# United States Patent

[11] 3,548,138



[72] Inventor **Gilbert A. Van Dine**
**Winfield Township, Du Page County, Ill.**



[21] Appl. No. **745,803**
[22] Filed **July 18, 1968**
[45] Patented **Dec. 15, 1970**



[73] Assignee **Bell Telephone Laboratories, Incorporated**
**Murray Hill, Berkeley Heights, N.J.**
**a corporation of New York**


---

[54] **ROLAMITE PUSHBUTTON SWITCH**
**8 Claims, 8 Drawing Figs.**


[52] **U.S. Cl.** ..... **200/159,** 200/153
[51] **Int. Cl.** ..... **H01h 3/12**
[50] **Field of Search** ..... 200/52Cap, 52L, 159, 153, (Inquired)



[56] **References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 3,225,228 | 12/1965 | Roshala | 310/12 |
| 3,419,697 | 12/1968 | Gove | 200/52(Cap)X |
| 3,452,175 | 6/1969 | Wilkes | 200/153 |
| 3,452,309 | 6/1969 | Wilkes | 335/1X |

FOREIGN PATENTS

| | | | |
|---|---|---|---|
| 526,230 | 6/1931 | Germany | Library |
| 1,083,412 | 6/1960 | Germany | 200/159 |
| 1,158,085 | 6/1958 | France | 200/159 |

OTHER REFERENCES

" Product Engineer" ; Vol. 38, No. 24, November, 1967, McGraw-Hill Publishers; p. 39

" Rolamite: A New Design Concept (I)" ; by D. F. Wilkes; October, 1967, Sandia Laboritores Publishers; all (just title page included). Group 340

" Rolamite: A New Design Concept (II)" ; by D. F. Wilkes; December, 1967, Sandia Laboritories Publishers; All (pp. 54, 68, 70, 86, 112, 127, 143, 163, & 170 & 201 included). Group 210



*Primary Examiner*—Robert K. Schaefer
*Assistant Examiner*—Robert A. Vanderhye
*Attorneys*—R. J. Guenther and Edwin B. Cave


---


**ABSTRACT:** The principles of a rollerband device are applied to the construction of a pushbutton switch by providing each of the two roller elements with a respective integral shaft and by providing shaft bearings on the inner surface of a hollow pushbutton member. Circuit completion may be effected, alternatively, by mechanical contacts, by light transmission, capacitively or inductively.

