 0.4 mm printed board having a surface area of approximately 20 mm by 5 m with horizontal strips in the 5 mm dimension as indicated as 47 to 50 for FIG. 19 which shown a part of the strip **14**. The strip **14** thus replaces the rotational elements of potentiometer so that hermetic sealing of the casing may be complete and a control which is resistant to wear as provided. The strips **47** to **50** etc, are interfaced to the microcontroller **30** so that as a finger is moved across the strip direction of movement and speed of movement may be determined. The information may be used in the same way as a rotary potentiometer.

It will be appreciated that incorporating a second strip at right angles to the strip **14** would allow full functionality of (eg) a computer mouse to be simulated.

Thus as shown in FIG. 19, if a user moves a finger such that, for example, the presence of the finger bridging **48**, **49** and **50** subsequent to the presence of a finger bridging **47** to **50** indicates that the user would wish to rotate a potentiometer in a counter-clockwise direction. Similarly, detection of a finger bridging **47** and **48** subsequent to there having been no previous bridge indicates rotation in a clockwise direction.

It will be appreciated, however, that if the tilt detection mechanism hereinbefore described indicates that the device is in the left hand rather than the right hand the functionality of bridging and unbridging is reversed accordingly.

Entry of data files, for example the composition of letters or reports can be carried out using either the write sensing arrangement, hereinbefore described, to determine input alphanumeric which may be stored for subsequent transmission to a printer or for transfer as data files to a PC for example. Data entered and converted into appropriate stored information may be displayed on the display screen if required.

Cursor movement around the display screen to select a position to which information is to be placed may be by use of either the potentiometer arrangement described with reference to FIG. 19 or by use of the tilt sensing mechanism hereinbefore described in combination with one of the soft keys to indicate that an insert or delete position is being selected.

In an alternative method of operation and referring to FIG. 7a and initially to FIG. 7b, use of the stylus of FIG. 1 as a non-connected input device for a PC allows all of the functions of the hand held computer to be duplicated. For example, where alphanumeric data is input in the manner previously described with reference to FIGS. 10 to 14 a more powerful PC may be able to effect autocorrelation much more rapidly than the microcontroller **30** of the device



itself. In this case, referring specifically to FIG. 7b, once the initialisation process has been completed at **100**, one or both of the accelerometers may be read at **705** at 10 ms intervals as indicated at step **710** and the voltage data is transferred to the serial port for transmission by the wireless link or by use of infrared transmission.

A corresponding program in the PC itself will read from radio receiver **36** and the receive port the data defining the voltage from one or both the accelerometers. Autocorrelation will be carried out on the reading to generate appropriate characters at step **725**, the characters being displayed on the PC screen at step **730** and possibly being transmitted back to the hand-held PC.

In an alternative implementation autocorrelation may be carried out within the microcontroller **30** and data defining input characters themselves be transmitted to the PC.

Note that the transmission of comma separated variables (CSV) format ASCII is transmitted at 418 MHz using an amplitude modulated radio transmitter from RF Solutions of Lewes East Sussex UK. In the PC CMOS voltage levels converted by the RS232 conversion unit can be used to provide raw data to the PC. Windows 3.1 terminal software is capable of reading CSV data and spreadsheet can read and plot data graphically.

In a still further use of the accelerometer **31, 32** arrangement password protection of the hand-held computer may be provided. Thus, once trained to a user's signature, for example, a stored waveform corresponding to accelerometer voltage outputs read at 10 ms intervals can be used. Thus the user does not require to remember any special passwords and cracking of the signature code is extremely difficult since, for example forging a signature will result in a different acceleration pattern to that of the natural signature writer.

Thus it may be possible to use a hand-held computer of this nature to provide transmission of security information for, for example, electronic point of sale authorisations, access restriction and the like.

A still further use of the transmission and reception capability allows a local area paging system to be developed. Thus if several users work in reasonable proximity to each other it is possible to transmit a message directly from one hand-held computer to another such that, for example, telephone messages taken by one person in an office and files created may be transmitted using a digital serial identity to another specified hand-held computer unit.

