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**Wang**

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(54) **LOW PROFILE JOY STICK AND SWITCH**

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(52) **U.S. Cl.** ..... **345/161**; 200/6 A
(58) **Field of Search** ..... 345/161, 157, 345/168; 74/471 XY; 341/20; 200/612; 338/128, 131

(56) **References Cited**

U.S. PATENT DOCUMENTS

| | | | | |
|---|---|---|---|---|
| 3,394,611 | A | | 7/1968 | Beurrier |
| 4,325,050 | A | | 4/1982 | Suszynski |
| 4,375,631 | A | | 3/1983 | Goldberg |
| 4,490,710 | A | | 12/1984 | Kopsho, Jr. et al. |
| 4,559,420 | A | | 12/1985 | Yamada |
| 4,587,510 | A | | 5/1986 | Kim |
| 4,620,176 | A | | 10/1986 | Hayes |
| 5,229,742 | A | | 7/1993 | Miyamoto et al. |
| 5,473,325 | A | | 12/1995 | McAlindon |
| 5,823,057 | A | | 10/1998 | Hsien |
| 6,059,660 | A | | 5/2000 | Takada et al. |
| 6,078,247 | A | | 6/2000 | Shimomura |
| 6,307,486 | B1 | * | 10/2001 | Takeda et al. ..... 341/20 |
| 6,353,430 | B2 | * | 3/2002 | Cheng et al. ..... 345/161 |
| 6,538,639 | B1 | * | 3/2003 | Takahashi ..... 345/161 |
| 6,580,418 | B1 | * | 6/2003 | Grome et al. ..... 345/161 |

FOREIGN PATENT DOCUMENTS

| | | | |
|---|---|---|---|
| DE | 4123503 CE | 4/1995 | |

* cited by examiner

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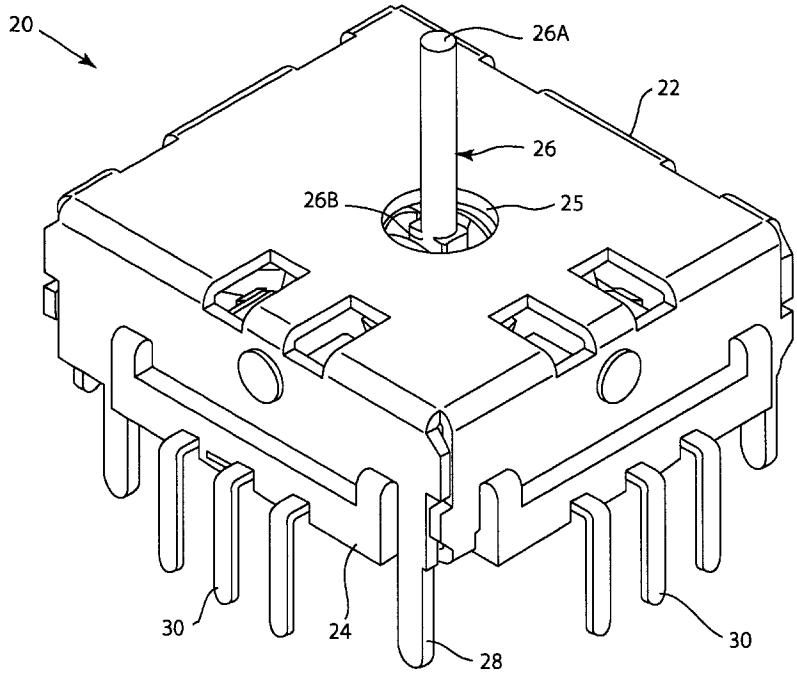
(57) **ABSTRACT**

A joystick has a base and a cover mounted over the base. A stick has a first end extending from the cover and a second end. A gimbal has a first and second yoke that are coupled to the stick to allow the stick to move. The yokes each have a first and second end. A pair of wipers is mounted to the first ends of the yokes. A pair of resistors is positioned between the wipers and the base. The resistors are adapted to generate an electrical output signal indicative of a position of the stick when a voltage is applied to the resistors. Several terminals are mounted to the base. A first portion of the terminals are electrically connected to the resistors. A switch is positioned in the base below the second end of the first yoke. The switch is activated when the first yoke is sufficiently rotated so as to cause the second end of the first yoke to contact the switch and to close the switch.

