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Arndt et al.

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[54] KEYBOARD APPARATUS WITH MOISTURE PROOF MEMBRANE

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[52] **U.S. Cl.** .....**200/5 R,** 200/153 T, 200/159 B, 200/168 G

[51] **Int. Cl.** **H01h 3/12**

[58] **Field of Search** .....200/5, 46, 82 C, 83 G, 153 T, 200/159, 168 G

[56] **References Cited**

UNITED STATES PATENTS

3,594,684	7/1971	Miller	200/159 B X
2,750,480	6/1956	Freeman	200/168 G
3,382,338	5/1968	Arseneault et al.	200/159 B
2,376,403	5/1945	Thompson et al.	200/5 E
2,875,287	2/1959	Van Sickle	200/153 T X
3,240,884	3/1966	Boadle et al.	200/5 R
3,350,518	10/1967	Krakinowski et al.	200/46
3,472,974	10/1969	McGough	200/5 R
3,448,417	6/1969	Schiller et al.	200/5 E

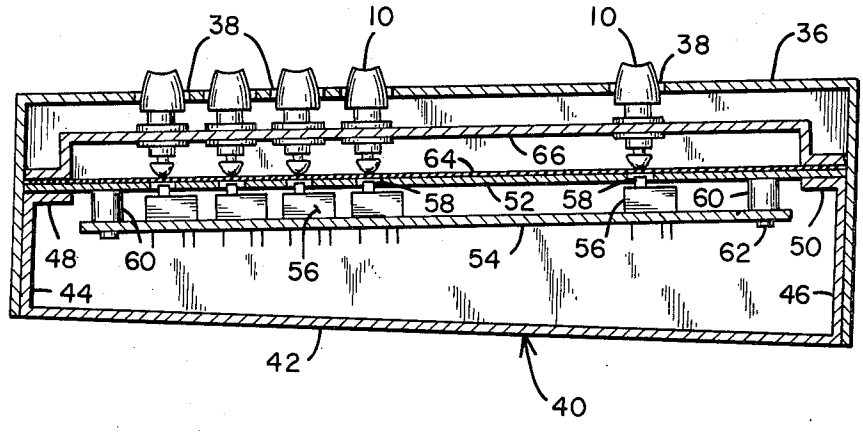
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[57] **ABSTRACT**

An electromechanical keyboard for use with a typewriter or other computer type data entry device designed to meet stringent environmental specifications. The electrical switches employed on the keyboard are totally enclosed in a metal compartment and are actuated through a deformable membrane such that moisture and dust cannot deleteriously affect the switches. Because the switches are contained within a metal compartment, a high degree of RFI shielding is afforded so that radiated emanations are low.

