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U1S S2424**

(56) Documents Cited
US 4763116 A US 4552360 A

(58) Field of Search
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Online: WPI

(54) **Spherical cursor positioning device rotatable about a single axis.**

(57) A simplified 'trackerball' giving one dimensional cursor movement to assist young children to learn to use computer input devices. A substantially spherical and hollow hand contacting member 18 is mounted to rotate around a single axis shaft 22 and is strengthened internally at its equator by a steel disk 20. A pinion 32 is attached to one end of the axis shaft and drives a crown gear 34 on a second shaft 40 mounted orthogonally to the first, this second shaft carries an optical encoder disk 42 comprising radial slots. The command signal is generated by two pairs of LEDs and a phototransistor offset w.r.t. the axis of the second shaft comparing the timing of the light pulsed transmitted through the slots.

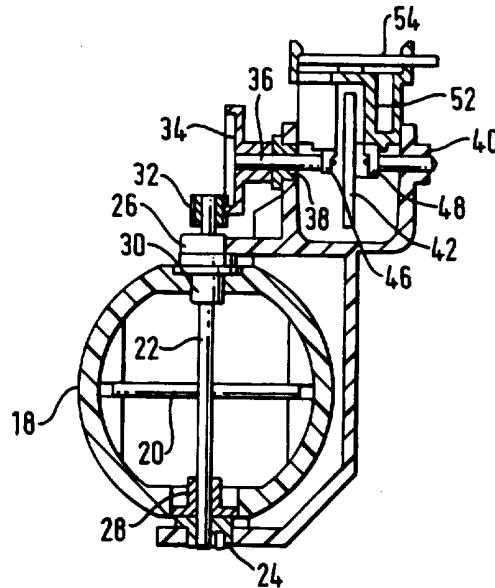


FIG. 3b

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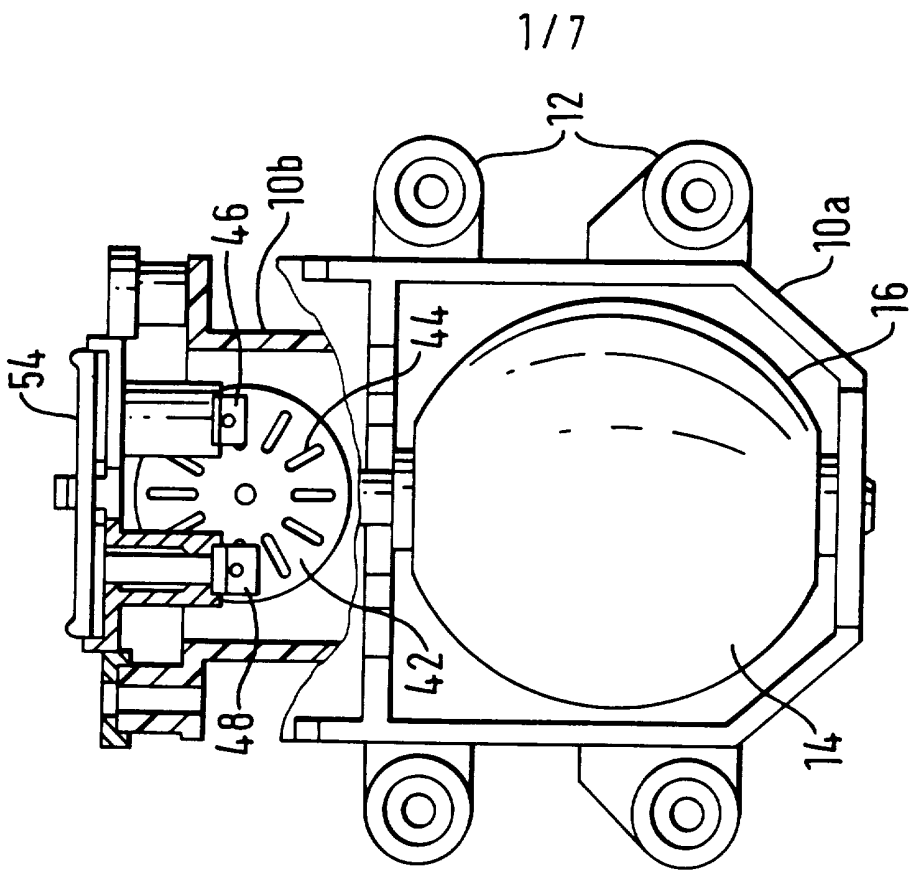