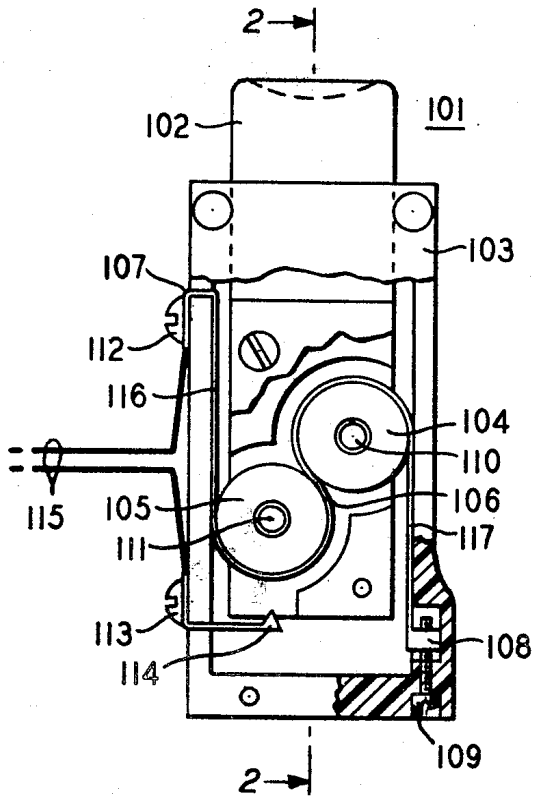



FIG. 1

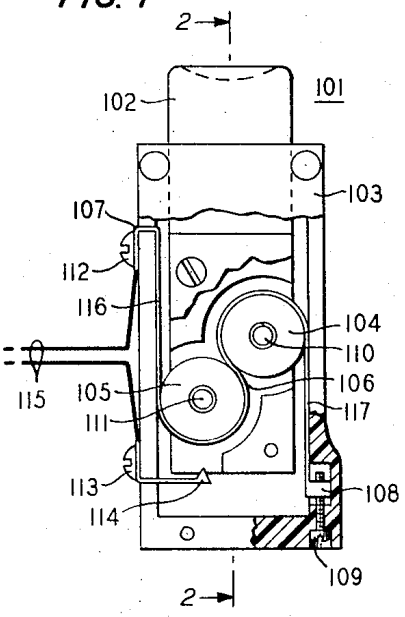



FIG. 2B

FIG. 2C

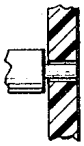


FIG. 2A

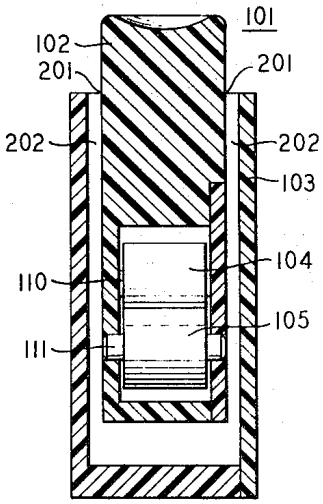



FIG. 3

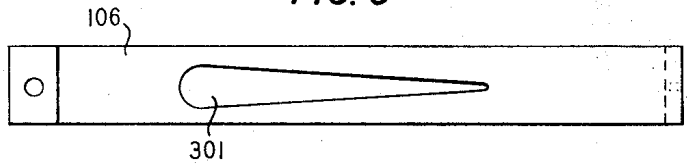



FIG. 4

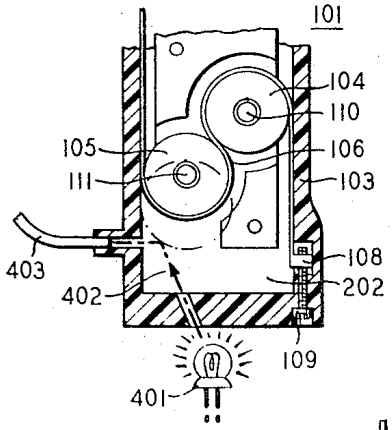



FIG. 5

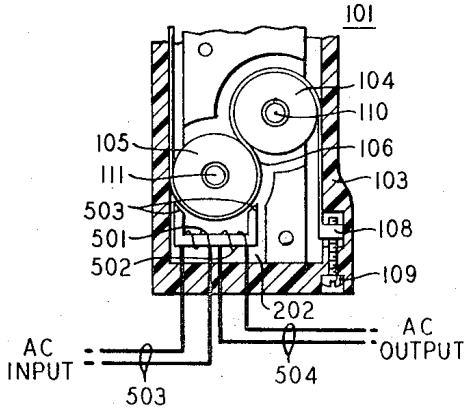
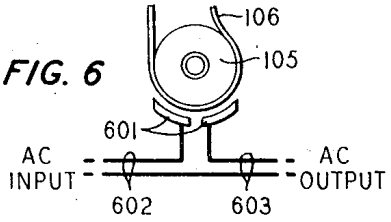



FIG. 6




INVENTOR
G. A. VAN DINE
BY
ATTORNEY

# ROLAMITE PUSHBUTTON SWITCH

## BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to manually operable electrical switches and more particularly to pushbutton switches.

2. Description of the Prior Art

Increasingly widespread use of pushbutton switches throughout the computer field in telephony and in assorted automatic control systems has served to focus attention on a number of problems inherent in the operation, maintenance and construction of such switches. Undue friction between the moving parts, misalignment, introduction of dirt and foreign substances, contact wear, and unsuitable force versus depression characteristics are some of the problems involved, any one of which may adversely affect either the reliability or the convenience of switch operation which in turn adversely affects the operation of the associated equipment.

A typical, conventional and widely used type of pushbutton switch is shown by R. E. Wirshing in U.S. Pat. No. 2,873,334, issued on Feb. 10, 1959. Considering the simplicity of the function performed, it is evident that the structure of switches is undesirably complex. Accordingly, a broad object of the invention is to simplify the construction of pushbutton switches. Another object is to enhance the reliability of such switches.

Inasmuch as keyboards being utilized in the computer and communications fields are increasing in size and complexity, the rapidity with which a number of pushbutton switches can be sequentially operated is now a major consideration in pushbutton design. The speed of operation is in large measure affected by the pushbutton "feel," which is primarily determined by the force versus depression characteristic. In the prior art this consideration has played a minor role, and has necessarily been compromised or controlled by consideration given to other requirements. Accordingly, a primary object of this invention is to incorporate in a pushbutton switch preselected force versus depression characteristics substantially independent from other design requirements.