8 Claims, 2 Drawing Figures



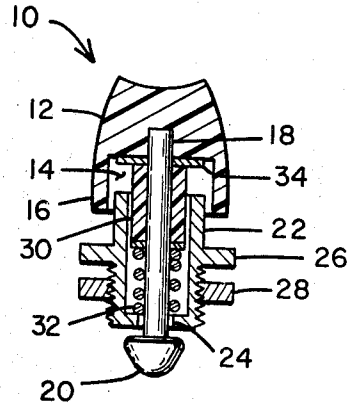


Fig. 1

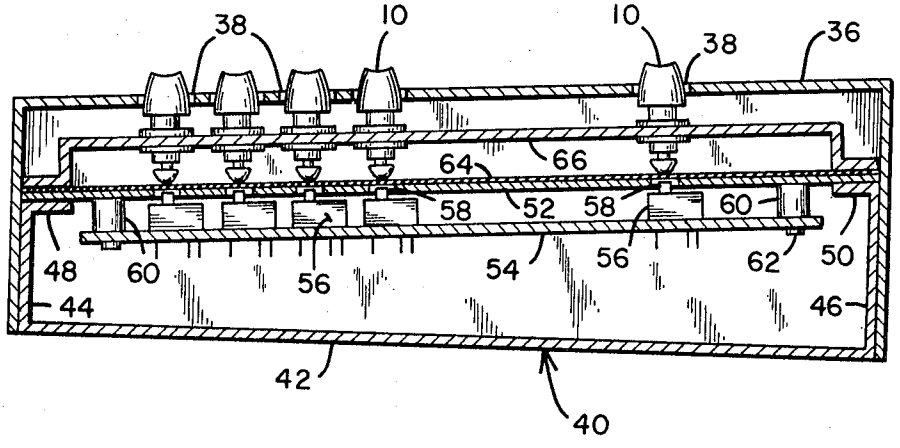


Fig. 2

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KEYBOARD APPARATUS WITH MOISTURE PROOF MEMBRANE

BACKGROUND OF THE INVENTION

This invention relates generally to electromechanical keyboards, and more specifically to a new and improved design of such a keyboard which insures high reliability and substantial freedom from unwanted radio frequency interference radiation.

The keyboards used in equipment designed for military applications must meet stringent specifications in terms of shock and vibration, radio frequency interference, salt spray, etc. Most present day prior art keyboards of which we are aware are not constructed to meet these military requirements. Oftentimes the keyboard is not properly enclosed such that dust and water vapor can enter the mechanism and cause failures. Further, known designs are not sufficiently rugged to withstand the shock and vibration requirements. Further, known keyboards are oftentimes noisy in terms of RFI radiation.

The design of the present invention obviates most of the defects in these prior art arrangements. The keyboard of the present invention comprises a plurality of pushbutton keys, which when depressed, causes reciprocal movement of an actuator rod. Operatively associated with the pushbutton rods are a plurality of pin-plunger type electrical switches. The pushbutton actuators are designed so as to prevent dust and moisture from entering and affecting their working parts. Similarly, the actuators have critical dimensions such that the parts thereof act as waveguides at the noise frequencies involved. The actuators are mounted in a first compartment with the pushbutton keys extending through the top thereof so as to be accessible to the operator. The pin-plunger type switches are mounted in a second compartment with their respective pin-plungers aligned with apertures formed in the top of the second compartment. When the first compartment along with its associated pushbutton actuators is juxtaposed on the second compartment, the actuator rods are aligned with the apertures in the top of the second compartment so that when a particular key is depressed, the actuator rod will be moved in a direction to operate the pin-plunger of the electrical switch. In order to prevent moisture from entering the second compartment and affecting the electrical switches a continuous flexible membrane such as a rubber sheet is disposed between the first and second compartments. As the actuator is depressed, the actuator rod deforms the rubber sheet in the area of the aperture in the top of the second compartment and is forced against the pin-plunger of the electrical switch.

It is accordingly an object of the present invention to provide a new and improved electrical keyboard mechanism.

It is another object of the invention to provide an improved keyboard which meets stringent military specifications.

Still another object of the invention is to provide an improved electrical keyboard which is extremely rugged, sealed against moisture and dust and which effectively reduces the amount of RFI noise radiated therefrom.

These and other objects of the invention will become apparent to those skilled in the art upon reading the following specification in light of the accompanying drawings.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional view illustrating a preferred form of pushbutton type actuator used with the keyboard; and

FIG. 2, is a cross-sectional view of the keyboard assembly.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1, there is shown a pushbutton **10** which may be molded from plastic and which is cup-shaped. Specifically, the pushbutton **10** has a body **12** and a hollowed out portion **14** surrounded by a skirt **16**. Also formed in the body of the pushbutton is a bore **18**. The diameter of the bore **18** is slightly less than the diameter of an actuator rod **20** such

that when the actuator rod is forced into the bore **18** a firm friction fit is established.

The actuator assembly **10** of FIG. **1** is adapted to be mounted in a mounting plate. Specifically, the assembly includes a cylindrical plunger guide **22** which is tubular in shape and which has a shoulder **24** extending inwardly at the bottom end thereof. The plunger guide is also provided with an outwardly extending shoulder or flange **26** which is adapted to rest against the mounting plate. The assembly is fastened in place by means of a nut **28** which cooperates with threads formed on the external surface of the plunger guide **22**.

Surrounding the actuator rod **20** is a shaft guide **30** having a diameter slightly less than the internal diameter of the plunger guide **22** so that it can operate in telescope fashion within the plunger guide **22**.