Turning to FIG. 16, in addition to the simple 60 second voice note storage chip **34**, the microphone **18** may also be connected by the amplifier and filter arrangements to provide voice input to the microcontroller **30**. Voice recognition software can thus be used to convert the voice input to data, the keys or fingertip switches **18** to **20** having appropriate use for pause, record, etc as hereinbefore described with reference to the spoken memorandum chip. Converted data can thus be transferred to the memory or displayed on screen or as hereinbefore described with reference to using pen input for handwriting correlation by a PC serial data to the PC representing the voice input can be provided. This is indicated at **39**.

In an alternative method of working, the microcontroller causes storage of the speech input in the memory **38** without effecting conversion, the information being transmitted via the serial output port either in the docking station or by the radio link to a PC which may use voice recognition software to carry out the conversions. It may be preferable to use a PC to carry out the conversion rather than a microcontroller incorporated in the pen since significant processing power

may be required. However, the inclusion of voice recognition software in the microcontroller **30** is possible.

It will also be realised that a data store may be used to store received speech signals. Thus several speech notes each time/date stamped may be held for subsequent use. If a suitable store is included then the speech storage chip, hereinbefore described, may be omitted from the stylus to allow additional memory chip space.

It will be noted that since the hand-held computer of the invention includes microphone, loudspeaker and function keys use of the device as a cellular telephone is also envisaged.

Where cellular phone functionality is included within the stylus or where the stylus is in contact with a PC for example by IRDA or radio transmission, the use of the microphone input for substantial dictation purposes is possible and also the use of substantially larger data files than could otherwise be stored locally.

Thus the input speech will be stored in a buffer by the microcontroller **30** and periodically, when the buffer contains a substantial amount of data, a network connection to either network data storage means or to a predetermined PC is effected. Stored buffered data is then transferred to the remote location. Since the network connection is not permanently required the cost of transferring the data by this means is less significant and periods of network signal weakness can be overcome.

Data buffered in this manner may be date and time stamped or, if the stylus incorporates GPS (global positioning systems) may be location stamped also.

Data may similarly be recovered such that large text documents required by a user may have portions stored in the buffer for display and sequential recovery of other parts of the document from the remote location using telephony as required. Photographic data, for example from a digital camera, may similarly be saved to the network by way of the buffered store.

The various functions above described enable the provision of a full PDA function including diary alarm and scheduling functions as well as data input, file creation and storage. The user may select the mode of operation using either soft buttons or movement input and the use of the accelerometers **31, 32** is determined from the mode selected by the user. Electronic mail and fax facilities may be incorporated in the PDA functions allowing reception or transmission of data via the unit. The transmission capability of the unit may be associated with a receiver in a printer for example or a printer incorporating a docking station may be used to allow the printing of data from the PDA. Note that infrared transmission may be used.

As will be appreciated one of the major problems with any hand-held portable device is the use of rechargeable batteries which have a limited power life between charges. The hand-held computer of the present invention therefore incorporates a number of power saving facilities arranged particularly to close down back lighting of the small LCD screen **5** if it is not appropriate. Thus if the accelerometers indicate that there is no current usage of the system then powering down of the detection circuitry and back lighting of the screen may occur. However, in a further use of the proximity detector **15**, it is possible to turn back lighting on and off in dependence upon whether the user is looking at information on the screen or not. Thus, referring to FIG. 15, the pyroelectric detector conversion detects presence of movement to maintain back lighting. Pyroelectric detectors tend to detect presence of a person by movement through a

parallel beam of infrared such that when movement is detected across a Fresnel lens an AC signal is generated.

Thus the pyroelectric system can be used to detect the presence of a user and in the absence of use power down of the back lighting at least may occur. Infrared sensors may similarly be used to detect the presence or absence of body heat. Note the pyroelectric detector, as previously described, can be used to control the character zoom feature hereinbefore described. A suitable detector is a Murata type IRAE700STO.

