United States Patent

Lu Conic et al.

[15] **3,643,049**

[45] **Feb. 15, 1972**

[54] ROLLER-BAND DEVICE

[72] Inventors: **Andrew Lu Conic**, New Port; **Patrick Martin Maloney**, St. Paul; **Gary Raymond Bluem**, Golden Valley, all of Minn.

[73] Assignee: **Kroy Industries, Inc.**, Minneapolis, Minn.

[22] Filed: **Feb. 6, 1970**

[21] Appl. No.: **9,162**

[52] U.S. Cl. ..... **200/153 R**, 200/166 BB, 308/6, 74/89.2

[51] Int. Cl. **H01h 13/12**, H01h 3/00, H01h 1/16

[58] Field of Search ..... 200/166 BB, 166 BH, 153 R; 308/6, 202, 209; 73/515; 74/89.2

[56] **References Cited**

UNITED STATES PATENTS

3,548,138	12/1970	Van Dine	200/153 R X
2,765,454	10/1956	Long	200/166 BB X
3,167,962	2/1965	Scotto	73/515 X
3,384,850	5/1968	Cameron et al.	200/166 BB X
3,488,098	1/1970	Sobczak	308/6

OTHER PUBLICATIONS

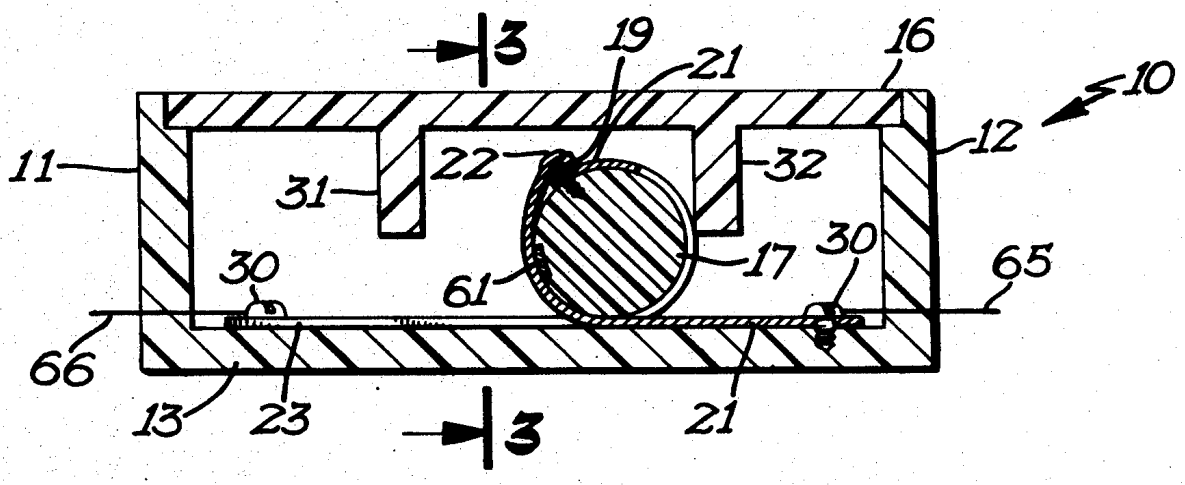
Wilkes, Rolamite: A New Mechanical Design Concept; Research Report SC-RR-67-656A, Dec. 1967, publication of AEC; pp. 70, 166, 167, 194-195 included; copy in Group 210

Primary Examiner—Robert K. Schaefer
Assistant Examiner—Robert A. Vanderhye
Attorney—Frederick E. Lange, William C. Babcock and David N. Fronek

[57] **ABSTRACT**

A roller-band device which utilizes a roller with a flexible band encircling it. The band has two sections which are electrically insulated from each other and the roller is nonconductive but has one or more conductors extending axially along its surface and disposed so that, in certain positions of the roller and band, the two sections of the band are bridged and an electrical circuit is completed therebetween and, in other positions of the roller, the electrical circuit is broken between the two sections of the band. One section of the band may include a plurality of legs, each electrically insulated from each other, and with each of the legs being bridged by the conductor means in different positions of the roller and band. In another embodiment the conductor means is arranged so that a circuit is completed to all of the legs simultaneously upon the roller and band moving to a predetermined position. A keyboard arrangement is disclosed wherein a plurality of switches of this type are utilized together, each with a different combination of legs connected into the output circuit to provide a coded signal to a device such as used in computer periphery equipment. Also disclosed is a roller-band device of the type described above having a unique actuating means, especially useful in connection with a keyboard switch, which includes a force-amplifying connection between the manual actuator and the roller and band and which provides a breakaway action as the manual actuator is operated.