**26 Claims, 7 Drawing Sheets**



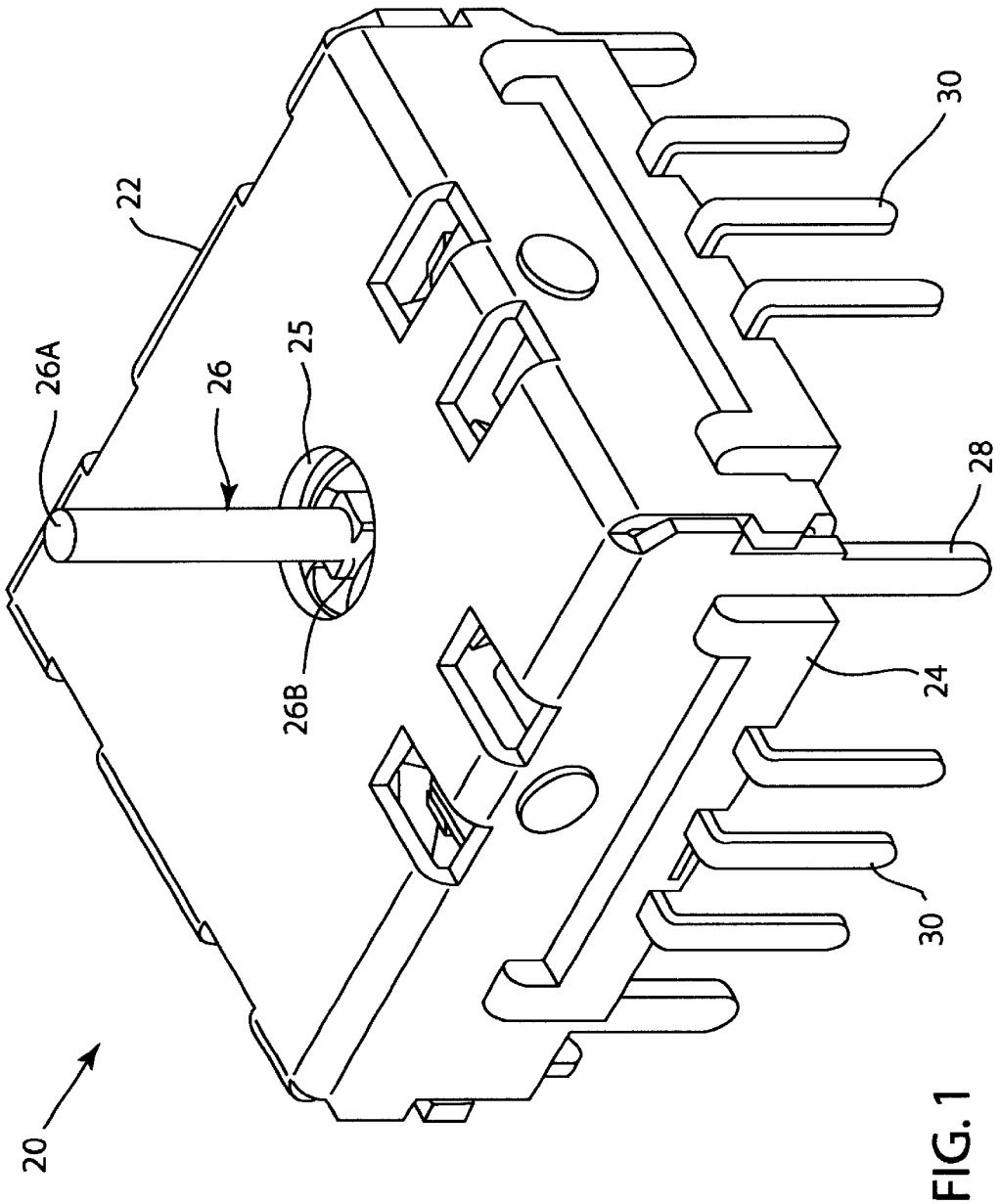



FIG. 1

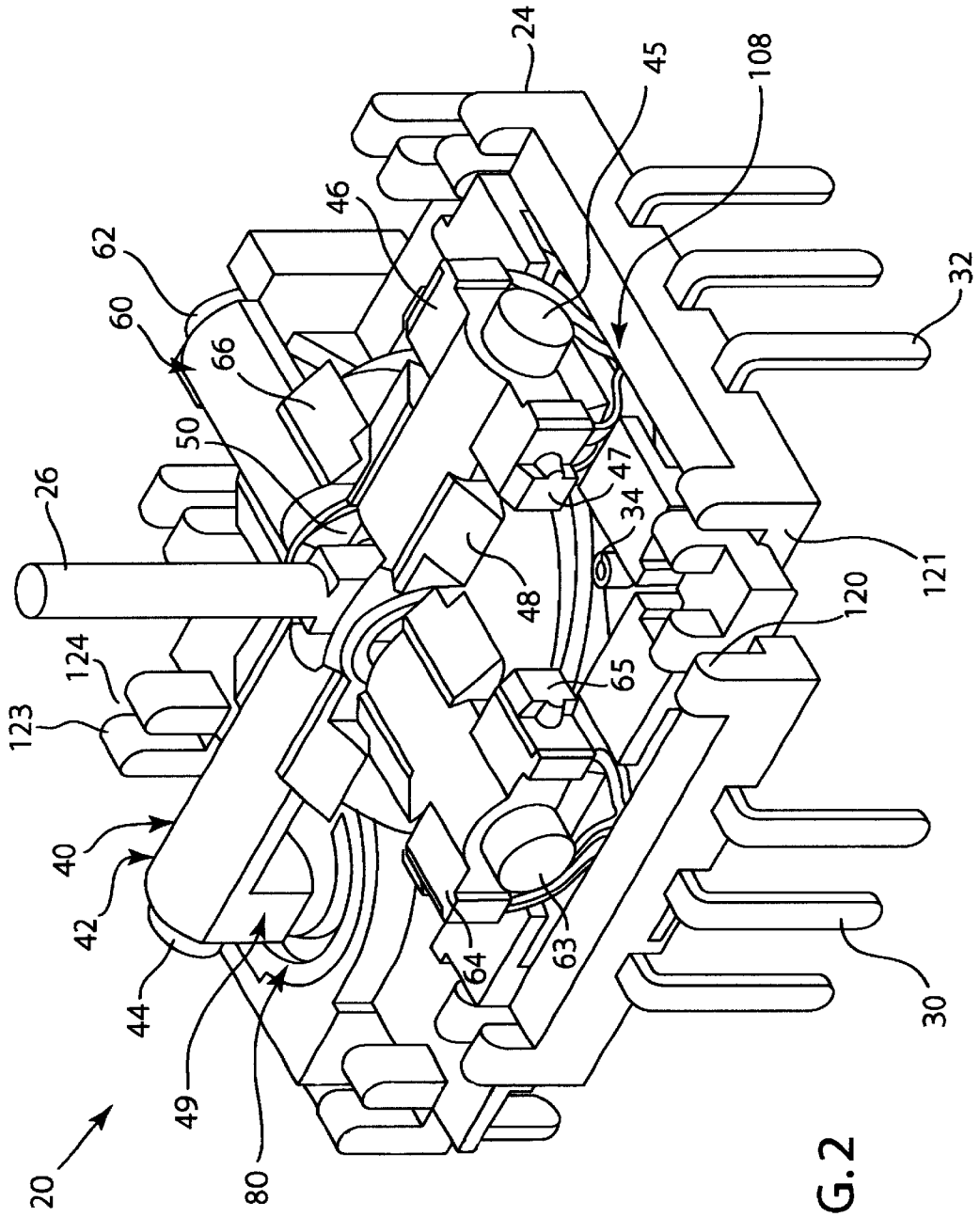