FIG. 1a

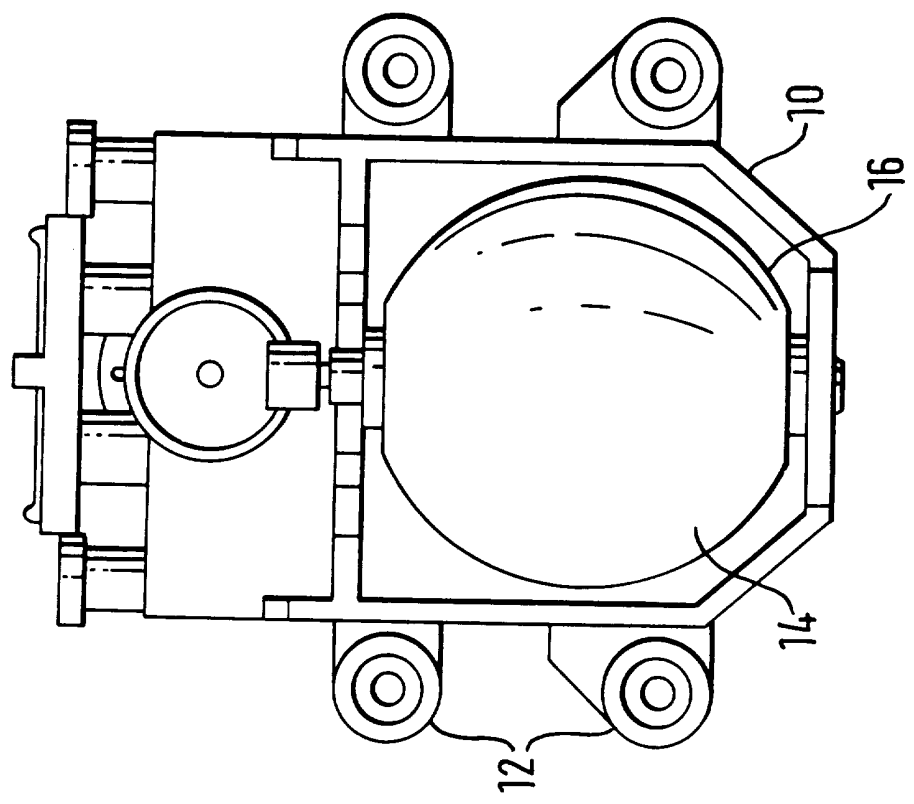


FIG. 1b

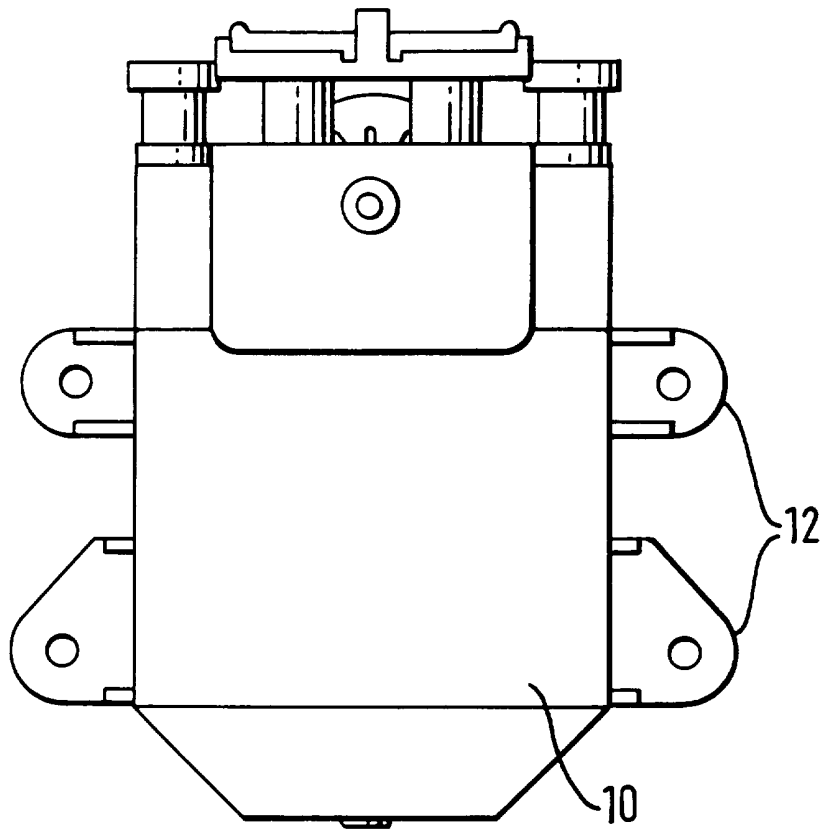


FIG. 2

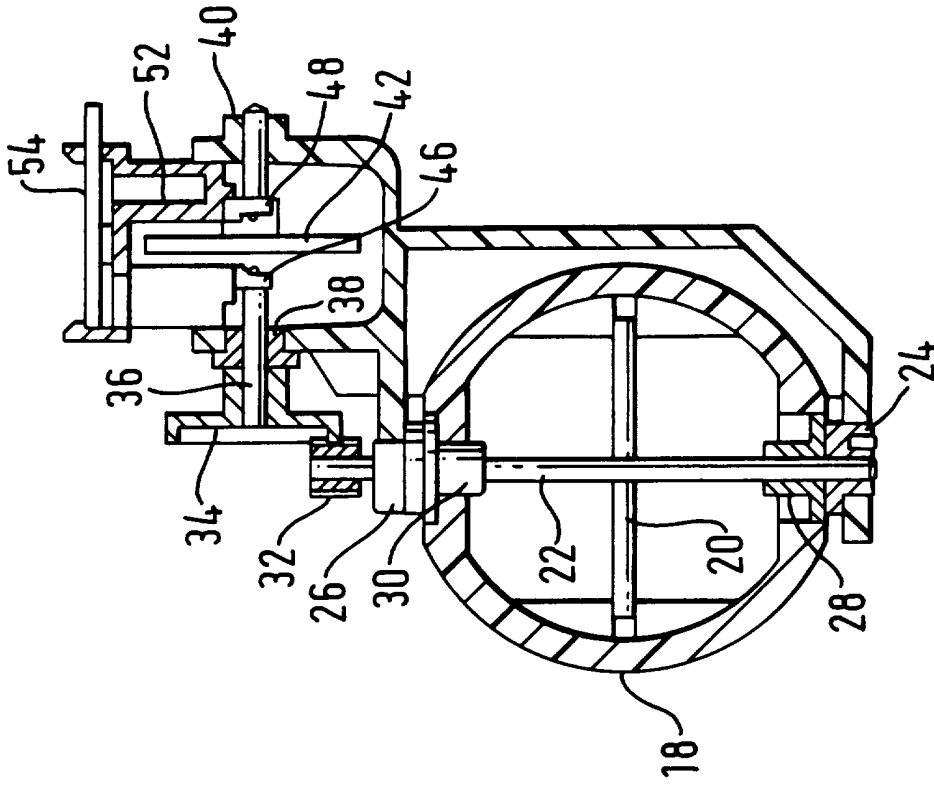


FIG. 3b

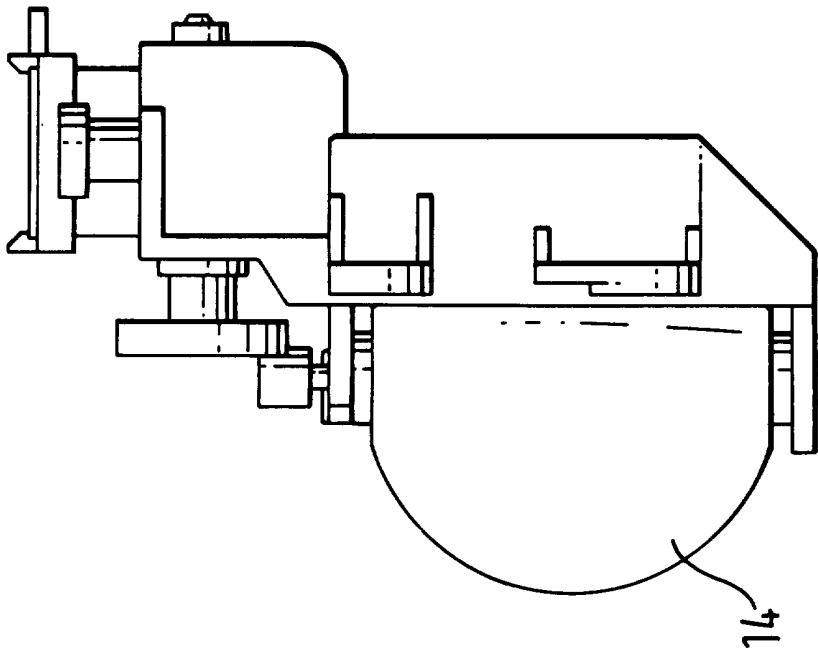


FIG. 3a

417

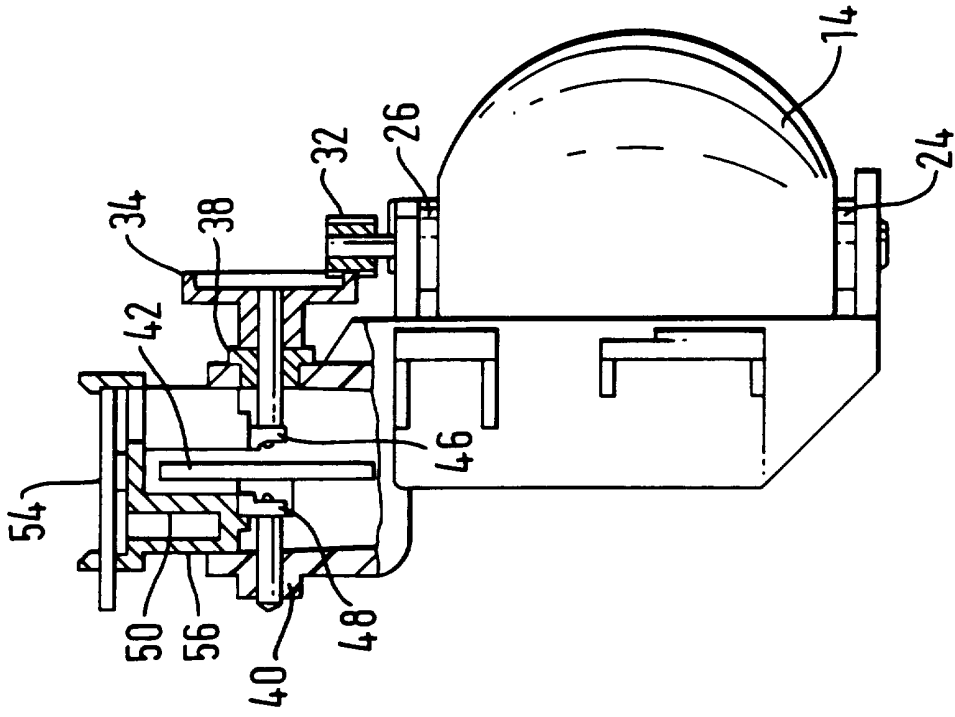


FIG. 4b

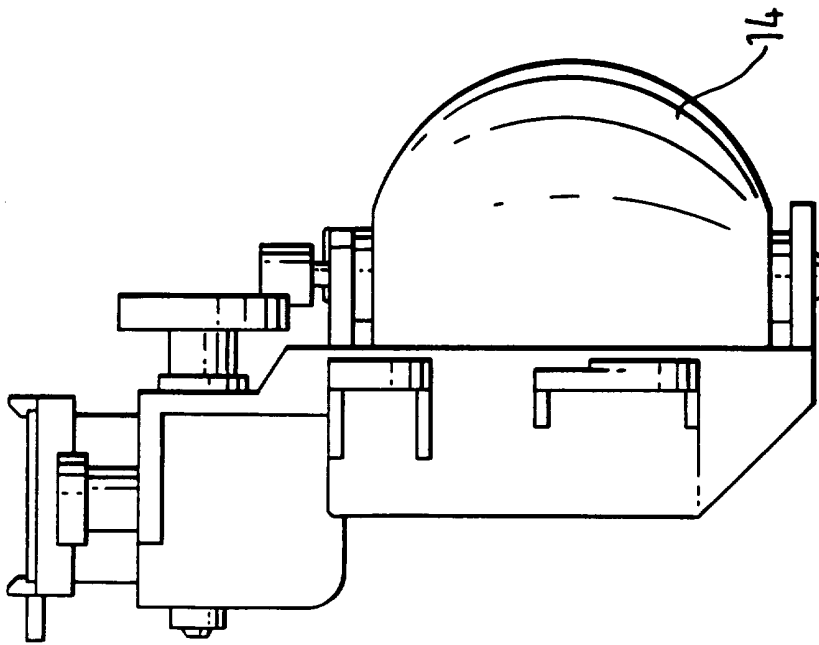


FIG. 4a

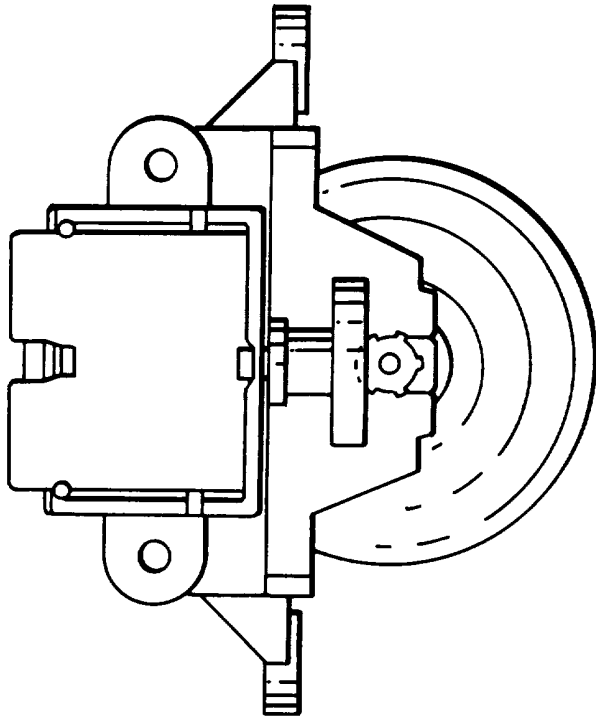


FIG. 6

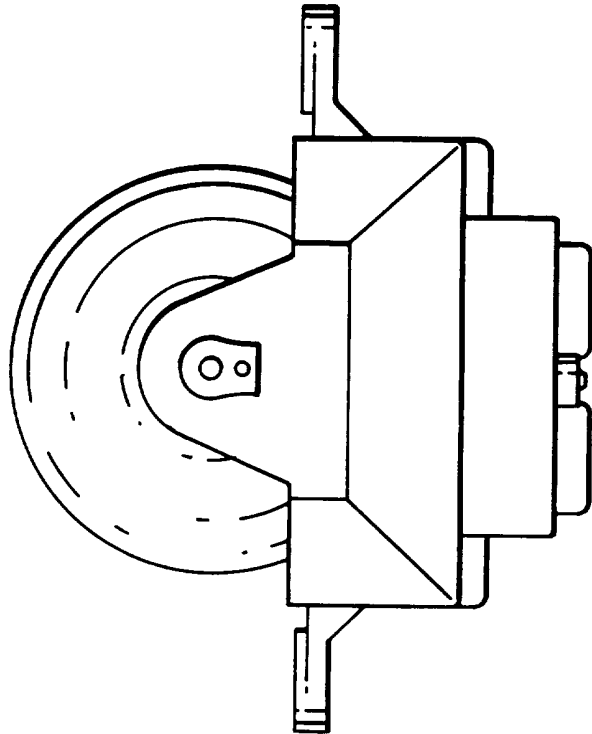


FIG. 5

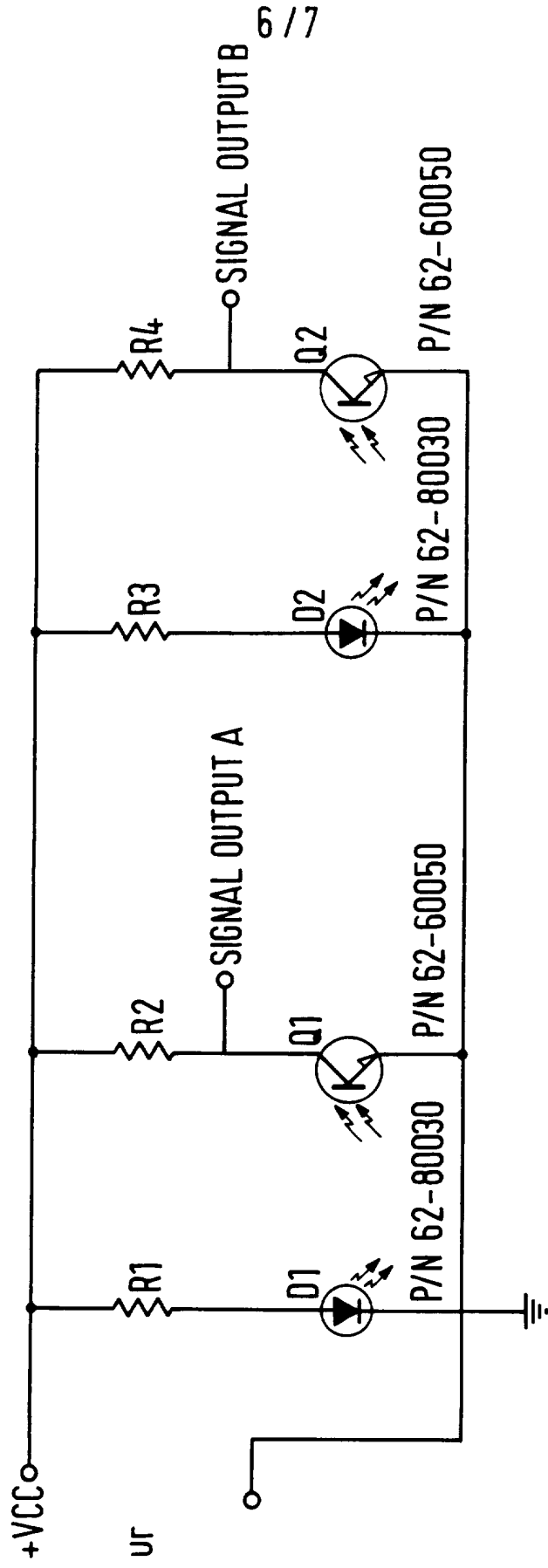


FIG. 7

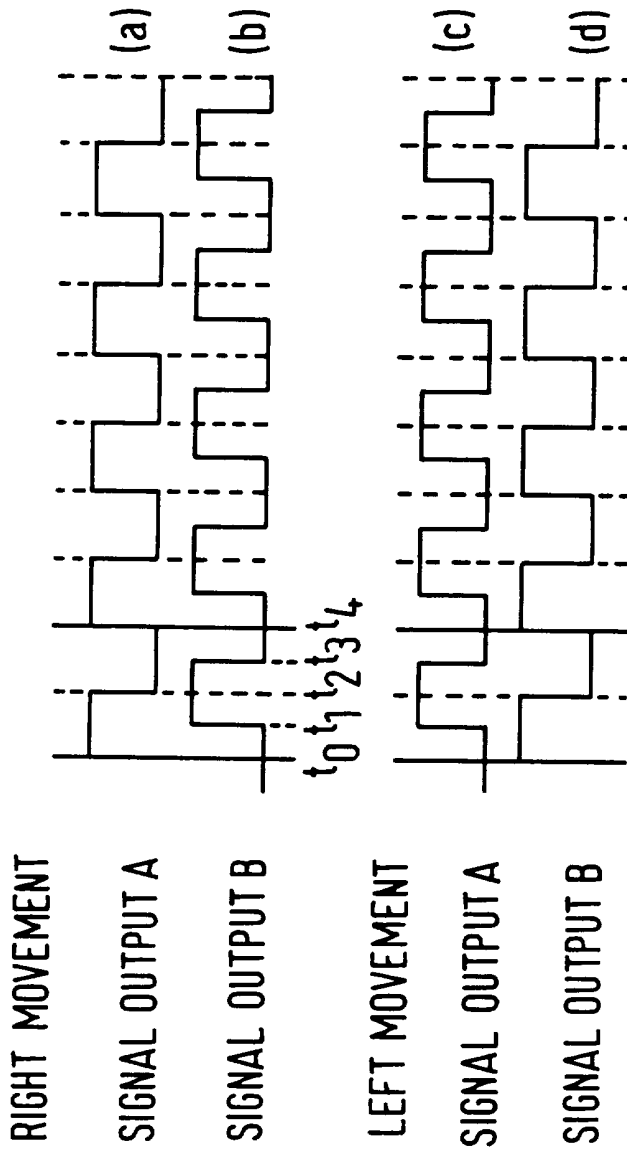


FIG. 8

Cursor Positioning Device

The invention relates to a cursor positioning device and in particular to a cursor positioning device which is suitable for use with children's toys or games.

In recent years computer and electronic games and toys have become increasingly
5 common and are often favoured by children over traditional toys and board games. As
the costs of the electronic components used in such toys and games have fallen, they
have been incorporated into a wide range of devices from highly sophisticated computer
games for teenagers to relatively simple and inexpensive toys and games for younger