29 Claims, 17 Drawing Figures



PATENTED FEB 15 1972

3,643,049

SHEET 1 OF 3

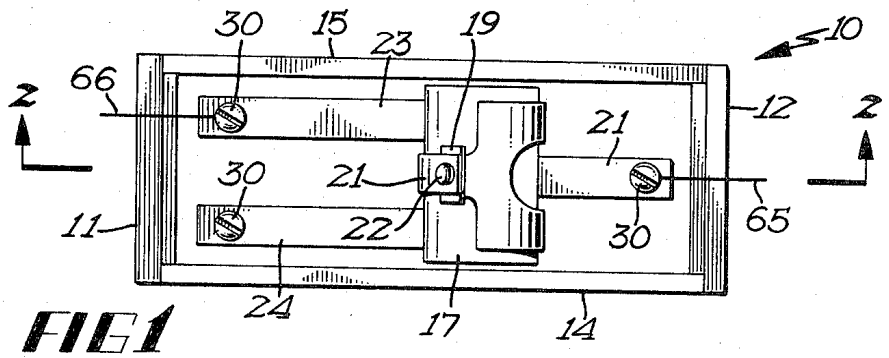


FIG 1

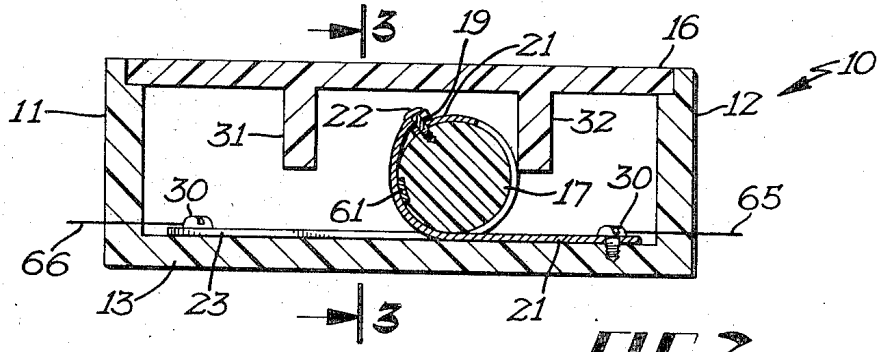


FIG 2

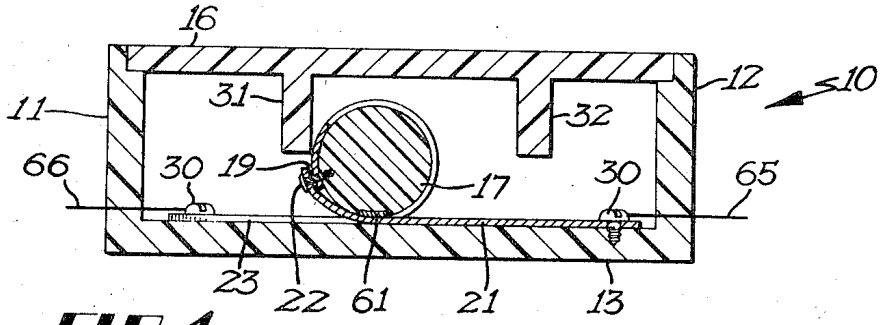


FIG 4

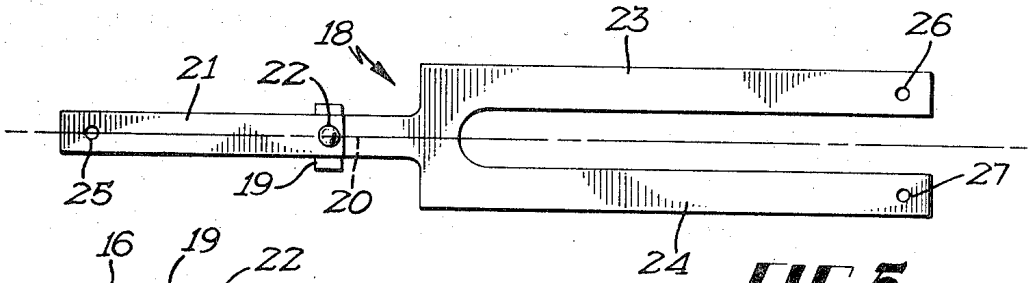


FIG 5

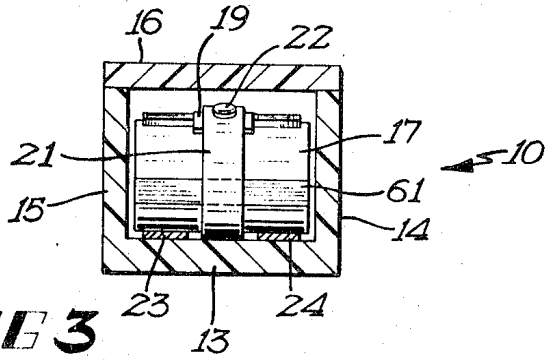


FIG 3

INVENTORS
PATRICK M. MALONEY,
BY GARY R. BLUEM
ANDREW LUCONIC
Donald R. Fontrom
ATTORNEY

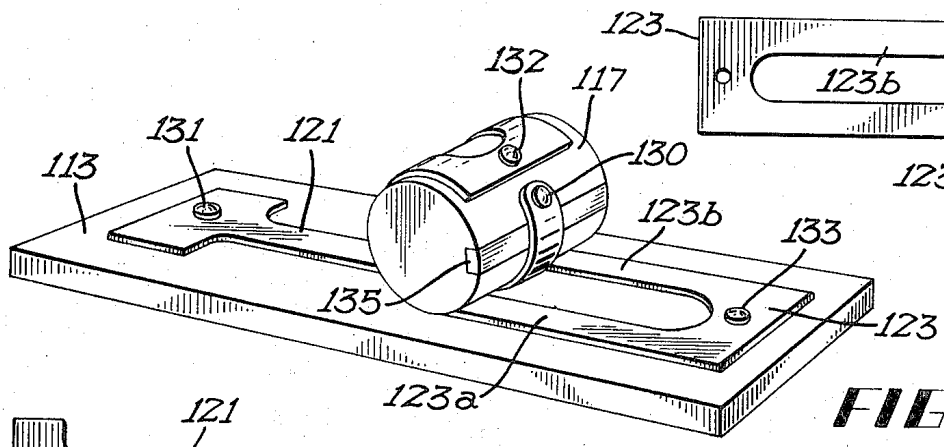


FIG 6

FIG 6B

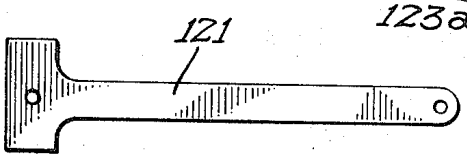


FIG 6A

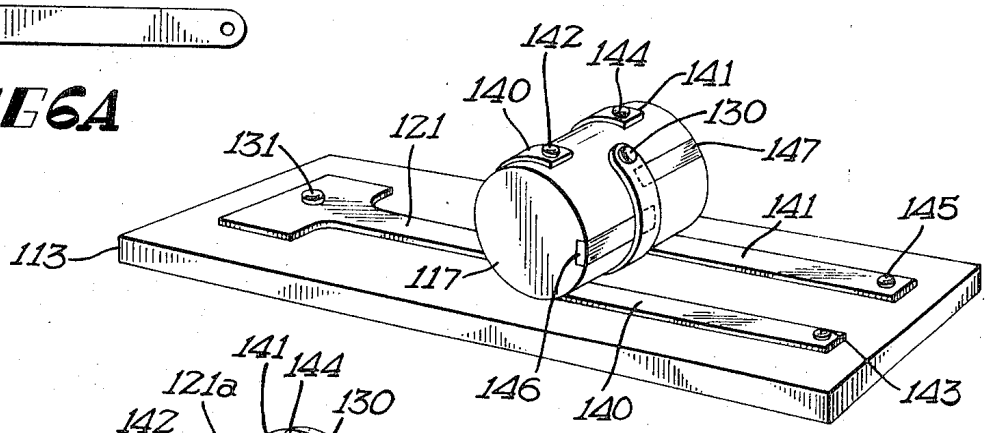


FIG 7

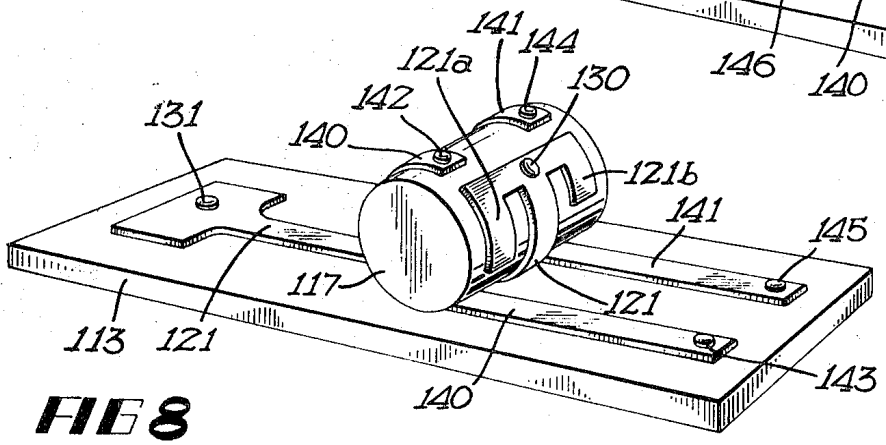


FIG 8

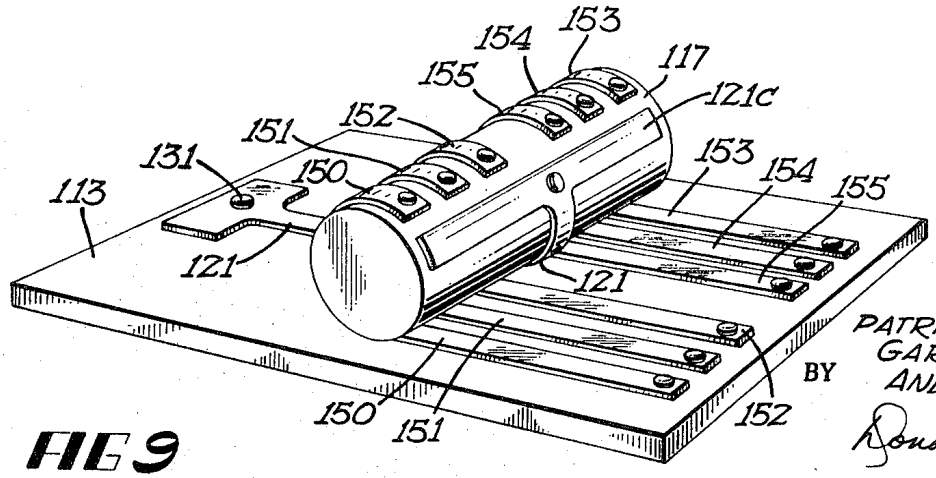


FIG 9

INVENTORS
PATRICK M. MALONEY,
GARY R. BLUEM,
ANDREW LUCONIC

BY Donald R. Goetrom
ATTORNEY

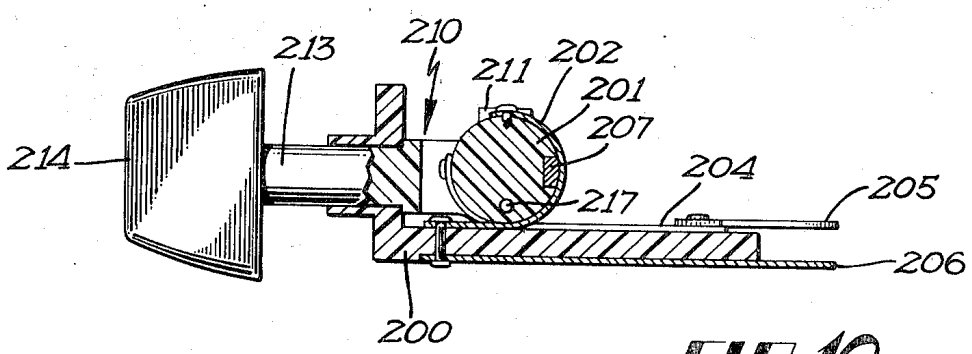


FIG 10

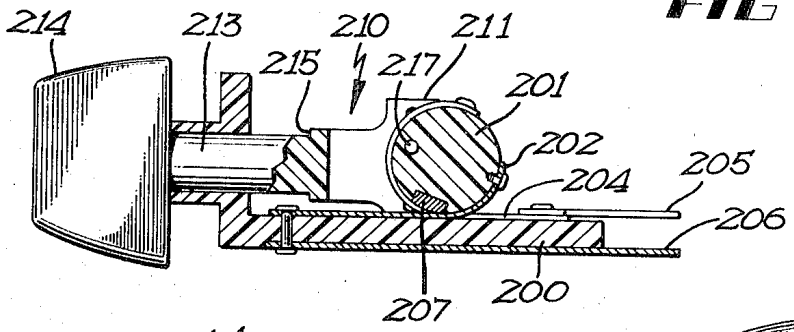


FIG 11

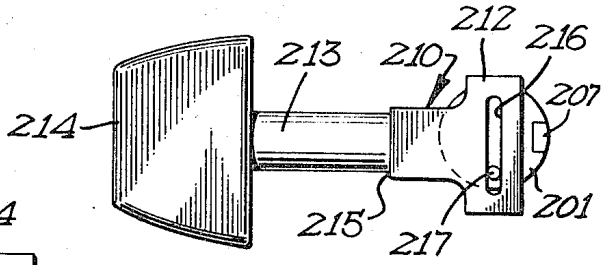


FIG 12

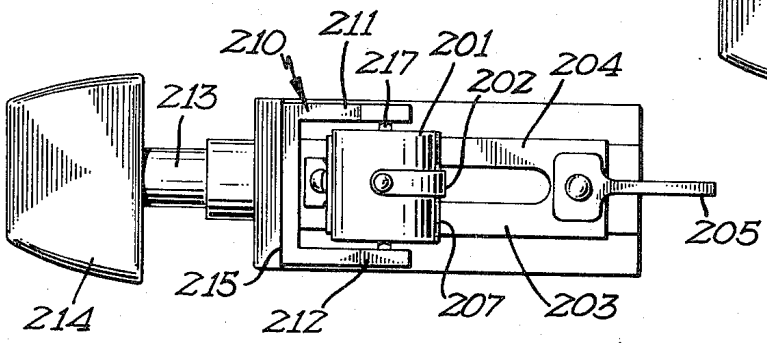


FIG 13

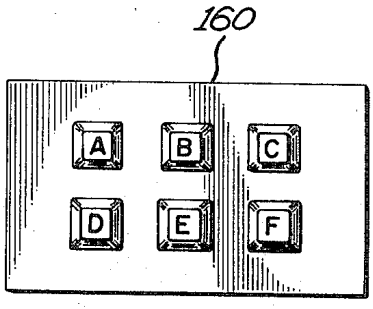


FIG 15

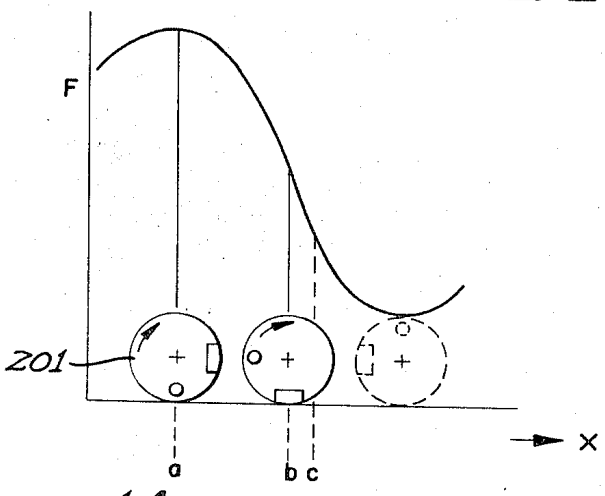


FIG 14

INVENTORS
PATRICK M. MALONEY,
GARY R. BLUEM,
ANDREW LUCONIC
BY Donald R. Goatrom
ATTORNEY

ROLLER-BAND DEVICE

BACKGROUND OF THE INVENTION

Roller-band devices have become relatively well known in the past few years, particularly since disclosure to the public of the work done by Donald Wilkes on so-called "Rolamite" devices. These devices are shown, for example, in U.S. Pat. Nos. 3,452,175 and 3,452,309, both issued to Donald Wilkes and assigned to the United States of America. Rolamite devices utilize a flexible band formed into a generally S-shaped configuration with two rollers, one disposed on either side of the band and in one of the loops of the S-shape. These devices provide a relatively low-friction mechanism which, it has been suggested, may utilize to provide a multitude of switching and other functions in response to a relatively small input force.

Another form of roller-band device utilizing a single roller has been disclosed, for example, in U.S. Pat. No. 3,167,962 issued to Dominick Scotto and in U.S. Pat. No. 3,488,098 issued to Bernard Sobczak. In this type of device a single roller is utilized with a band having complimentary cutaway portions so that a tongue portion wraps around the roller and extends through a space between the pair of spaced leg portions and the ends of the band extend generally in opposite directions from the roller. They have the obvious advantage of being simpler than the Rolamite device in that they use a single roller and also that there is much less stress on the band since it is not doubled back against itself as is the case in the S-shaped band of the Rolamite devices.