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FIG. 2

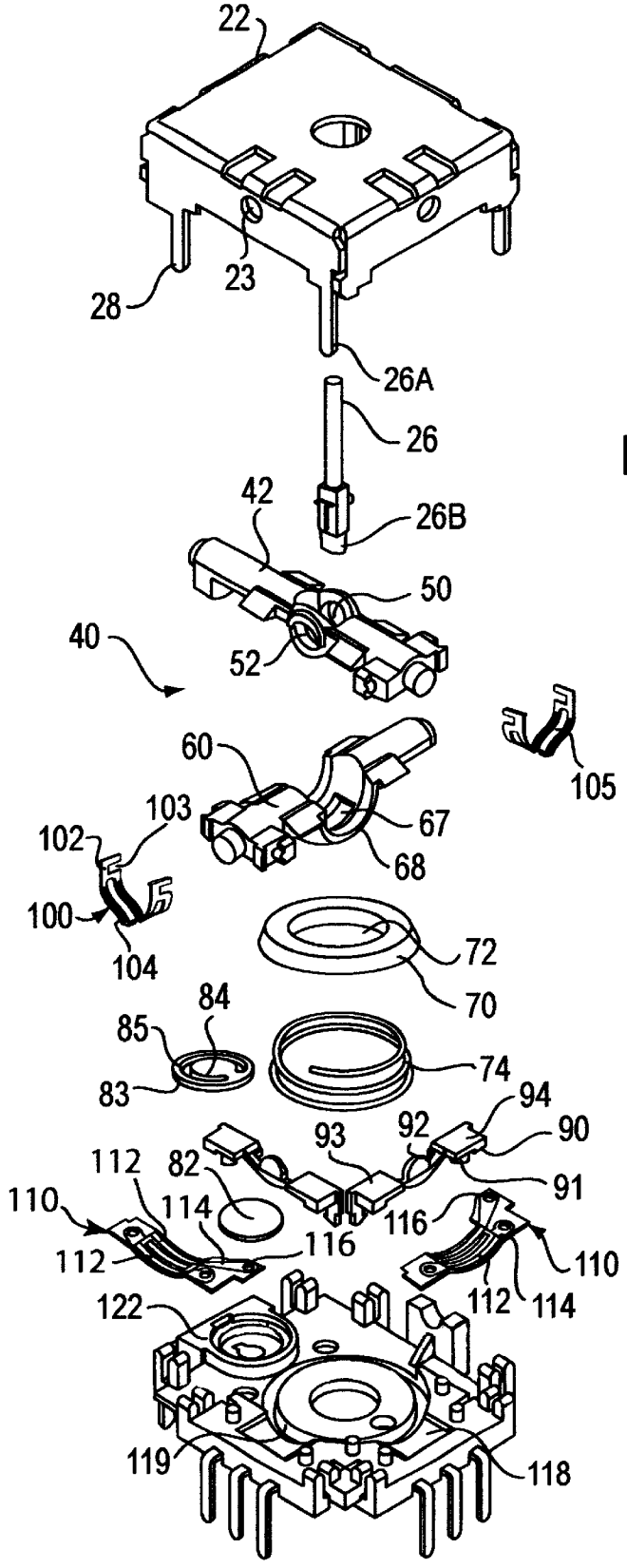
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FIG. 3