10 children. These toys and games can be of educational value, in particular for younger
children, in the development of skills such as reading, grammar, coordination and
building up vocabulary.

With the increasing importance of computers at all levels of life in the modern world,
most parents are keen that their children become familiar with computers and learn to
use them to at least some extent from an early age.

15 In many computer and electronic games and toys, it is common to use a mouse device
for moving a pointer or cursor into a particular position on a display or screen before
a control signal is input by depressing a switch or key. Conventional mouse devices
comprise a ball mounted within a housing, the ball rotating as the mouse is moved on
a flat surface. The ball is held in frictional engagement with two rollers each of which
20 is mounted on respective mutually orthogonal shafts. As the mouse is moved, the ball
rotates and the rollers and their respective shafts, in turn, rotate. The direction and
rotating angles of the rollers are each detected and converted into X and Y coordinates
to displace the cursor on the display or screen. The mouse is generally a separate unit
and is coupled to the computer or toy by a cable.

25 Such mouse devices are of complex construction and can be difficult to operate,
especially for children of very young ages. For very young children it takes a long time
to learn to associate their own movement of a mouse along a surface with that of a

cursor on a remote screen or display tend. Moreover, they tend to have rather clumsy hand movements and find it difficult to precisely manoeuvre the mouse in two coordinates, while simultaneously watching the screen or display.

Several cursor positioning devices used in association with devices such as keyboards
5 and remote controllers are known from the prior art.

GB-A-2260598 discloses a cursor positioning device incorporated into a keyboard, which is capable of displacing the cursor in any direction. The device comprises a rod-like composite body including two manipulative bodies which interlock for rotation together but are also moveable axially relative to each other. A series of detection mechanisms
10 are provided to detect rotation of the bodies, relative axial displacement of the bodies and displacement in a direction perpendicular to the axis of the composite body. However such a device is of complex construction and hence expensive to manufacture, rendering it unsuitable for use in children's toys and games.

A cursor positioning device of simpler construction is disclosed in US-A-4712101. This
15 device is also located at the front of a keyboard and comprises a rotatable shaft on which is mounted a freely slidable cylinder coupled to the shaft. Vertical movements of the cursor are achieved by rotation of the shaft while horizontal movements are achieved by sliding the cylinder along the shaft. Such a device is complex and difficult for a small child to manipulate since it requires both rotation and sliding in order to achieve two
20 directional movement of the cursor. However, such a device is bulky with the shaft extending along the entire length of the keyboard so that sliding of the cylinder in both directions can be facilitated. Hence, such a device is not suitable for use on children's games which are generally of compact size so that they can be easily held by the child.