## SUMMARY OF THE INVENTION

The stated objects and related objects are achieved in accordance with the principles of the invention by turning to account certain features of a relatively new mechanical force-translation device commonly termed a "roller band" which is also identified as a Rolamite device. A roller band comprises a pair of roller members with parallel axes in combination with a flexible metal band, such as steel, disposed in an S-configuration separating the rollers and looping around one side of each of the rollers. The assembly is slipped between parallel surfaces and the band ends are pulled into tension and anchored. The device is virtually frictionless and can be rolled from one end of its assembly to the other with very little force. In comparable arrangements of wholly conventional roller bearings or ball bearings, the friction forces are typically between 10 times and 100 times greater than in the roller band device. A roller band unit can be miniaturized to a remarkable degree, needs no lubrication in service, is inexpensive to produce, demands no precise tolerances and is relatively insensitive to dirt. A wide variety of uses has been suggested for various forms of the roller band device, including use as a thermostat, pivot, bearing, speed reducer, snap-action switch, valve, shock absorber, damper, relay and piston. Roller band devices and various proposed uses thereof are described in the Mechanical Design and Power Transmission portion of "Product Engineering," Nov. 6,1967, published by McGraw-Hill.

As indicated above, the general suggestion of adapting the principles of the roller band to a switch has been made in the prior art. The features of the invention disclosed herein are directed to specific and unique means for accomplishing the broadly suggested adaptation and more particularly to specific and unique means for adapting a roller band device to the needs of a pushbutton switch.



In accordance with the invention each of two roller elements in a roller band device is formed with respective integral shifts. Bearings for the shafts are provided on opposite interior surfaces of a hollow pushbutton member. An outer fixed casing member provides anchoring points for the spring band and also provides the parallel surfaces which support the rollers. Circuit completion may be effected advantageously by metallic contacts, by controlled light transmission, capacitively or inductively.

## DESCRIPTION OF THE DRAWING

FIG. 1 is a front view partially broken away and partially in cross section of a pushbutton switch in accordance with the invention;

FIG. 2A is a cross section view of the assembly shown in FIG. 1 taken along the staggered line 2–2;

FIG. 2B is a cross section view of a first alternative bearing detail for the device shown in FIG. 2A;

FIG. 2C is a cross section view of a second alternative bearing detail for the device shown in FIG. 2A;

FIG. 3 is a plan view of the band **106** shown in FIG. 1;

FIG. 4 is a partial cross section view of the assembly shown in FIG. 1 wherein circuit completion is effected by light transmission;

FIG. 5 is a partial cross section view of the assembly shown in FIG. 1 wherein circuit completion is effected inductively; and

FIG. 6 is a partial cross section view of the assembly shown in FIG. 1 wherein circuit completion is effected capacitively.

## DESCRIPTION OF THE EMBODIMENT

The switch assembly **101** shown in FIG. 1 includes a switch housing member **103** which provides parallel surfaces and anchoring points for the roller band. Within the hollow portion or cavity of the pushbutton **102** are mounted a pair of cylindrical rollers **104** and **105** with integral respective shafts **110** and **111**.

A spring band **106** which may advantageously be constructed of spring steel for example is looped around each of the rollers **104** and **105** in an S-configuration. One end **107** of the band **106** is anchored by terminal screw **112**, and the opposite end **108** is secured by a tension adjusting screw **109**. It will be obvious that a spring or other tensioning device may be substituted for the adjusting screw. Accordingly, both ends of the band **106** are anchored to the casing member. A second terminal screw **113** supports a switch contact **114**, and electrical leads **115** are fixed to the terminal screws **112** and **113**.

Operation of the pushbutton switch **101** is effected by pressing downwardly on the top portion of the pushbutton **102**. In accordance with the invention, the axes of the rollers **104** and **105** are parallel and remain equidistant irrespective of upward or downward travel. As a consequence the pushbutton **102**, being supported by the four shaft ends of the rollers, is constrained from any lateral or tilting motion, and is free to move along in the direction of roller motion. As the rollers **104** and **105** move downwardly together with the pushbutton **102** to which they are affixed, the end or free portion **116** of the band **106** is lengthened and the end or free portion **117** of the band **106** is shortened. During operation, the only potentially significant source of friction in the switch is present at the bearing points at which the shafts **110** and **111** support the pushbutton **102**. Such bearing points may readily be designed for minimal friction. Some slight additional friction occurs from the pressure of the rollers **104** and **105** against the spring band **106** and between the band **106** and the inner surfaces of the housing **103**. The combination of the friction forces indicated, however, is insignificant, and the force-displacement characteristics of the switch are determined almost entirely by the characteristics of the roller band unit itself. As is known in the prior art, the band characteristics may be tailored to meet specific needs by cutting holes or slots in the band **106**, such as the slot **301** shown in FIG. 3, or by varying the bandwidth or spring constant.

Thus, pushbutton force available for switch operation, as a function of the degree of pushbutton depression, may be precisely controlled in both amount and direction by proper band design. Since pushbutton switches commonly have requirements for a detent, the inherent ability to design the required force reversal at any point in the pushbutton travel is another consideration which makes the device particularly advantageous for use in such switches.