While roller-band devices of the types referred to above have become known and have been suggested as being capable of use in many applications, they have not actually found much commercial use. There has been a need for a simple switching device which provides good contact forces, can be made to respond to relatively small applied forces, is adaptable to operation in response to a variety of different types of forces, and particularly one which can be miniaturized and yet will be reliable, relatively inexpensive, and capable of switching a variety of current loads.

It has been realized that roller-band devices might be utilized in a switch which would satisfy some of these needs. However, attempts have generally been made to utilize some type of conventional switching arrangement operated by the moving roller and band and these have not been completely successful for a number of reasons.

BRIEF SUMMARY OF INVENTION

This invention provides a relatively simple switching apparatus utilizing a roller-band device of the type which uses a single roller. The device can be actuated in response to a number of different types of external forces. It is simple in construction and is capable of switching a variety of current loads. It may be utilized to perform a single switching function or it is particularly adaptable for use in switching between a common conductor and a plurality of separate signal-providing conductors. The roller has an electrically nonconductive surface and a band extends therearound and includes two electrically insulated sections with ends extending in opposite directions from the roller. The roller carries with it a conductor member which is effective to bridge between the two sections of the band in certain predetermined positions of the roller and band and to thus complete a circuit between these two sections of the band. These two sections of the band may actually comprise a plurality of electrically insulated legs and the conductor may be disposed so that these legs are simultaneously connected to the other portion of the band or may be arranged so that they are bridged sequentially as the roller and band move in a predetermined direction.

In a preferred embodiment a switching apparatus of the type described above is utilized in connection with a keyboard switch having a unique manual actuator for the switch device. The band has an internal bias urging it toward one end position and the actuator may be moved in response to an external force in opposition to the internal bias to perform the switching function. A force-amplifying means connects the manual actuator to the roller in such a way that a force substantially greater than that applied by the band to the roller must be applied by the external force to the actuator in order to overcome the force applied by the band. Preferably this force-amplifying arrangement is constructed so that as the roller and band are moved away from the end position to which the band urges them, the force required to move them drops off sharply so that a breakaway type function is provided.