In a further implementation of back lighting power down which is responsive to the viewer's vision in addition to the viewer's presence. It is known that when a subject looks directly at a lens and a flash occurs blood vessels at the rear of the eyes reflect back to the camera. It is thus possible to periodically flash a low level light and to sense red reflection using a photodiode sensor. Thus as shown at FIG. 15, the microcontroller 30 periodically causes an LED 60 to pulse. At the same time a photodiode 61 is monitored and, assuming presence of a user's eye 62 reflecting light from the pulse, the LCD will remain back lit as indicated at 58. It is further noted that a custom-built solar cell (not shown), for example a Solarex available from Farnell Electronics, may be used to assist triple charging of the battery 2.

If a user is not looking directly at the screen at the time the LED 60 is flashed there will be no reflection and the photodiode 61 will not activate. The microcontroller may therefore power down the back light 58 thus reducing the drain on the rechargeable battery 2.

Although the present invention has been described with reference to a particular implementation using accelerometers other position detection and location means may be used to implement movement detection arrangements. While herein references made to alphanumeric data it will be appreciated that katakana character and Cyrillic script inputs may also be detected using the acceleration method hereinbefore described.

Note when the hand-held computer is docked with a PC or is receiving data by way of cellular or radio transmission it is possible to display received information on the screen 5. Thus as indicated at FIG. 9 an initialisation message is output to the screen 5 and an appropriate buffer is cleared. As characters are received at the serial port they are transferred to the microcontroller at 905 and checked for frame validity at 910. Assuming that there is no error at 910 and that the received character is not a clear screen message as indicated at 915 then a character is transferred to the LCD 5 for display at 920.

Further possible uses of the portable computer of the invention include storing large numbers of speech modes which when down loaded to a PC with the pen either in a docking station or by IRDA or radio transmission are sorted. In this process the PC converts the each of the speech notes to text and scans the text for frequently occurring words, for example "meeting" and then sorts the stored notes into sub-directories. Alternatively, notes may be sorted by date, subject matter or size as will occur with a normal windows file. Key control words such as "alarm" may result in the speech note being converted into a timed alarm which may then be written back to the portable computer so that at the appropriate time the portable computer either announces the alarm or a vibrate to alert the user, the alarm being displayed as a text message. It will be appreciated that if a sufficiently powerful microcontroller is used in the pen then the speech to text conversion may take place in the portable computer unit. A suitable vibrating motor for use as a silent alarm can

be obtained from Murata of Japan. Situating the annunciator towards the barrel of the pen near the tip improves transmission.

The microcontroller may cause audio feedback of the current position of the stylus, for example by causing sounds of flicking pages when the pen is tilted forward or back.

While most emphasis herein has been on the display of alphanumeric, Katakana or Cyrillic characters, graphic information may also be viewed. For example, a file holding pictures related to a person may include three dimensional picture of that person's face. By revolving or tilting the computer the view may switch from a front view to a profile aspect. It will also be appreciated that an atlas may be stored in the data store and maps may be rotated to align with the direction of travel for example.

Additional functionality may be introduced to the hand-held computer by including a touch screen in front of the display screen such that a stylus can be used to select text or to cause localised movement of a cursor.

An autolocate function may be built into the microcontroller such that if no movement, ie no change in tilt of either the enclosed accelerometers occurs for a selectable period, probably 24 hours, the unit will sound an alarm at periodic intervals so that the user can locate it.

Note that the tilt sensors included herein measure tilt with respect to earth's gravity by use of a small beam arrangement. Other position sensors may be included. Global positioning by satellite is also a possible method of detecting a change in the position of the portable computer.

In a symbol counted mode it is possible for a user to flick the pen either as a tick or a cross, for example, in relation to a submitted document. The number of ticks or crosses may be counted and the result accumulated and transferred to data store or accumulated in a spreadsheet to which the user may input names, titles and the like. The use of other symbols in anticipated.

While as hereinbefore described the security signature is by use of acceleration, a pressure detector may be incorporated into the end of the device to further increase security by measurement of the profile as well as the two dimensional or three dimensional spatial sensor.