EP-A-O531829 discloses an input device suitable as a remote-controlled device for use
25 in TVs and video recorders. A manipulative roller of generally cylindrical shape projects from the upper surface of the device and serves both to actuate a push button switch and to control the position of a cursor. The manipulative roller is integral with a shaft and is coupled to the shaft of an encoder disc via a belt and pulley gearing

mechanism. The encoder detects the amount and direction of rotation of the manipulative roller. The shaft of the manipulative roller is supported in a moveable bearing member which is caused to pivot when the manipulative roller is pushed down, whereupon a ledge projecting from the moveable bearing member presses upon a push
5 button switch and actuates the same. However, this device is not suitable for use by young children as its operation is complex and requires some skill. The rather clumsy hand movements of small children may cause the switch to be prematurely actuated before the cursor has been moved to the correct position. Moreover, the cylindrical shape of the roller is relatively space consuming and difficult to manipulate for a young
10 child.

It was against this background that the device of the present application was developed. Applicant has recognised a need for a cursor positioning device which is suitable for use by young children. In particular, such a cursor positioning device could constitute a useful learning tool for young children, its simple construction making it easy to use and
15 serving to familiarize children with computers and to develop basic computer skills at a very early age. As children grow older and more competent, they can move on to the more complex conventional mouse devices and will find such devices much easier to use.

An object of the present invention is, therefore, to provide a cursor positioning device of relatively simple design, capable of effecting movement of the cursor along a single
20 axis only and which is suitable for use by young children in computer or electronic games and toys.

Broadly speaking and from one aspect, the invention resides in a cursor positioning device comprising a contact member mounted for rotation about a single axis, rotation of the contact member being detected and converted into displacement of a cursor,
25 characterised in that the contact member has a contact surface which is curved in two dimensions.

Such a contact member is easier to manipulate for a child than a cylindrical roller as there is less friction to movement along a surface due to a smaller area of contact. The

curved contact surface makes it easier for a child to manipulate the device than, for example, the cylindrical rollers described in the prior art above. Such a roller has a line contact with the surface on which it is to be moved and movement is constrained to an axis perpendicular to the axis of the roller. A two-dimensionally curved contact surface, on the other hand, has substantially a point contact with the surface on which it is to be moved and is more free to move in other directions. This is particularly important in the development of coordination skills of the child in learning to associate the movement of a remote device with that of a cursor on a screen or display. If the device is difficult to manipulate and can move freely on only one axis, a child becomes frustrated and loses interest quickly.

In addition, the curved contact surface of the contact member lends the cursor positioning device the appearance of a "conventional" mouse or trackball device and so the child can have the illusion of using a "grown-up" device rather than a toy. This is an important aspect in educational toys and games, as a young child is naturally more enthusiastic and willing to use a device which it associates with adults, at the same time developing the child's computer skills.

Moreover, the mounting of the contact member so that it rotates about a single axis only ensures that displacement of the cursor along a single axis only, is possible. Hence, the device is simple to use and understand by very young children whose coordination skills have not fully developed. The children can easily manoeuvre the device with one or both hands, while keeping their eyes and concentration on the position of the cursor on the display or screen.

Preferably, the contact member is mounted on a single primary shaft.

The single shaft construction of the device means that it is easier and cheaper to manufacture in comparison to conventional mouse devices with their two orthogonal shaft construction. This is important in the toy and game industries where in particular with very young children toys and games have a relatively short lifetime and parents are reluctant to spend a lot of money on such products.

In a preferred embodiment of the invention the contact member has a part-spherical shape and in a particularly preferred form the contact member is substantially spherical.

Use of such a spherical or part-spherical contact member further approaches the appearance of conventional cursor positioning devices, as it looks like the "ball" of a
5 computer mouse or trackball.

In a preferred embodiment, the cursor positioning device is integral with the main body of the toy or computer game. Mouse devices which are separate from the main body of the computer or game have a tendency to become lost or to get broken easily when the mouse falls or is thrown. With a broken or defective mouse device, the game or toy can
10 no longer be used and a replacement mouse device can be expensive and difficult to obtain. With an integral cursor positioning device, the risk of the device becoming lost or broken when it falls or is thrown by the child is reduced and there is no need for a connecting cable.

15 From another aspect, the invention resides in a cursor positioning device comprising a contact member mounted for rotation on a primary shaft, the rotation of the contact member being detected and converted into displacement of a cursor by an encoder mounted on a secondary shaft having an axis of rotation perpendicular to that of the primary shaft, characterised in that the primary and secondary shafts are connected by
20 positive gearing.

Such positive connection between the contact member and the encoder eliminates slippage problems which sometimes occur in conventional mouse devices when the ball is held in frictional engagement with two rollers. The arrangement of the gearing in such a way that rotation of the encoder occurs about an axis perpendicular to that of the shaft
25 of the contact member minimises the space occupied by the components of the device, rendering it more compact and hence suitable for use in children's toys.

From yet another aspect, the invention resides in a cursor positioning device comprising a contact member mounted for rotation on a primary shaft, rotation of the contact

member being detected and converted into displacement of a cursor by an optical encoder mounted on a secondary shaft with an axis of rotation perpendicular to that of the primary shaft, characterised in that the contact member is substantially spherical and the primary and secondary shafts are linked by positive gearing.

- 5 Friction and slippage problems associated with cylindrical rollers or balls held in frictional engagement are greatly improved by such a construction. In addition, the perpendicular arrangement of the primary and secondary shafts minimises the space required by the gearing leading to a compact device.

In order that the invention may be more readily understood, an embodiment in
10 accordance therewith will now be described, by way of example, with reference to the accompanying drawings, in which:-

Figure 1a is a top plan view of a cursor positioning device according to the invention.