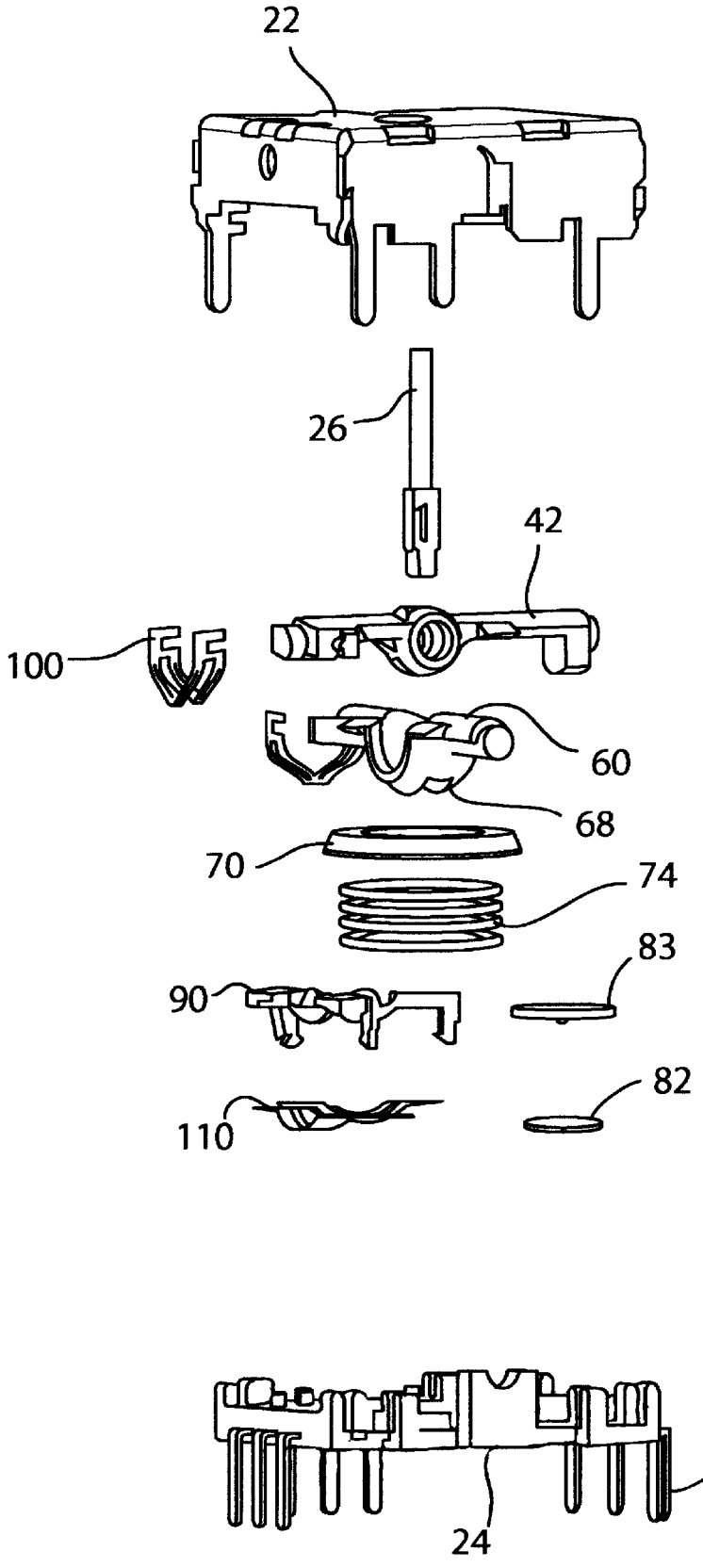


FIG. 4

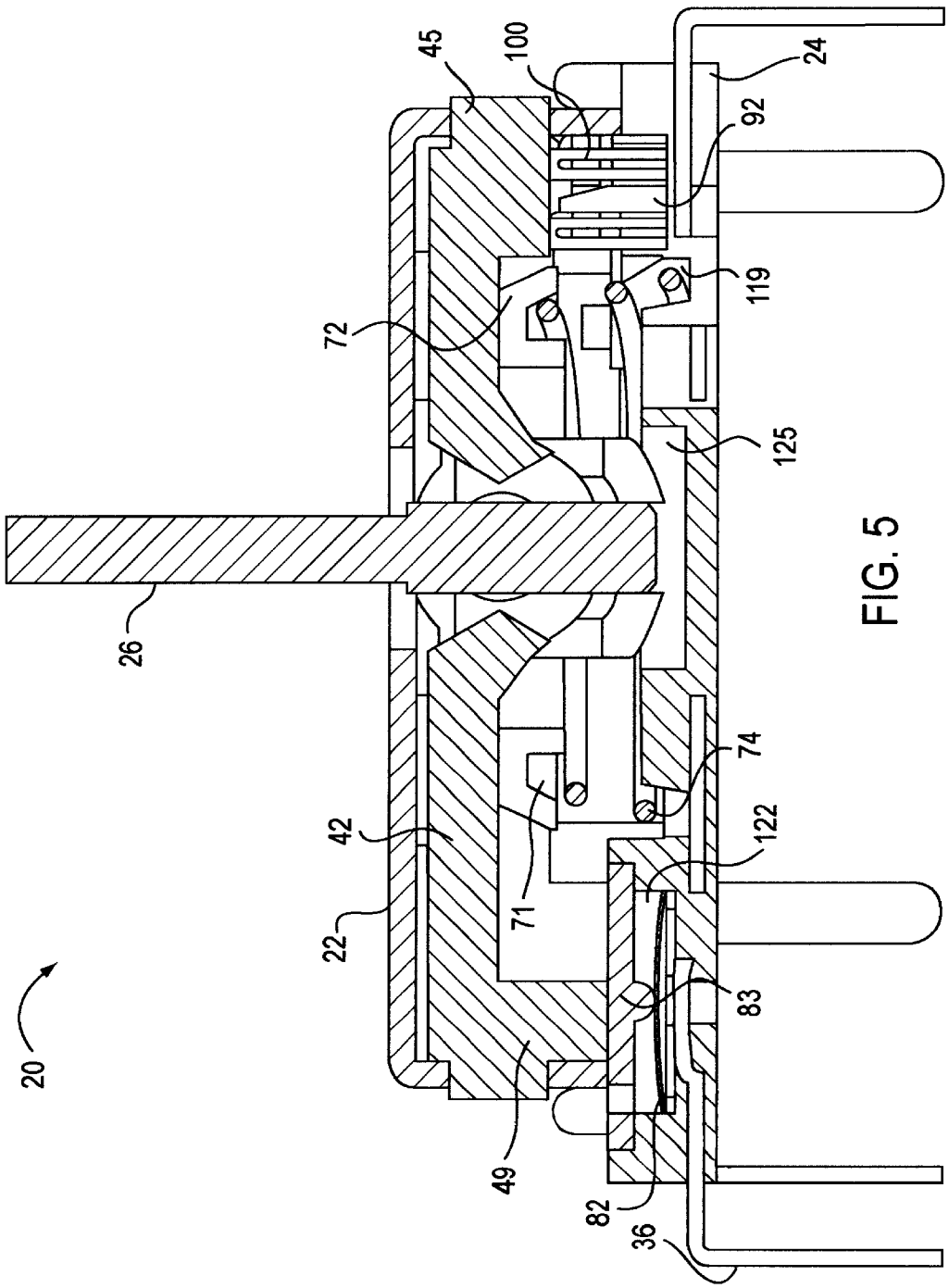


FIG. 5

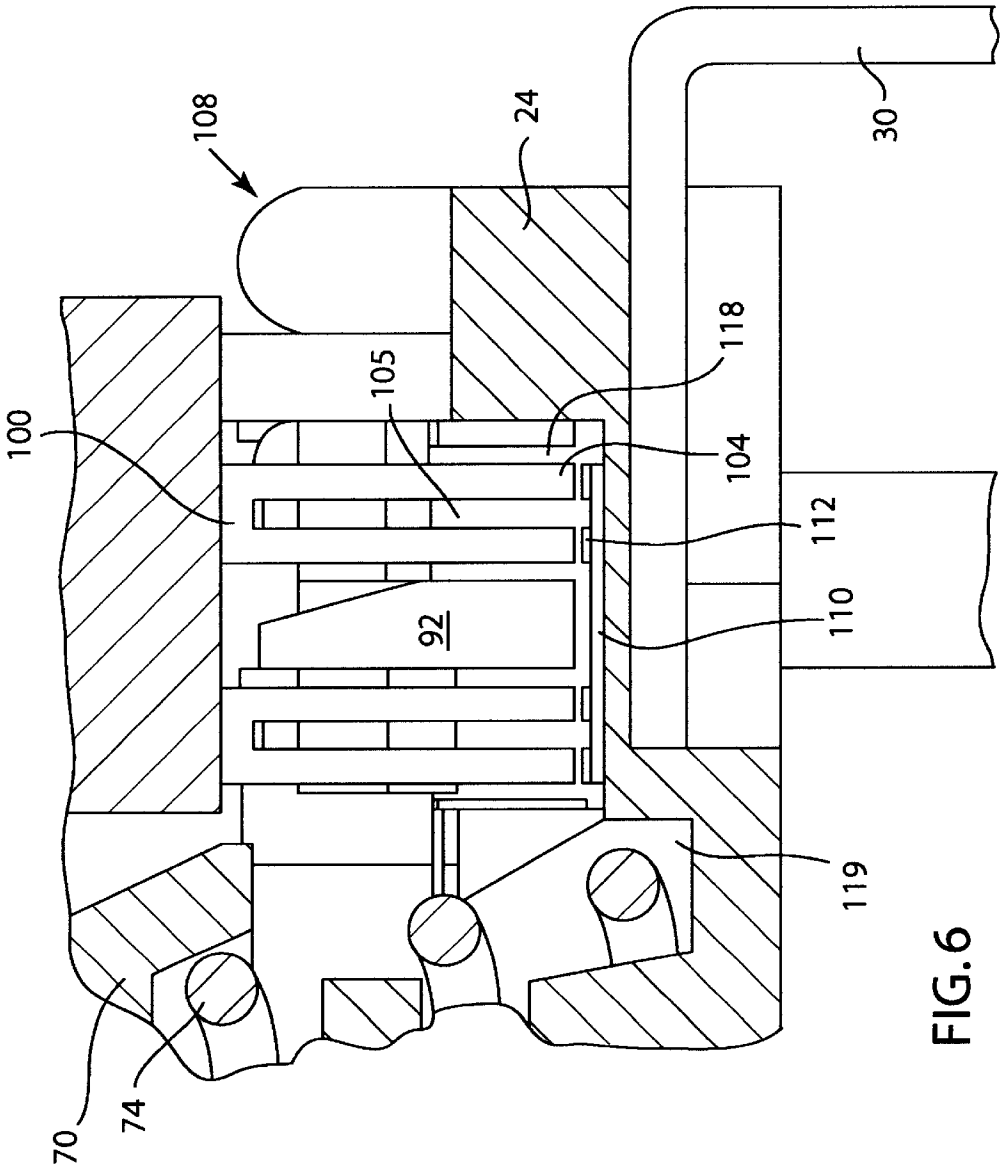


FIG.6

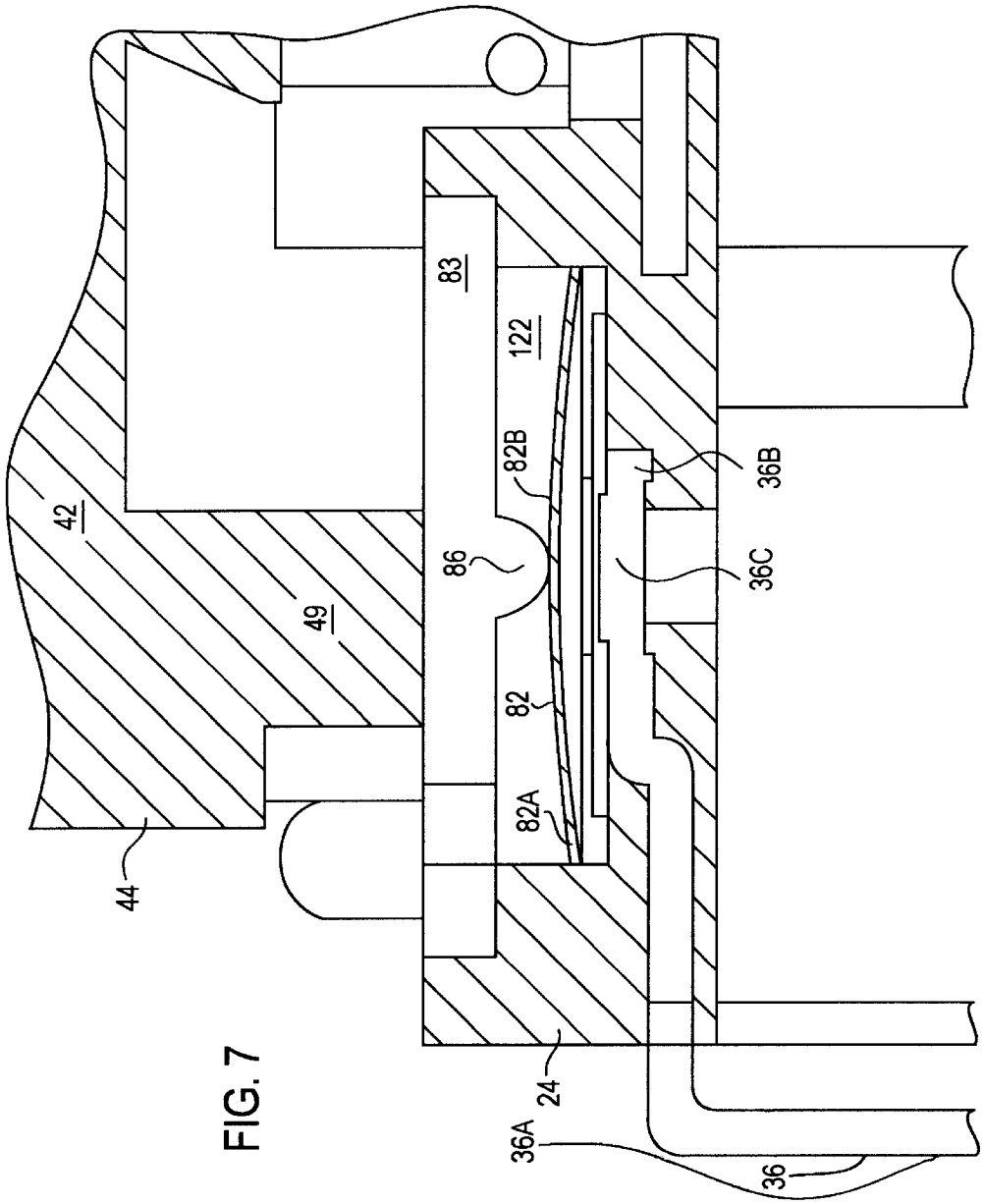


FIG. 7

# LOW PROFILE JOY STICK AND SWITCH

## CROSS REFERENCE TO RELATED AND CO-PENDING APPLICATIONS

This application is related to the following U.S. patent applications: U.S. patent application Ser. No. 09/274,951, filed Mar. 23, 1999 and titled, "Gimbal Mounted Joystick with Z-axis Switch".

The foregoing patent has the same assignee as the instant application and is herein incorporated by reference in entirety for related and supportive teachings.

## BACKGROUND OF THE PREFERRED EMBODIMENT(S)

1. Field of the Invention

This invention generally relates to a control device, like a pointing stick, for controlling the positioning, movement and operation of a responsive electrical device, like a cursor on a computer display screen. Specifically, there is a low profile joystick with a switch that can, for example, both direct a cursor on a screen and select items on the display screen by tapping on the pointing stick instead of clicking a mouse button.

2. Description of the Related Art

Various devices are well known for controlling cursor movement over a computer display screen of a computer and for signaling a choice of computer command identified by the position of the cursor on the display screen menu. The most commonly known devices are known as a "mouse" that has a ball on its underside rolled over a horizontal surface, with the x- and y-axis components of movement being sensed and transmitted through a connecting cable to a serial input port of the computer. The signal to the computer is varied by the amount and direction of movement of the mouse ball, and causes the cursor on the display