A plurality of switches of this type may be utilized together to form a keyboard arrangement. Preferably each of the individual switches has a plurality of insulated legs as described above and all are connected simultaneously to the common conductor as the roller is moved to a predetermined position by the application of a force, preferably by a human operator, to the actuator. Thus a plurality of identical switches may be utilized to assemble a keyboard but only selected legs of each switch are connected into the output circuit so that a typical keyboard function, as utilized in computer peripheral equipment, is provided.

An object of the invention is to provide a simple electrical switching device utilizing a roller-band device.

Another object of the invention is to provide a roller-band switching device which is simple and easy to manufacture, capable of switching a variety of current loads, and is particularly adaptable to miniaturization.

Another object of the invention is to provide a roller-band switching device capable of switching between a common conductor and a plurality of separate output conductors.

Another object of the invention is to provide a roller-band switching device as aforesaid which is adaptable to be operated in response to a variety of different external forces.

Another object of the invention is to provide a roller-band switching device utilizing a simple actuating means, especially useful for manual operation, which provides positive actuation and breakaway-type response.

Still another object of the invention is to provide a roller-band switching device of the type described in the last-recited object including a force amplifying means between the roller and the manual actuating means so that a greater force must be applied to the manual actuator in order to operate the switch than the force which is applied to the roller by the band itself.

Still another object of the invention is to provide a switch apparatus as aforesaid which is particularly adaptable for use in a keyboard switching application wherein a plurality of identical switches may be utilized to build up a keyboard by selectively connecting different output terminals of the various switches.

These and other objects of the invention will become apparent upon reading the detailed description thereof which follows.

DESCRIPTION OF DRAWING

FIG. 1 is a top view of a schematic showing of a simple form of a switch utilizing this invention.

FIG. 2 is a longitudinal cross-sectional view of the device taken generally along line 2—2 of FIG. 1.

FIG. 3 is a transverse cross-sectional view of the device taken generally along line 3—3 in FIG. 2.

FIG. 4 is a longitudinal cross-sectional view, generally similar to FIG. 2, but disclosing the roller and band which form a part of the invention, in a different position.

FIG. 5 discloses a plan view of a band which forms a part of the device.

FIG. 6 shows schematically a form of the invention generally similar to that disclosed in FIGS. 1 through 5 but with a somewhat modified band arrangement.