Figure 1b is a top plan view corresponding to Figure 1a with the part of the housing removed to illustrate internal components of the device.

- 15 Figure 2 is a bottom plan view of the cursor positioning device of Figure 1a.

Figure 3a is a side view from the right of the cursor positioning device of Figure 1a.

Figure 3b is a side view corresponding to Figure 3a with part of the housing removed to illustrate internal components of the device.

- 20 Figure 4a is a side view from the left of the cursor positioning device of Figure 1a.

Figure 4b is a side view corresponding to Figure 4a with part of the housing removed to illustrate internal components of the device.

Figure 5 is a front view of the cursor positioning device of Figure 1a.

Figure 6 is a rear view of the cursor positioning device of Figure 1a.

Figure 7 is a circuit diagram of a sensor used in the cursor positioning device of Figure 1a.

Figure 8 is a timing diagram of the signals from the circuit of Figure 7.

5 Referring to Figures 1a to 6 of the drawings, there is shown a cursor positioning device comprising a plastics housing (10) which supports the components of the device. The housing essentially consists of two parts, a first part (10a) of generally rectangular shape in which a ball (14) is supported and an extension (10b) of generally U-shape in which the components of a detector are supported. The housing (10) is secured to the main
10 body (not shown) of a computer game or toy by means of four peripheral fasteners (12) mounted on the first part (10a) of the housing.

The ball (14) is of generally spherical shape and projects through a window (16) in the upper surface of the housing (10). The ball (14) has a hollow interior, its wall (18) being
15 moulded from a suitable plastics material such as ABS. A supporting disc plate (20) of mild steel is provided within the hollow interior of the ball (14) for increased strength and to prevent the ball (14) being crushed during use.

The disc plate (20) has a circular aperture at its centre through which a primary shaft (22) passes. The primary shaft (22) is orthogonal to the general plane of the disc plate
20 (20) and extends centrally through the ball's (14) interior. The primary shaft (22) passes through the wall (18) of the ball (14) at opposite ends of the shaft and is supported by bearings (24, 26) supported in turn by the housing (10). At one of its ends, the primary shaft (22) protrudes through the bearing (26) and beyond. Cylindrical studs (28, 30) are mounted on the primary shaft (22), one close to each end thereof at the positions where
25 the primary shaft (22) passes through the wall (18) of the ball (14). These studs (28, 30) serve to attach the ball (14) to the primary shaft (22).

At the end of the primary shaft (22) that protrudes through the bearing (26), a pinion

gear (32) is attached to the primary shaft (22). The pinion gear (32) meshes with a perpendicularly-mounted crown gear (34) mounted at one end of a secondary shaft (36) which extends through the U-shaped extension (10b) of the housing (10) in which it is supported by a bushing (38) and a bearing (40).

5 An encoder disc (42) is mounted on the secondary shaft (36) between the bushing (38) and the bearing (40) and is provided with a series of identical elongate rectangular apertures (44). The longitudinal axes of the apertures (44) extend radially with respect to the encoder disc (42) and are disposed with equi-angular spacing around the disc (42). Two optical sensors (46, 48) are situated on opposite sides of the axis of rotation of the
10 encoder disc within the U-shaped extension (10B) of the housing. The sensors (46, 48) are not directly opposed to each other with respect to the axis of rotation of the encoder disc (42) but are slightly offset as shown.

Each optical sensor (46, 48) comprises a light emitting diode (not shown) and a phototransistor (not shown) mounted in supporting legs (50) and (52) respectively and
15 positioned on opposite sides of the encoder disc (42). A printed circuit board (54) is mounted on supporting legs (56) which extend from the U-shaped extension (10b) of the housing. The printed circuit board (54) has electrical components thereon connected to a source of electric power and a control circuit (not shown).

In operation, a child rotates a contact surface of the ball (14) which projects through the
20 window (16) in the housing (10) in a desired direction, causing the primary shaft (22) and the pinion gear (32) to rotate in the same direction. Rotation of the pinion gear (32) causes rotation of the crown gear (34), the secondary shaft (36) and the encoder disc (42) about an axis perpendicular to that of the primary shaft (22).

As the encoder disc (42) rotates, light beams emitted by the respective diodes will
25 successively pass through an aperture (44) at those positions where an aperture (44) is located in the path of the beam. The corresponding phototransistors of each optical sensor (46, 48) are respectively switched on and off as light from the beam is received and then interrupted and a pulse sequence is generated. The offset arrangement of the

optical sensors (46, 48) ensures that the phototransistors of the respective sensors (46, 48) are not switched simultaneously. Hence, one phototransistor will be switched on before the other, the delay between the switching of the respective phototransistors being dependent on the direction and speed of rotation of the ball (14). The direction of rotation of the ball (14) can be detected from the sequence in which the respective phototransistors are switched.

Referring to Figure 7 of the drawings, the optical sensors (44, 46) are shown schematically in a circuit diagram. The diode and phototransistor of optical sensor (44) are represented by D1 and Q1 respectively while the diode and phototransistor of optical sensor (46) are represented by D2 and Q2 respectively. Load resistors (R1, R2, R3, R4) associated with the sensors (44, 46) are mounted on the printed circuit board (54) and the components are fed with a supply voltage Vcc. The output signals from optical sensors (44, 46) are output at nodes A and B respectively.

The output signals from nodes A and B are shown in Figures 8a-d. As previously described, the signals at nodes A and B are decoded so that the direction of motion is determined from the order in which the pulses of the respective signals occur while the distance moved is determined by counting the pulses of the respective signals. The circuitry and software used for decoding the various signals will be readily apparent to those skilled in the art and shall not be described herein.