screen to have a corresponding movement. One or two "mouse" or "click" buttons, located on the top of the mouse at the forward end, permit the computer operator to enter a selection or other command to the computer (the command typically being shown by the position of the cursor on a displayed menu) upon pressing one or the other or both buttons, depending upon the software associated with the device. Such a device, requires a flat, horizontal surface.

Another well known electrical controlling and signaling mechanism is a "joystick." The joystick is typically an elongated stick that extends upwardly from a base connected to the computer console by means of a cable. The joystick is operated by tilting the upstanding stick in various directions to cause the cursor or other display element to move in a direction and usually at a speed corresponding to the direction and pressure exerted on the stick by the computer operator. The operation of a joystick, however, frequently requires a separate button to be pushed, for example, to select icons on the screen.

Despite the advantages of each type of controller, none had, for example, allowed the user to both control a cursor movement and select items on the display screen using exclusively a single part of the device, namely a shaft, and being exclusively manipulated and activated by potentially using only one finger. Additionally, it is important to have an extremely low profile and small footprint, or small surface area used on a printed circuit board that has the joystick mounted thereon. Moreover, it is important to have as few parts to the design as possible, to reduce the complexity and cost of manufacturing. Finally, it is important that any



joystick design have a centering position having the stick or main shaft pointing straight up when not in use. Most prior art designs have complex and costly methods of achieving the centering position. A current unmet need exists for a low profile joystick with a switch.

## SUMMARY OF THE PREFERRED EMBODIMENT(S)

It is a feature of the invention to provide a joystick and switch for controlling the positioning, movement and operation of a responsive electrical device, like a cursor on a computer display screen.

A further feature of the invention is to provide a joystick that includes a base and a cover mounted over the base. A stick has a first end extending from the cover and a second end. A gimbal has the second end of the stick mounted thereto. The gimbal is located above the base. The gimbal has a first and second yoke that is coupled to the stick for allowing the stick to move. The yokes each have a first and second end. A pair of wipers is mounted to the first ends of the yokes. A pair of resistors is positioned between the wipers and the base. The resistors are adapted to generate an electrical output signal indicative of a position of the stick when a voltage is applied to the resistors. Several terminals are mounted to the base. A first portion of the terminals are electrically attached to the resistors. A switch is positioned in the base below the second end of the first yoke. The switch is activated when the first yoke is sufficiently rotated so as to cause the second end of the first yoke to contact the switch and to close the switch. The switch is electrically connected to a second portion of the terminals.

The invention resides not in any one of these features per se, but rather in the particular combination of all of them herein disclosed and claimed and it is distinguished from the prior art in this combination of all of its structures for the functions specified.