As has been mentioned hereinbefore, a number of keys, switches and buttons are provided on the casing of the portable computer. In a further implementation an on/off switch may be provided operated by pressure on the "nib-end". Whilst such switch pressure is not used for detecting input text per se, it may be used to turn functions on and off. This may be used in a normal writing mode, for example, touching the pen tip against a writing surface to turn on the accelerometer detection functions. Releasing pressure on the tip then stops the accelerometer signals being considered as potential input to be decoded.

Any of the other switches may be used in certain modes to turn on or off text detection, for example, or to stop screen scrolling for example.

Calculator functions in the portable computer may be provided simply by writing the numerals and appropriate mathematical symbols in the normal manner. The tilt sensor software will determine the numerals and characters entered and perform an appropriate calculation for display on the display screen.

A further function, for example for clock setting causes display of an analogue clock face on the display means 5. Time changes may be entered by selecting an appropriate mode and moving the user's wrist. Tilt sensing is used to determine forward or backward adjustment of the time stored.

What is claimed is:

1. A portable computer comprising:
  - movement detection means responsive to movement of the computer to produce an electrical output signal representative of such movement,
  - a storage medium for storing data defining a multiplicity of displayable pages each comprising of a plurality of lines;
  - a display having a corresponding plurality of lines to enable one of the multiplicity of pages to be displayed; and
 processing means responsive to the output of said movement detection means to determine detected movement data defining a user's intention;
- the processing means using said movement data to provide a mode response selected from a multiplicity of stored possible modes, at least some of which define selection for display of a further one of the pages from the multiplicity of pages, the further one of the pages being adjacent to a previously selected page being currently displayed;
- wherein detected movement data is used to effect scrolling of displayed information such that portions of data defining alphanumeric or graphic information outside a currently displayed screen is selectable by the user, the scrolling of displayed information effectively displaying a part of an adjacent screen.
2. A portable computer comprising:
  - movement detection means responsive to movement of the computer to produce an electrical output signal representative of such movement;
  - a storage medium for storing data defining a multiplicity of displayable pages each comprising of a plurality of lines;
  - a display having a corresponding plurality of lines to enable one of the multiplicity of pages to be displayed; and
 processing means responsive to the output of said movement detection means to determine detected movement data defining a user's intention;
- the processing means using said movement data to provide a mode response selected from a multiplicity of stored possible modes, at least some of which define selection for display of a further one of the pages from the multiplicity of pages, the further one of the pages being adjacent to a previously selected page being currently displayed;
- in which a relative lateral tilting movement causes the display of information stored as to one or other side of currently displayed information.
3. A portable computer comprising:
  - movement detection means responsive to movement of the computer to produce an electrical output signal representative of such movement;
  - a storage medium for storing data defining a multiplicity of displayable pages each comprising of a plurality of lines;
  - a display having a corresponding plurality of lines to enable one of the multiplicity of pages to be displayed; and
 processing means responsive to the output of said movement detection means to determine detected movement data defining a user's intention;
- the processing means using said movement data to provide a mode response selected from a multiplicity of stored possible modes, at least some of which define selection for display of a further one of the pages from

- the multiplicity of pages, the further one of the pages being adjacent to a previously selected page being currently displayed;
- in which relative rolling movement causes the display of information stored as above or below currently displayed information.
- 4. A portable computer comprising:
  - movement detection means responsive to movement of the computer to produce an electrical output signal representative of such movement;
  - processing means responsive to the output of said movement detection means to determine detected movement data defining a user's intention;
  - the processing means using said data to provide a mode response selected from a multiplicity of stored possible modes; and
  - wherein the processing means is responsive to detected movement data to determine a most likely orientation of a computer display means, the processing means causing the displayed information to be oriented accordingly.
- 5. A portable computer as in claim 4, in which a plurality of switch means responsive to user action is included adjacent to the display means, the respective function of each of the switch means being oriented to match the orientation of displayed information.
- 6. A portable computer as in claim 4 further comprising a touch sensitive static potentiometer strip responsive to movement of a user's finger to simulate movement of a potentiometer, the orientation of said potentiometer reflecting the orientation of the displayed information.
- 7. A portable computer comprising:
  - movement detection means responsive to movement of the computer to produce an electrical output signal representative of such movement;
  - processing means responsive to the output of said movement detection means to determine detected movement data defining a user's intention, the processing means using said data to provide a mode response selected from a multiplicity of stored possible modes; and
  - proximity detection means which provides signals indicative of the proximity of a computer display screen to a user's view, the processing means being further responsive to changes in relative proximity to increase or decrease the density of displayed information.
- 8. A portable computer comprising:
  - movement detection means responsive to movement of the computer to produce an electrical output signal representative of such movement;
  - a storage medium for storing data defining a multiplicity of displayable pages each comprising of a plurality of lines;
  - a display having a corresponding plurality of lines to enable one of the multiplicity of pages to be displayed; and
 processing means responsive to the output of said movement detection means to determine detected movement data defining a user's intention; the processing means using said movement data to provide a mode response selected from a multiplicity of stored possible modes, at least some of which define selection for display of a further one of the pages from the multiplicity of pages, the further one of the pages being adjacent to a previously selected page being currently displayed;
- radio transceiver means, the processing means being responsive to detected movement data which identifies