When the switch shown in FIG. 1 reaches the lower end of its travel, mechanical contact is made between the switch contact 114 and the conductive spring band 106, thus completing a circuit path between the leads 115. The motion of the band at the moment of contact is partially at right angles to the contact 114, producing a wiping action which is known from the prior art to be particularly advantageous for keeping contacts clean.

As shown in FIG. 2A the integral shafts 110 and 111 of the rollers 104 and 105 are supported in corresponding apertures in the sides of the pushbutton 102. Even greater simplicity in fabrication may be achieved by employing dimplelike depressions on the interior surface of the pushbutton 102 to serve as bearing surfaces for the shafts 110 and 111, as shown in FIG. 2B. Another alternative bearing arrangement is shown in FIG. 2C.

A wide variety of materials may be employed for the construction of a switch in accordance with the invention. Plastics such as nylon and Teflon are particularly advantageous materials for the rollers and their integral shafts, owing to their low cost, suitability for mass production and their low coefficients of friction.

Circuit completion of a switch in accordance with the invention may be effected by various means as shown, for example, in FIG. 4 where a light source 401 introduces a beam 402 into the cavity 202 of the housing 103. When the switch 101 is moved to its "on" position, the light beam 402 is reflected from the highly reflective surface of the band 106 into a light-conducting optical fiber 403. The light thus transmitted may then be employed to effect circuit completion by means of a conventional photosensitive device.

Another means of circuit completion by a switch in accordance with the invention is shown in FIG. 5. Coils 501 and 502 are positioned within the cavity 202 but the inductive coupling between them is normally insufficient to pass the alternating current signal from the input leads 503 to the output leads 504. When the switch 101 is operated, however, the roller and band bridges the gap between the pole pieces 503. Provided the band, or both the band and the roller are made of magnetically permeable material, the inductive coupling between the coils increases sufficiently to permit the completion of an inductive path from leads 503 to leads 504.

FIG. 6 illustrates a means of circuit completion employing capacitive coupling. An AC input is coupled from the input leads 602 to the output leads 603 by means of the capacitive plates 601 in combination with the conductive band 106.

It is to be understood that the embodiment described herein is merely illustrative of the principles of the invention. Various modifications thereto may be effected by persons skilled in the art without departing from the spirit and scope of the invention.

I claim:

1. A switch comprising, in combination;
a substantially hollow body portion;
a partially hollow pushbutton member mounted for pistonlike movement within said body portion;
a flexible resilient band with each of the end portions thereof affixed to respective diametrically opposed parallel surfaces of the inner surface of said body portion;
the center portion of said band being disposed in an S-type configuration between said end portions;
a pair of substantially cylindrical roller members each positioned and constrained within one of the open curves of said S-type configuration of said band;
said roller members each including a pair of protruding, integral shaft members;
said pushbutton member including first bearing means supported by said shaft members thereby permitting rotational movement of said shaft members;
said parallel portions serving as second bearing means for supporting said band as said roller members bear outwardly against said band, said roller members being constrained thereby to roll in a linear direction only;
whereby the force-displacement characteristics of said pushbutton member are determined primarily by the characteristics of said band rather than by frictional forces; and
electrical circuit means operatively responsive to a preselected length of travel of said pushbutton member.

2. Apparatus in accordance with claim 1 wherein said protruding shaft members are integral with said roller members.

3. Apparatus in accordance with claim 1 wherein said first bearing means comprises depressions on the inner surfaces of said pushbutton member.

4. Apparatus in accordance with claim 1 wherein said circuit means includes a light source directing a light beam into the lower portion of said body member, said band serving as a reflecting surface for said beam when said band is moved into the path of said beam, and means for conducting said beam when so reflected thereby to complete said circuit.

5. Apparatus in accordance with claim 1 wherein said circuit means includes first and second pairs of leads, each of said pairs terminating in a respective coil positioned in spaced relation to each other within the lower portion of said body member and mounted on a common core of magnetic material, said band, being comprised of magnetically permeable material, completing inductive coupling between said coils when moved into close proximity therewith by the downward movement of said pushbutton.

6. A pushbutton switch comprising, in combination:
a substantially hollow cylindrical body member;
a substantially hollow cylindrical pushbutton member;
a roller band mechanism comprising a resilient band and a pair of roller members housed substantially within said pushbutton member;
said roller members each including a respective integral shaft member;
first bearing surfaces on the inner surface of said pushbutton member for support by said shaft members;
second bearing surfaces on the inner surface of said body member for supporting said roller members as they press outwardly against said band, the ends of said band being affixed to said body member; and
means responsive to the downward movement of said pushbutton and said roller band mechanism for completing an electrical circuit.

7. Apparatus in accordance with claim 6 wherein said first bearing surfaces comprise apertures in the walls of said body member.

8. Apparatus in accordance with claim 6 wherein said first bearing surfaces comprise depressions in the walls of said body member.