FIG. 6A discloses one section of a band which forms a part of the structure of FIG. 6.

FIG. 6B discloses another band portion which forms a part of the structure of FIG. 6.

FIG. 7 discloses a modified form of the switch device disclosed in FIG. 6.

FIG. 8 discloses still another modification of the switch device.

FIG. 9 discloses still another embodiment of the switch device substantially of the type disclosed in FIGS. 6 through 8.

FIG. 10 is a longitudinal cross-sectional view of a keyboard switch constructed according to this invention and including a unique manual actuating means for the switch apparatus.

FIG. 11 is a longitudinal cross-sectional view substantially the same as FIG. 10 except that the switch mechanism is disclosed in an actuated position.

FIG. 12 is a fragmentary view disclosing in greater detail some of the elements of the switch mechanism of FIGS. 10 and 11.

FIG. 13 is a top view of the keyboard switch disclosed in FIGS. 10 and 11.

FIG. 14 is a graphical representation of the forces applied by a force-amplifying mechanism which forms a part of the keyboard switch.

FIG. 15 discloses somewhat schematically and in simplified form a keyboard using a plurality of switches constructed generally according to the invention as disclosed in the previous figures.

DETAILED DESCRIPTION

Referring to the drawing, reference numeral **10** refers generally to a roller-band switching device which is shown schematically for the sake of simplicity. It includes a support means which may be a casing or frame, preferably made of moulded plastic, and which includes a boxlike member having end walls **11** and **12**, a bottom wall **13**, and sidewalls **14** and **15**. A cooperating cover **16**, also preferably of molded plastic, may fit onto the case and may be secured thereto by appropriate means such as adhesive or thermal bonding (not shown). Disposed within the opening in the casing is a single roller set **17** encircled by a flexible band **18**. Band **18** can best be seen in FIG. 5. As seen there, it has a longitudinally extending centerline **20** and is generally symmetrical with respect thereto. Band **18** includes two separate sections, the first being a left-hand end (as seen in FIG. 5) which comprises a tongue **21** of relatively narrow width. This portion is connected to a second section comprising a pair of spaced legs **23** and **24**, spaced a distance slightly greater than the width of tongue **21**. The two sections of the band overlap but are separated by an insulative member **19** and are connected by an insulative pin **22** which extends through the two sections of the band and into roller **17** to secure the two sections of the band thereto. Near the end of tongue **21** and of legs **23** and **24** are provided apertures **25**, **26**, and **27**, respectively, for securing the band to the support means. It will be appreciated that the free end of legs **23** and **24** may be connected and a single aperture provided for connecting them to the support.

As seen in FIGS. 1 and 2, band **18** is wrapped around roller **17** with the two sections thereof extending around the roller in opposite directions and with tongue **21** extending through the space between legs **23** and **24** and with the tongue and leg portions then extending substantially in opposite directions from the roller. They are attached to the bottom wall **13** of the support by appropriate means such as screws **30**, rivets or the like, extending through the apertures in the band. Alternatively, they may be attached to the support by heat staking. The band is mounted under tension so as to hold the roller in position and so that the sections of the band rather tightly engage the surface of the roller. It will be appreciated that the band and roller move together, without substantial sliding friction therebetween, in a direction generally normal to the axis of the roller and generally parallel to the bottom and side walls of the casing. The limits of movement of the roller and band may be determined by appropriate stops which have been shown, for convenience, as stop members **31** and **32** extending down from cover **16**.

As indicated, roller **17** is electrically insulative, or at least its surface engaged by the band is electrically insulative. Each of the band sections is electrically conductive. Extending axially along the surface of roller **17** is a conductive strip of material **61**. This conductive strip is relatively narrow and thin, and preferably provides a surface substantially continuous with the surface of the rest of the roller. The conductor **61** is disposed so that when the roller and band occupy the position disclosed in FIGS. 1 and 2 (in engagement with end stop **32**), only tongue **21** engages conductor **61**. However, it is disposed so that when the roller moves to the left, to the end position disclosed in FIG. 4, this conductive strip also is engaged by legs **23** and **24**. Thus, in the position disclosed in FIGS. 1 and 2 there is no electrical connection between the tongue and the legs and the two sections of the band remain electrically insulated from each other. However, when the band moves to the position disclosed in FIG. 4, conductor **61** engages not only tongue **21** but also legs **23** and **24**, thereby electrically connecting the two sections of the band. Obviously appropriate electrical conductors may be connected to the two sections of the band. By way of example, an electrical conductor **65** is disclosed as connected to the tongue **21** and another electrical conductor **66** is as connected to leg **23**, and thus to the other section of the band.

As disclosed, the effective cross-sectional area of the two legs is substantially greater than the cross-sectional area of the tongue and hence the band provides an internal bias urging the roller and band into engagement with stop **32**. Any type of force may be utilized to move the roller toward stop **31**. For example, the switch may operate as a tilt switch whereby it will move when tilted to a position so that gravity provides sufficient force upon the roller to cause it to overcome the bias exerted by the band. It may also be used as a motion or acceleration switch wherein it will be responsive to some predetermined force which will overcome the internal bias of the band. As will be discussed further in connection with other embodiments of the invention, an external means may be provided for applying a force manually to the roller to cause it to move. This type of switch may be utilized in many applications and with various modifications depending upon the particular requirement encountered. Since the ends of the band are connected to the support structure under tension, the two sections of the band engage rather tightly the conductive member **61** so there is substantial contact force therebetween and a relatively large electrical current may be switched, if desired.

FIG. 6 discloses schematically a modified form of the same switch apparatus disclosed in FIGS. 1 through 5. Here a roller **117** is encircled by a band made up of two separate sections **121** and **123**. Roller **117** is electrically nonconductive or at least has a nonconductive surface. Band sections **121** and **123** are electrically conductive members. Member **121** serves the function of a tongue member similar to tongue **21** in the previous embodiment and member **123** is a generally rectangular member which has a central portion removed leaving a pair of spaced legs **123*a*** and **123*b*** joined at each end. One end of member **121** is connected to roller **117** by an appropriate pin or the like **130** while the other end is connected to a base or support **113** by an appropriate pin or rivet **131**. Member **123** has one end connected to roller **117** by an appropriate pin or the like **132** while the other end is connected to support **113** by an appropriate rivet or the like **133**. The space between legs **123*a*** and **123*b*** is wide enough so that tongue **121** may be disposed therebetween without engaging the legs. The two band sections extend from the point at which they are attached to the roller, which is relatively close together thereon, generally in opposite directions around the surface of the roller. A conductor **135** extends along the surface of roller **117** and, in the position disclosed in FIG. 6, is engaged only by a tongue **121**. It will be appreciated that as roller **17** moves to the right, this conductor will engage legs **123*a*** and **123*b***, also completing an electrical circuit between the two sections of the band.