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another device to cause the transmission of coded signals including a message for display.

9. A portable computer as in claim 8 in which the processing means is responsive to received encoded radio signals to activate a paging alert.

10. A portable computer as in claim 9, in which the page alert comprises a tone.

11. A portable computer as in claim 9, in which the paging alert comprises an operation of a vibrating means.

12. A portable computer as in claim 8, in which the processing means causes the display of a message derived from the information received.

13. A portable computer comprising:

a casing for housing other components of the portable computer, the casing being shaped to facilitate a user holding the portable computer as a writing stylus; and a display screen;

wherein said casing includes a radiused triangular cross-section along a substantial portion of its length and a flattened section incorporating the display screen, and an angular shaping between a forward holding area adapted to rest in the user's fingers and rearward flattened area holding the display screen the shaping being such as to provide a natural viewing angle of the incorporated display screen while the casing is held as a writing stylus.

14. A portable computer as in claim 13, in which the shaping causes the rearward screen area to be supported by the dorsal areas of a user's hand.

15. A portable computer comprising:

movement detection means responsive to movement of the computer to produce an electrical output signal representative of such movement;

a storage medium for storing data defining a multiplicity of displayable pages each comprising of a plurality of lines;

a display having a corresponding plurality of lines to enable one of the multiplicity of pages to be displayed; and

processing means responsive to the output of said movement detection means to determine detected movement data defining a user's intention;

the processing means using said movement data to provide a mode response selected from a multiplicity of stored possible modes, at least some of which define selection for display of a further one of the pages from the multiplicity of pages being the further one of the pages being adjacent to a previously selected page being currently displayed;

wherein the processing means is responsive to detected movement data to determine a most likely orientation of the display, the processing means causing the displayed information to be oriented accordingly.

16. A portable computer comprising:

movement detection means responsive to movement of the computer to produce an electrical output signal representative of such movement;

a storage medium for storing data defining a multiplicity of displayable pages each comprising of a plurality of lines;

a display having a corresponding plurality of lines to enable one of the multiplicity of pages to be displayed; and

processing means responsive to the output of said movement detection means to determine detected movement data defining a user's intention;

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the processing means using said movement data to provide a mode response selected from a multiplicity of stored possible modes, at least some of which define selection for display of a further one of the pages from the multiplicity of pages, the further one of the pages being adjacent to a previously selected page being currently displayed;

in which a plurality of switch means responsive to user action is included adjacent to the display, the respective function of each of the switch means being oriented to match the orientation of displayed information.

17. A portable computer comprising:

movement detection means responsive to movement of the computer to produce an electrical output signal representative of such movement;

a storage medium for storing data defining a multiplicity of displayable pages each comprising of a plurality of lines;

a display having a corresponding plurality of lines to enable one of the multiplicity of pages to be displayed;

processing means responsive to the output of said movement detection means to determine detected movement data defining a user's intention, the processing means using said movement data to provide a mode response selected from a multiplicity of stored possible modes, at least some of which define selection for display of a further one of the pages from the multiplicity of pages, the further one of the pages being adjacent to a previously selected page being currently displayed; and

a touch sensitive static potentiometer strip responsive to movement of a users finger to simulate movement of a potentiometer, the orientation of said potentiometer reflecting the orientation of the displayed information.