There has thus been outlined, rather broadly, the more important features of the invention so that the detailed description thereof that follows may be better understood, and so that the present contribution to the art may be better appreciated. There are, of course, additional features of the invention that will be described after this which will form the subject matter of the appended claims. Those skilled in the art will appreciate that the preferred embodiment may readily be used as a basis for designing other structures, methods and systems for carrying out the several purposes of the present invention. It is important, therefore, that the claims are regarded as including such equivalent constructions since they do not depart from the spirit and scope of the present invention.

## BRIEF DESCRIPTION OF THE DRAWINGS

These and other features of the invention can best be understood by the following description of the accompanying drawings as follows:

FIG. **1** is a perspective view of a joystick and switch of the present invention.

FIG. **2** is a perspective view of a FIG. **1** with the cover removed.

FIG. **3** is an exploded perspective view of a FIG. **1**.

FIG. **4** is another exploded perspective view of a FIG. **1**.

FIG. **5** is a cross-sectional view of FIG. **1** FIG. **6** is a partial cross-sectional view of FIG. **1**.

FIG. **7** is another partial cross-sectional view of FIG. **1**.

It is noted that the drawings of the invention are not to scale.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGS. **1–7**, there is a joystick and switch **20** that can, for example, be used to control the movement of a cursor on a computer screen (not shown). The joystick **20** is made up of a base **24**, cover **22**, stick **26**, gimbal **40**, flexible film **110**, wiper **100** and switch **80**.

Cover **22** has several pins **28** and holes **23**. Cover **22** is mounted over base **24**. An aperture **25** allows stick **26** to pass through cover **22**. Base **24** has a recess **118**, a groove **119**, a slot **120**, a bottom surface **121**, a cavity **122**, posts **123**, slot **124**, cavity **125** and terminals **30** and **36**. Cover **22** is preferably stamped metal and base **24** is preferably formed from injection molded plastic. A stick **26** has ends **26**A and **26**B. End **26**B is attached to a gimbal **40**.

Gimbal **40** has an upper yoke **42**, and a lower yoke **64**. Upper yoke **42** has ends **44** and **45**. Each yoke end has opposed projections **46** extending outwardly. Each projection **46** has a post **47**. Yoke **42** has four tabs **48** that are centered about a slot **50** in the center of the yoke. A hole **52** passes through yoke **42**. Similarly, lower yoke **60** has ends **62** and **63**. Each yoke end has opposed projections **64** extending outwardly. Each projection **64** has a post **65**. Yoke **60** has four tabs **66** that are centered about a slot **67** in a U-shaped center section **68**. Stick **26** is pivotally coupled to gimbal **40** by press fitting end **26**B through slots **50** and **67**. After assembly, ends **45** and **63** are rotatably supported in holes **23**.

Washer **70** has a recessed raceway **71** and a hole **72**. Washer **70** resides under lower yoke **60**. A spring **74** is located in raceway **71** and extends into groove **119**. Spring **74** biases washer **70** toward yoke **60**.

Switch **80** has a metal dome **82** and an actuator **83**. Actuator **83** has a disc **84** that is defined by a slot **85**. A bump **86** extends from disc **84**. Actuator **83** is formed from plastic. Switch **80** is mounted in cavity **122**. Dome **82** has an outer edge **82**A that is placed over a terminal end **34**. A center portion **82**B of dome **82** is mounted over the contact portion **36**C of pin **36** adjacent to end **36**B. The switch is activated when stick **26** rotates yoke **60** sufficiently so as to cause boss **49** to contact disc **84**. Disc **84** is bent downward which causes dome **82** to collapse and to contact portion **36**C thus completing an electrical circuit between terminal end **34** and contact portion **36**C.

A pair of wipers **100** are mounted to projections **45** and **63**. Wiper **100** has a blade **102**, a cutout **103**, a contactor **104** and a slot **105**. Wipers **100** are mounted by sliding blades **102** over posts **47** and **65**. After mounting, posts **47** and **65** are located in cutouts **103**. Flexible film **110** is mounted in recess **118**. Flexible film is preferably a Kapton film. Flexible film **110** has resistors **112** mounted on a curved upper portion. Conductors **114** connect to each end of resistors **112**. Conductors **114** surround an aperture **116**. Resistors **112** and conductors **114** are conventional polymer conductors and resistors. Contactor **104** slides along and is in electrical contact with resistor **112**. Wiper **100** and flexible film **100** form a variable resistor or potentiometer **108**. Aperture **116** is mounted over terminal end **34** and is electrically connected to terminal end **34** by either soldering or crimping. A terminal end **32** would be inserted into another printed circuit board (not shown) where it would be electrically connected to an electrical device or circuit such as a computer or controller.

A retainer block **90** is mounted over flexible film **100**. Retainer block **90** has a finger **91**, a post **92** and ends **93** and **94**. Finger **91** snaps into slot **120** to retain block **90** to base **24**. Post **92** is located in slot **105** of wiper **100** and separates contactors **104**. Ends **93** and **94** are mounted over conductors **114** and apertures **116** and help to retain flexible film **110** in recess **118**.

Variable resistor **108** allows the sensing of the rotational position of each yoke **42** and **60**. A voltage is applied between two of terminals **30** that are connected to resistors **112**. As yokes **42** and **60** move, contactor **104** moves on resistor **110** and the voltage between the two terminals **30** changes. Thus, the output voltage between two of terminals **30** that are connected to resistor **112** is proportional to the position of the yoke. Because stick **26** is attached to the yoke, the voltage is also proportional to the position of the stick **26**.

The stick **10** is shown in a centered or centering position. That is, a position that has stick **26** in a vertical position that allows the shaft to be moved an equal and maximum distance in all directions perpendicular to the shaft. The spring **74** forces washer **70** against yokes **42** and **60**. This forces the stick **26** into a vertical centered position. When stick **26** is moved off center, tabs **66** and **48** contact washer **70**, which presses washer **70** downwardly. Since washer **70** is biased by spring **74**, the user pressing on stick **26** feels a feedback force. Also, once the user releases stick **26** washer **70** pressing on tabs **48** and **66** urges stick **26** back into a centering position.