FIG. 7 discloses a modification of the structure disclosed in FIG. 6. Here the structure is generally the same in that a roller 117 has connected thereto an electrically conductive band made up of two sections electrically insulated from each other. These sections include a conductive tongue 121 connected to roller 17 by an appropriate pin 130 and has its other end connected to support 113 by a rivet 131. However, the other section of the band is made up of two separate leg members 140 and 141 spaced generally as were legs 123A and 123B in the structure disclosed in FIG. 6. Leg 140 is connected to roller 117 by a pin or the like 142 and has its other end connected to support 113 by a rivet or the like 143. Similarly, leg 141 is connected to roller 117 by a pin 144 and has its other end connected to support 113 by a rivet 145. In this embodiment, legs 140 and 141 are electrically insulated from each other. They are also electrically insulated from tongue 121. In this embodiment two separate conductors are provided on the surface of roller 117. The first of these, a conductor 146, is disposed so that it may bridge tongue 121 and leg 140 in certain positions of the roller and a second conductor 147 is disposed so that it will bridge between tongue 121 and leg 141 in certain positions of the roller. As disclosed in FIG. 7, conductors 146 and 147 are disposed so that, as roller 117 moves to the right (as seen in FIG. 7) a circuit will first be completed between tongue 121 and leg 140. Then, upon further movement, a circuit will also be completed between tongue 121 and leg 141.

FIG. 8 shows a roller-band switch structure generally similar to that disclosed in FIG. 7 except that the means for providing the bridging between tongue 121 and legs 140 and 141 has been modified. Here tongue 121, adjacent the end at which it is connected to roller 117, is provided with a laterally extending portion so that this end of the tongue looks substantially like the letter "T." At one end of the crossbar on this "T," a portion 121*a* extends down, generally parallel to leg 140, and to a position so that upon movement of roller 117 toward the right (as seen in FIG. 8) it will engage leg 140, thus electrically connecting tongue 121 and leg 140. At the other end of the crossbar on the "T" there is provided a shorter downwardly extending portion 121*b* extending generally parallel to leg 141 and disposed so that upon movement of the roller some additional amount toward the right (as seen in FIG. 8) it will engage leg 141 completing a circuit between tongue 121 and leg 141. In this type of structure, downwardly extending portions 121*a* and 121*b* are bonded to the surface of roller 117 by appropriate means so that they are raised only a very slight distance above the surface of the roller and will not substantially interfere with the rolling movement of the roller along legs 140 and 141.

It will be appreciated that more than two legs may be utilized in connection with the switching apparatus as disclosed in FIGS. 7 and 8. Additional conductor members may be utilized on the surface of the roller in a structure like that disclosed in FIG. 7 or the crossbar on the "T" may simply be made longer and have additional downwardly extending portions in a structure similar to that disclosed in FIG. 8. Also it will be appreciated that the various legs may make electrical contact with tongue 121 all at the same time or they may be arranged to make such contact in any desired sequence.

FIG. 9 discloses an arrangement wherein a plurality of legs (six of them are shown by way of example) are connected to a single roller 117 which also has connected thereto a tongue 121. In FIG. 9 there are disclosed legs 150, 151, 152, 153, 154, and 155 disposed so that they are arranged generally parallel with tongue 121 and with three of the legs on either side of tongue 121, substantially symmetrically, so that roller 117 will be maintained in its proper alignment. In FIG. 9 tongue 121 has been disclosed with an elongated portion 121*c* which appears like the crossbar of a large "T" across the end of tongue 121 and disposed so as to engage simultaneously all six of the legs when the roller moves to a predetermined position. Portion 121*c* may be provided with downwardly extending portions adapted to engage the different ones of the legs at different positions of the roller if desired. The arrangement disclosed in FIG. 9 is especially useful perhaps with a substantially greater number of legs involved, in connection with keyboard switches or the like for use in connection with computer peripheral equipment. A very simple keyboard has been disclosed in FIG. 15 where the keyboard 160 has a plurality of these switches labeled A, B, C, D, E, and F mounted thereon. All of these switches may be made identically except that different ones of the legs therein will be actually connected into an output surface. Conventionally, in order to obtain the proper signals in keyboard devices a multitude of diodes are required. By simply providing each of the legs with an appropriate terminal for connection to a printed circuit board and then by removing certain of the legs from each of the otherwise identical switches, switches can simply be plugged into the printed circuit board and used in connection with a binary coded system for computer peripheral equipment or the like.

FIGS. 10 through 13 disclose a keyboard switch utilizing a roller-band switching arrangement substantially as disclosed and described previously herein and also including a unique manual actuating means therefor. Here a support member 200 may be formed with an L-shape and is preferably formed of an insulative material such as molded plastic. A roller 201 is encircled by a flexible conductive band made up of a tongue 202 and a pair of spaced legs 203 and 204.

Legs 203 and 204 are connected to a common electrical conductor 205 while tongue 202 is connected to a conductor 206. Legs 203 and 204 and tongue 202 are chosen so that the legs provide a force urging the roller to the right (as seen in FIG. 10) with a substantially greater force than that applied by tongue 202 urging it to the left. Thus, the apparatus in FIG. 10 has an internal bias urging it to the right with a predetermined force. A conductor 207 is embedded in the surface of roller 201 in a position where it is continuously engaged by tongue 202 and wherein it will engage legs 203 and 204 only when the roller is moved a predetermined distance to the left (as seen in FIG. 11).

A manual actuating means for the keyboard switch includes a yoke 210 having spaced finger members 211 and 212 spaced so that they are disposed along opposite ends of roller 201. Yoke 210 has a stem 213 which extends through an opening in the upright leg of base 200 and, spaced a distance from this upright portion of the base, the base for the yoke includes an abutment surface 215 which, when it engages the upstanding portion of the support, defines an end position for the roller as will be described hereinafter.

Fingers 211 and 212 have vertically extending slots 216 formed therein. Extending from the ends of roller 201 are a pair of aligned pins 217 extending into slots 216 in fingers 211 and 212. Pins 217 are offset from the axis of the cylindrical roller by a substantial distance.