Referring to Figures 8a and 8b, a typical sequence will be described. At an initial time t_0 , the child begins to rotate the ball (14) to the right. The phototransistor Q1 of sensor (46) is exposed to light from diode D1 through a slot (44) in the encoder disc causing it to switch ON and causing the signal at node A to go HIGH. Light from D2 of sensor (48) is blocked at this time, as there is no slot in the path of the beam to allow light to reach Q2. Therefore, phototransistor Q2 is OFF and output signal B LOW. Since Q1 receives light before Q2, it is known that the encoder disc is rotating in a clockwise direction and hence the ball is being rotated to the right. The direction of rotation of the ball (14) can be established at this stage, since the direction of rotation of the encoder disc will be detected since Q1 is receiving light before Q2. At time t_1 , the encoder disc

(42) has rotated to a position where a slot (44) lies in the path of the beam from D2 causing phototransistor Q2 to switch ON and output signal B to switch HIGH. Hence, both transistors Q1 and Q2 are ON at this time. At time t_2 , the encoder disc (42) has rotated to a position where slot (44) has moved out of the path of the light beam from
5 D1 causing Q1 to switch OFF and output signal at node A to go LOW. Similarly at time t_3 , the encoder disc (42) has rotated to a position where the light beam of D2 is blocked and so, Q2 switches OFF and output signal B goes LOW. The cycle then begins again at time t_4 and continues until such time as rotation of the ball (14) stops and the cursor is in the desired position.

10 A similar sequence is shown in Figures 8c and 8d for rotation of the ball (14) in the opposite direction, i.e to the left. In this case, since Q2 is switched ON before Q1 it can be detected that the encoder disc (42) is rotating in an anticlockwise direction and hence the ball (14) is being rotated to the left.

15 Whilst a particular embodiment has been described, it should be appreciated that various modifications may be made without departing from the scope of the invention. Moreover whilst the invention has been described with particular reference to a children's toys and games as a learning tool to familiarise young children with computers, it should be understood that the cursor positioning device can be used in other applications.

CLAIMS

1. A cursor positioning device comprising a contact member mounted for rotation about a single axis, rotation of the contact member being detected and converted into displacement of a cursor, characterised in that the contact member has a contact surface
5 which is curved in two dimensions.
2. A cursor positioning device according to claim 1, characterised in that the contact member is at least part spherical.
3. A cursor positioning device according to claims 1 or 2, characterised in that the
10 contact member is substantially spherical.
4. A cursor positioning device according to any of claims 1 to 3 characterised in that the contact member is mounted on a primary shaft.
5. A cursor positioning device according to claim 4, characterised in that it further comprises encoder means for detecting and converting rotation of the revolving member
15 into displacement of a cursor, the encoder being mounted on a secondary shaft the axis of rotation of which is perpendicular to that of the primary shaft, the shafts being connected by positive gearing means.
6. A cursor positioning device according to claim 5, characterised in that the encoder means is an optical encoder comprising an encoder disc and two optical detectors.
- 20 7. A cursor positioning device according to claim 6, characterised in that the encoder disc is provided with a series of equiangularly spaced, elongate apertures, the longitudinal axes of which extend radially with respect to the disc.
8. A cursor positioning device according to claim 6, characterised in that the optical sensors are situated on opposite sides of the axis of rotation of the encoder disc and each
25 comprise a light emitting diode and a phototransistor.

9. A cursor positioning device according to claim 8, characterised in that the optical sensors are offset with respect to the axis of rotation of the encoder disc.
10. A cursor positioning device according to any of claims 5 to 9, characterised in that the positive gearing means comprises a pinion gear and crown gear.
- 5 11. A cursor positioning device according any preceding claim, characterised in that the contact member has a hollow interior containing a supporting disc plate mounted perpendicularly with respect to the axis of rotation of the contact member.
12. A cursor positioning device according to claim 11 when appended to claim 4, characterised in that the primary shaft passes through an aperture in the centre of the
10 supporting disc plate.
13. A cursor positioning device comprising a contact member mounted for rotation on a primary shaft, the rotation of the contact member being detected and converted into displacement of a cursor by an encoder mounted on a secondary shaft having an axis of rotation perpendicular to that of the primary shaft, characterised in that the primary and
15 secondary shafts are connected by positive gearing.
14. A cursor positioning device according to claim 13, characterised in that the positive gearing comprises a pinion gear and crown gear.
15. A cursor positioning device according to claim 13 or claim 14, characterised in that the contact member has a contact surface which is curved in two dimensions.
- 20 16. A cursor positioning device according to claim 15, characterised in that the contact member is at least part spherical.
17. A cursor positioning device according to claims 15 or 16, characterised in that the contact member is substantially spherical.

18. A cursor positioning device comprising a contact member mounted for rotation on a primary shaft, rotation of the contact member being detected and converted into displacement of a cursor by an optical encoder mounted on a secondary shaft with an axis of rotation perpendicular to that of the primary shaft, characterised in that the
- 5 contact member is substantially spherical and the primary and secondary shafts are linked by positive gearing.
19. A cursor positioning device according to any preceding claim which is integral with a cursor display device.
- 10 20. A cursor positioning device substantially as hereinbefore described with reference to the accompanying drawings.
21. A cursor display device including a cursor positioning device according to any preceding claims.



Application No: GB 9601424.6
Claims searched: 1-12

Examiner: J. C. Barnes-Paddock
Date of search: 29 February 1996

**Patents Act 1977
Search Report under Section 17**

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:
UK CI (Ed.O): F2Y (YTA YTB YCB)
Int CI (Ed.6): A63F 9/00, 22 G06K 11/18
Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
Y	US 4,763,116 (EICHHOLZ) Fig. 2 Two single axis cursor positioners	1
Y	US 4,552,360 (COLECO) Fig. 4 Note the curved profile of spinner 32	1

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.