One of ordinary skill in the art of designing joysticks will realize many advantages from using the preferred embodiment. In particular, joystick and switch **20** have a low height or profile due to the mounting of variable resistors **108**. Further, the integration of switch **80** within the base **24** leads to an overall compact package size. Specifically, by placing switch **80** inside there is eliminated the extra space that would have been used if switch **80** were to be placed on the outside base **24**.

Although the invention has been taught with specific reference to these embodiments, someone skilled in the art will recognize that many other changes can be made in form and detail without departing from the spirit and the scope of the invention. The described embodiments are to be considered in all respects only as illustrative and not restrictive. The scope of the invention is, therefore, indicated by the appended claims rather than by the foregoing description. All changes which come within the meaning and range of equivalency of the claims are to be embraced within their scope.

What is claimed is:

**1**. A joystick, comprising:

a) abase;

b) a cover mounted over the base;

c) a stick having a first end extending from the cover and a second end;

d) a gimbal having the second end of the stick mounted thereto, the gimbal located above the base, the gimbal having a first and second yoke coupled to the stick for allowing the stick to move, the yokes each having a first and second end;

e) a pair of wipers, mounted to the first ends of the yokes;

f) a pair of resistors positioned between the wipers and the base, the resistors adapted to generate an electrical output signal indicative of a position of the stick when a voltage is applied to the resistors;

g) a plurality of terminals mounted to the base, a first portion of the terminals electrically connected to the resistors; and

h) a switch, positioned in the base below the second end of the first yoke, the switch activated when the first yoke is sufficiently rotated so as to cause the second end of the first yoke to contact the switch and to close the switch, the switch electrically connected to a second portion of the terminals.

**2**. The joystick of claim **1**, wherein the resistors are mounted to a flexible film.

**3**. The joystick of claim **2**, wherein the flexible film is mounted in a recess in the base.

**4**. The joystick of claim **1**, wherein the switch is mounted in a cavity in the base.

**5**. The joystick of claim **1**, wherein the first yoke is mounted over the second yoke.

**6**. The joystick of claim **5**, wherein a spring is mounted between the second yoke and the base, the spring forcing the joystick into a centering position.

**7**. The joystick of claim **6**, wherein a washer is mounted between the second yoke and the spring.

**8**. The joystick of claim **3**, wherein a retainer block is mounted over a portion of the flexible film, the retainer block being attached to the base.

**9**. The joystick of claim **1**, wherein the first end of the yokes has an opposing pair of projections, the wipers slidably attached to the projections.

**10**. The joystick of claim **1**, wherein each of the yokes have an opposing pair of tabs, the tabs contacting the washer in an alternating manner when the stick is moved off a center position, the washer not being in contact with the tabs when in the center position, the washer contacting the tabs when not in the center position, the spring biasing the washer toward the tabs such that the stick returns to the center position when not being depressed.

**11**. The joystick of claim **8**, wherein the wiper is bifurcated and the retainer block has a finger extending from the retainer block through the bifurcated wiper.

**12**. The joystick of claim **2**, wherein the flexible film has an aperture, the aperture being mounted over an end of the terminal.

**13**. The joystick of claim **12**, wherein the end of the terminal is compressed over the aperture.

**14**. The joystick of claim **1**, wherein the stick is press-fit into a slot in the first yoke.

**15**. A joystick, comprising:

a) a base having a cavity and at least one recess;

b) a cover mounted over the base;

c) a stick having a first end extending from the cover and a second end;

d) a first and second yoke, the second end of the stick attached to the first yoke, the yokes each having a first and second end;

e) at least one wiper, the wiper mounted to the first ends of the yokes;

f) a flexible film positioned in the recess;

g) at least one resistor positioned on the flexible film, the resistor adjacent to and in contact with the wiper and the base, the resistor adapted to generate an electrical output signal indicative of a position of the stick when a voltage is applied to the resistor; and

h) a plurality of terminals mounted to the base, a first portion of the terminals electrically connected to the resistors.

**16**. The joystick of claim **15**, wherein a switch is mounted in the cavity, below the second end of the first yoke, the switch activated when the first yoke is sufficiently rotated so as to cause the second end of the first yoke to contact the switch and to close the switch, the switch electrically connected to a second portion of the terminals.

**17**. The joystick of claim **15** wherein the first yoke is mounted over the second yoke.

**18**. The joystick of claim **15**, wherein a spring is mounted between the second yoke and the base, the spring forcing the joystick into a centering position.

**19**. The joystick of claim **18**, wherein a washer is mounted between the second yoke and the spring.

**20**. The joystick of claim **15**, wherein a retainer block is mounted over a portion of the flexible film, the retainer block being attached to the base.

**21**. The joystick of claim **15**, wherein the first end of the yokes has an opposing pair of projections, the wipers slidably attached to the projections.

**22**. The joystick of claim **15**, wherein each of the yokes have an opposing pair of tabs, the tabs contacting the washer in an alternating manner when the stick is moved off a center position, the washer not being in contact with the tabs when in the center position, the washer contacting the tabs when not in the center position, the spring biasing the washer toward the tabs such that the stick returns to the center position when not being depressed.

**23**. The joystick of claim **20**, wherein the wiper is bifurcated and the retainer block has a finger extending from the retainer block through the bifurcated wiper.

**24**. The joystick of claim **15**, wherein the flexible film has an aperture, the aperture being mounted over an end of the terminal.

**25**. The joystick of claim **24**, wherein the end of the terminal is compressed over the aperture.

**26**. The joystick of claim **15**, wherein the stick is press-fit into a slot in the first yoke.

* * * * *