In a preferred form, as disclosed in FIGS. 10 through 13, the structure if arranged so that when the roller is in its unactuated position wherein cap 214 is released, pin 217 is disposed substantially on a vertical line through the axis of the roller and disposed below the axial center of the roller. The band is exerting a predetermined force on the roller urging it to the right and opposing its movement by the application of a force to cap 214. When a force is applied to button 214, roller 201 may be moved to the left but only upon the application of a force sufficient to overcome the force applied by the band acting through the lever arm which is has due to the pin and slot arrangement. The lever arm referred to is the lever arm between the instantaneous center about which the roller is moving at any given instant and the pin. This force is cyclic as can be seen in FIG. 14 which is a graph of the force which must be applied to overcome the bias of the band acting through this lever arm. As seen there, this force is at a maximum at position *a* which is the position that the roller occupies in FIG. 10. Thus a substantially greater force than the force actually applied by the band must be applied to pushbutton 214 in order to depress it and move the roller. As a force

sufficient to overcome the bias of the spring acting through this lever arm is applied, the roller is moved towards the left and the lever arm continuously changes reducing the amount of force which must be applied. This amount of force drops off rapidly as can be seen in FIG. **14** so that a breakaway action is obtained once the pushbutton is activated. When the lever arm is equal to the radius of the roller, the force required is equal to the force applied by the band. As can be seen, when the roller reaches position *b* this force has dropped off substantially and has a relatively large rate of decrease. In this position the pin is located substantially on a horizontal line through the center of the roller and the roller has been moved approximately 90°. As can also be seen in FIG. **14**, the roller need be moved only a slight distance further in order to accomplish full contact with legs **203** and **204**. This is accomplished at approximately the position represented by position *c* on FIG. **14**.

The structure described in connection with FIGS. **10** through **14** is such that a relatively lightweight band, providing a relatively small amount of force on a roller, can be utilized even in an application where a substantially greater amount of force is desired to be required to activate the switch. The pin and slot arrangement provides a force amplifying means between the actuator (provided by the yoke and pushbutton) and the roller. Also, it provides breakaway action so that once sufficient force is applied to begin movement of the roller, it moves away very quickly and with increasing ease. This assures fast contact between conductor **207** and legs **203** and **204** and also makes the switch easier to operate which is important especially when utilized in a keyboard. If desired, the same mechanism may be used and the relationship of the pins to the yoke changed so that the actuator will have a mechanical advantage, that is, so that the force required to move the yoke would be less than the spring force applied by the band.

It will be obvious that the keyboard switch which has just been described may be utilized using a large variety of roller-band type switches including those described in connected with the other embodiments herein. A particular advantage is obtained with a switch arrangement having a plurality of legs, generally of the type disclosed in FIG. **9**, so that a plurality of identical switches can be utilized in a keyboard eliminating the need for different switches utilizing a plurality of diodes as is common now. All that would need to be done is to connect appropriate ones of the legs of each of the switches into the output circuit.

This invention provides a very simple switching arrangement utilizing a roller-band device capable of switching a variety of current loads, readily adaptable for miniaturization, and particularly useful in keyboard switches or the like. The device is extremely simple and easy to manufacture and a single switch may be utilized to perform a plurality of switching functions. It is especially adaptable for use in connection with a keyboard switch of the type disclosed with a forced amplifying arrangement between the manual actuator and the roller providing the desired "touch" for the key and also providing breakaway action. The structure described is not only useful in keyboard switches but may be used in toggle switches, G-switches, or many other types.

Various modifications of the invention disclosed herein may become apparent to those skilled in the art in view of the disclosure herein. It is intended that this disclosure be by way of example only and not by way of limitation and therefore it is intended that this invention be limited solely by the scope of the dependent claims.

The embodiments of the invention in which an exclusive property or right is claimed are defined as follows:

1. In a roller-band device including a roller and a flexible band substantially encircling the roller and having end portions extending generally in opposite directions from the roller, the roller and band being rollable together without substantial friction therebetween, the improvement comprising the roller having an electrically nonconductive surface about which the band extends, the band being comprised of two electrically conductive sections, said sections being electrically insulated from each other, and conductor means movable with the roller and disposed to electrically connect the two sections of the band in predetermined positions of the band and roller.

2. The device of claim **1** including support means and wherein one section of the band comprises a pair of spaced leg members extending in one direction around said roller and the other section of said band comprises a tongue portion disposed between said leg portions and extending in the other direction around said roller, said tongue and leg sections extending generally in opposite directions from the roller and being connected at their ends to said support means.

3. The device of claim **1** wherein said conductor means comprises a plurality of conductor members movable with said roller and disposed in a position to bridge between said first and second sections of the band in a plurality of different positions of the roller and band.

4. The device of claim **2** wherein said leg portions are electrically insulated from each other and wherein the conductor means movable with the roller comprises means adapted to bridge between said tongue and one of said leg portions in one position of the roller and band and to bridge between the tongue and the other leg portion in another position of said roller and band.

5. The device of claim **1** wherein one of said band sections comprises a plurality of spaced and electrically insulated leg portions connected along the surface of said roller and extending in one direction therearound, the other of said sections includes at least one conductive tongue portion disposed between adjacent ones of said leg portions, connected to said roller and extending in the other direction therearound, said tongue portion being disposed on the roller so that said leg portions are arranged generally symmetrically about it, and wherein the conductor means is disposed for bridging between and electrically connecting said tongue portion to said leg portions in one or more predetermined positions of the roller and band.

6. The device of claim **5** wherein said tongue portion acts as a common electrical conductor and said leg portions as separate output conductors, and wherein the conductor means movable with the roller is constructed and disposed so that different ones of said leg portions are electrically connected to said tongue portion in different positions of said roller and band.

7. The device of claim **5** wherein each of said leg portions has an output terminal adapted for connection to a printed circuit board or the like and wherein said conductor means is effective to bridge all of said leg portions and said tongue portion simultaneously in predetermined positions of said roller and band.

8. The apparatus of claim **7** wherein a plurality of similar switches are utilized in a keyboard with each switch thereon having a different combination of output terminals connected into the output circuit.

9. The device of claim **2** wherein said conductor means is a conductive member imbedded in the roller along a portion of the surface thereof and substantially continuous with the surface of said roller in a position wherein it is engaged only by said tongue portion in certain positions of said roller and band and simultaneously by said leg portions and said tongue portion in other positions of the said roller and band.

10. The device of claim **2** wherein said conductor means is an electrical conductor member common with said tongue portion and secured to a portion of the surface of the roller in a position where it will be engaged by said leg portions only in certain predetermined positions of said roller and band.

11. The device of claim **1** including support means, the ends of said first and second band sections being fixed to said support means and said roller and band being movable back and forth on said support means, actuating means including a yoke member mounted on said support means for movement generally along the direction of movement of the roller and

band, means connecting said yoke means to said roller, and means yieldably urging said yoke means, said roller and said band to one position, said yoke means being movable by an external force when in opposition thereto and in the other direction.