18. A portable computer comprising:

movement detection means responsive to movement of the computer to produce an electrical output signal representative of such movement;

a storage medium for storing data defining a multiplicity of displayable pages each comprising of a plurality of lines;

a display having a corresponding plurality of lines to enable one of the multiplicity of pages to be displayed; and

processing means responsive to the output of said movement detection means to determine detected movement data defining a user's intention;

wherein detected movement data is used to effect scrolling of displayed information such that portions of data defining alphanumeric or graphic information outside a currently displayed screen is selectable by the user, the scrolling of displayed information effectively displaying a part of an adjacent screen.

19. A portable computer as in claim 18, including a sound output device, the processing means being arranged to provide output of speech or other sound signals derived from stored data.

20. A portable computer as in claim 18, including radio transmission or infrared transmission means, the processing means being responsive to detected movement data to output to the transmission means signals representative of the detected movement.

21. A portable computer as in claim 18, including radio transmission or infrared transmission means, the processing means being responsive to detected movement data to output to the transmission means signals representative of alphanumeric characters.

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22. A portable computer as in claim 18, in which the processing means stores data defining an authorised user's password, the processing means being locked in a secure mode until detected movement data corresponding to the security data is received.

23. A portable computer as in claim 18, further comprising a sound input device, the processing means being responsive to voice input signals from a user to derive alphanumeric data.

24. A portable computer as in claim 23, further including a sound output device in combination with a radio transceiver whereby cellular or radio telephony networks may be used.

25. A portable computer as in claim 18 housed in a casing shaped to facilitate a user holding the computer as a writing stylus.

26. A portable computer as in claim 25, in which the casing comprises a radiused triangular cross-section along a substantial portion of its length.

27. A portable computer as in claim 26, in which the casing includes a flattened section incorporating a display screen.

28. A portable computer comprising:

movement detection means responsive to movement of the computer to produce an electrical output signal representative of such movement;

a storage medium for storing data defining a multiplicity of displayable pages each comprising of a plurality of lines;

a display having a corresponding plurality of lines to enable one of the multiplicity of pages to be displayed; and

processing means responsive to the output of said movement detection means to determine detected movement data defining a user's intention;

in which a relative lateral tilting movement causes the display of information stored as to one or other side of currently displayed information.

29. A portable computer as in claim 28 housed in a casing shaped to facilitate a user holding the computer as a writing stylus.

30. A portable computer as in claim 29, in which the casing comprises a radiused triangular cross-section along a substantial portion of its length.

31. A portable computer as in claim 30, in which the casing includes a flattened section incorporating a display screen.

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32. A portable computer comprising:

movement detection means responsive to movement of the computer to produce an electrical output signal representative of such movement;

a storage medium for storing data defining a multiplicity of displayable pages each comprising of a plurality of lines;

a display having a corresponding plurality of lines to enable one of the multiplicity of pages to be displayed; and

processing means responsive to the output of said movement detection means to determine detected movement data defining a user's intention;

in which relative rolling movement causes the display of information stored as above or below currently displayed information.

33. A portable computer as in claim 32 housed in a casing shaped to facilitate a user holding the computer as a writing stylus.

34. A portable computer as in claim 33, in which the casing comprises a radiused triangular cross-section along a substantial portion of its length.

35. A portable computer as in claim 34, in which the casing includes a flattened section incorporating a display screen.

36. A portable computer comprising:

movement detection means responsive to movement of the computer to produce an electrical output signal representative of such movement;

a storage medium for storing data defining a multiplicity of displayable pages each comprising of a plurality of lines;

a display having a corresponding plurality of lines to enable one of the multiplicity of pages to be displayed; and

processing means responsive to the output of said movement detection means to determine detected movement data defining a user's intention;

wherein the processing means is responsive to detected movement data to determine a most likely orientation of the display, the processing means causing the displayed information to be oriented accordingly.

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