12. The device of claim 11 wherein said band sections are formed of a flexible resilient material and are constructed so that an internal bias urges said roller and band in one direction, said roller is generally cylindrical in shape, said yoke means has a pair of finger members straddling said roller and extending along opposite ends thereof, each of said finger members has elongated slots therein, a pair of pins are disposed in opposite ends of said roller and offset from the axis thereof, and said pins are disposed in the slots in said finger portions of said yoke member to connect said yoke means to said roller, said offset pins and the cooperating slots providing a force amplification means whereby the force exerted upon said roller by said band sections are amplified and said roller and band can be moved against the bias of said band sections only by the application of a greater amount of force to said yoke means by an external force.

13. The device of claim 12 wherein said pins and cooperating slots are arranged to give a breakaway action whereby the force applied thereto by the internal bias of said spring decreases as said roller and band are moved against said force.

14. The device of claim 11 wherein one of said band sections comprises a tongue section connected to said roller and extending in one direction around the surface thereof and having its end connected to said support means, the other said band section comprises a plurality of electrically insulated leg members each connected to said roller and extending generally in the opposite direction around the periphery thereof and having their remote ends also connected to said support means, the tongue section providing a common electrical lead and said leg members providing a plurality of electrical output circuits, and said conductor means bridging between and electrically connecting said tongue section and said leg members at predetermined positions of said roller and band.

15. A roller-band device of the single roller type comprising support means, a roller rollable in a generally singular plane, a flexible band substantially encircling said roller said band including a first section having at least two spaced legs and a second section having a tongue member said legs and said tongue extending directly from said roller in substantially opposite directions and in substantially the same plane along which said roller rolls, said legs and tongue connected to said support means whereby said roller and band are movable together back and forth on said support means, actuating means including yoke means movably mounted on said support means for movement generally along the direction of movement of said roller and band thereon, said yoke means having spaced finger portions disposed on opposite ends of said roller, means operably connecting said finger portions and said roller, means yieldingly urging said roller and band and said yoke means in one direction on said support means toward an end position, and said yoke means being externally operable to move it and said roller and band in the opposite direction on said support means toward a second end position, and conductive means responsive to the movement of said roller for completing an electrical circuit when said roller is in one of said end positions.

16. The device of claim 15 wherein said band is a resilient flexible band formed so that an internal bias therein urges said roller and band in said one direction toward said end position.

17. The device of claim 16 wherein the means connecting said roller and said finger portion means of said yoke means includes force-amplifying means whereby the external force required to operate said yoke means is different than the force applied to said roller by said band.

18. A roller-band device comprising support means, a roller having an electrically insulative surface, a flexible band substantially encircling said roller and having ends extending in substantially opposite directions from said roller and connected to said support means whereby said roller and band are movable together back and forth on said support means, said band including a first section comprising an electrically conductive tongue member, said legs and tongue being connected to said roller and extending in opposite directions therearound, said tongue and said legs being electrically insulated from each other, conductor means including means for completing the circuit between said tongue and said legs in predetermined positions of said roller and band, actuating means including yoke means movably mounted on said support means for movement generally along the direction of movement of said roller and band thereon, said yoke means having spaced finger portions disposed on opposite ends of said roller, means operably connecting said finger portions and said roller, means yieldably urging said roll and band and said yoke means in one direction on said support means toward an end position, and said yoke means being externally operable to move it and said roller and band in the opposite direction on said support means.

19. The device of claim 18 wherein said leg and said tongue are formed of resilient flexible material and wherein said legs and tongue have different effective cross-sectional areas and thereby provide an internal bias urging said roller and band in said one direction.

20. The device of claim 19 further including force-amplifying means between said roller and said yoke means whereby the force which must be applied to said yoke means in order to overcome said internal bias is greater than the force applied to said roller by said band.

21. The device of claim 19 wherein said first section of the band includes a plurality of legs each providing an output electrical circuit member, said second section includes at least one tongue member providing a common electrical connection and said conductor means is effective to connect said tongue member and said legs at predetermined positions of said band and said roller.

22. The device of claim 21 wherein said conductor means is disposed so that said legs are all connected simultaneously to said tongue upon movement of said roller and band to a predetermined position.

23. The device of claim 21 wherein said conductor means is disposed and arranged so that different ones of said leg members are connected to said tongue in different predetermined positions on said roller and band.

24. A roller-band device comprising support means, a substantially cylindrical roller, a flexible band substantially encircling said roller and having ends extending in substantially opposite directions from said roller and connected to said support means whereby said roller and band are movable together back and forth on said support means, said band formed so that an internal bias therein urges said roller and band in one direction toward an end position, actuating means including yoke means movably mounted on said support means for movement generally along the direction of movement of said roller and band thereon, said yoke means having spaced finger portions disposed on opposite ends of said roller, said finger portion means including force-amplifying means whereby the external force required to operate said yoke means is different from the force applied to said roller by said band, said spaced finger portions further including aligned slots which are generally normal to the direction of movement of said roller and band and said yoke, means operably connecting said finger portions and said roller including a pair of pins extending from the opposite ends of said roller and disposed in said slots, said pins being offset from the axis of said roller, means yieldably urging said roller and band and said yoke means in one direction on said support means toward an end position, and said yoke means being externally operable to move it and said roller and band in the opposite direction on said support means.

25. The device of claim 24 wherein said pin and slot connection is arranged so that the offset pins provide a lever arm

which varies upon movement of said roller to require a declining force on said actuator as said roller is moved away from said end position, thereby giving breakaway action to said device.

26. A roller-band device comprising support means, a roller having an electrically insulative surface, flexible, electrically conductive, band means encircling said roller with ends extending generally in opposite directions therefrom, said band means including two separate band sections, one of said sections being connected to said roller and extending in one direction therearound, the other of said sections including at least two spaced legs connected to said roller on opposite sides of said one band section and extending in the other direction around said roller, and means connecting the remote ends of said band sections to said support means and maintaining said band sections in tension whereby said roller and band are movable back and forth on said support.

27. The apparatus of claim **26** further including conductor means movable with said roller and adapted to electrically connect two band sections in predetermined positions of said roller and band.

28. The apparatus of claim **26** wherein said first and second legs are electrically insulated from each other, and the apparatus further includes conductor means movable with said roller and adapted to bridge between said one band section and the first of said legs in one position of said roller and band and to bridge and electrically connect said one band section and the other of said legs in another position of said roller and band.

29. The apparatus of claim **26** wherein said first and second leg portions of said other band section are electrically insulated from each other, and the apparatus further includes electrically conductive means movable with said band and adapted to bridge between said one band section and each of said legs simultaneously upon movement of said roller and band to a predetermined position.

* * * * *