A return spring **32** surrounds the actuator rod **20** and is disposed between the inwardly extending shoulder **24** and the bottom surface of the shaft guide **30** so as to normally urge the shaft guide and pushbutton upward to the position illustrated in the drawing. It is to be especially noted that when the pushbutton is in its relaxed condition with no downward force applied thereto, the skirt **16** on the pushbutton **10** extends down sufficiently far to at least partially surround the plunger guide **22**. Thus, the skirt serves to prevent foreign particles such as dust, moisture, etc. from entering the plunger guide and fouling the operation of the actuator.

An "E" ring **34** is secured to the upper end of the actuator rod **20** and serves to hold the shaft guide **30** and the return spring **32** in position in the event that the pushbutton **10** is removed. Removal of the pushbutton may be desirable to permit replacement with pushbuttons having different alphanumeric symbols. When the pushbutton **10** is depressed by the operator's finger, the pushbutton **10**, the actuator rod **20**, and the shaft guide **30**, move downward a distance determined by the spacing between the bottom surface of the E ring **34** and the top surface of the tubular plunger guide **22**.

Now that the details of the actuator mechanism have been described in detail, consideration will be given to the keyboard assembly itself. Referring to FIG. **2**, there is shown a cross-sectional view taken through the keyboard assembly. As is illustrated, the keyboard assembly includes a cover member **36**, having a top and four sides (only two of which are shown in the cross-sectional view) extending downward therefrom. Formed in the top of the cover **36** is a pattern of apertures **38** which permits the pushbutton keys **10** (FIG. **1**) to extend therethrough.

The keyboard assembly further includes a channel **40** having a bottom **42** and two upward extending sides **44** and **46**. The sides **44** and **46** are bent inwardly at the top edge thereof to provide a lip **48** and **50** which acts as a support for an apertured plate **52**. The pattern of apertures in the plate **52** corresponds to the position of the actuator assemblies employed on the keyboard.

Mounted beneath the apertured cover plate **52** is a printed circuit board **54** having a plurality of pin-plunger type electrical switches **56** mounted thereon. A typical example of a pin plunger type switch suitable for use in the present invention is disclosed in the McGall U.S. Pat. No. 1,960,020. This type of switch is commonly referred to in the art as a "microswitch." Switches **56** include a pin-plunger **58** which, when depressed, causes contacts internal to the switch to close and establish continuity between predetermined conductors on the printed circuit board **54**.

As is illustrated in FIG. **2**, the printed circuit board **54** is supported from the cover plate **52** by means of a spacer **60** and a suitable fastener **62**. The top surface of the cover plate **52** is covered by a deformable membrane **64** which serves as a gasket as will be further described hereinbelow.

An actuator mounting plate **66** is located beneath the cover member **36** in a spaced apart relationship with respect to the cover plate **52** and the membrane or gasket **64** such that when the actuator assemblies are in their relaxed condition the lowermost ends of the actuator rods **20** are just touching the

top surface of the membrane **64**. Also, the spacing is such that the pushbutton **10** extends through the apertures **38** in the cover member **36** so as to be accessible to the operator. Thus it can be seen that the cover member **36** and the actuating mounting board **66** form a first compartment having a perforated top **36**, a bottom **66** along with side walls. The actuator assemblies of FIG. **1** are mounted on the mounting board **66** which constitutes the bottom of the first compartment such that the pushbuttons **10** extend through the apertures **38** in the top **36**. The aperture plate **52** and the channel **40** form a second compartment having a bottom and side walls and a plurality of pin-plunger electrical switches **56** are mounted within this second compartment such that the pin-plungers **58** of the switches are aligned with the apertures in the top plate **52**. The continuous flexible membrane **64** is disposed between the bottom of the first compartment and the top of the second compartment and the two compartments are juxtaposed with respect to each other so that the actuator rods **20** of the pushbutton actuators are aligned with the apertures in the top **52** of the second compartment.

In operation, then, when the operator depresses one or more keys with his fingers, the actuator rods **20** move downward against the force of the return spring **32** (FIG. **1**) and are constrained by the guides **22** and **30**. The degree of travel of the actuator rods is sufficient to deform the flexible membrane **64** in the neighborhood of the apertures in the cover plate **52** to the extent that the membrane and actuator rods meet the pin-plunger on the switches **56** to cause the switch to be operated.

Because the cover member **36** and channel **40** are formed from metal, a high degree RFI interference shielding is obtained, to thereby prevent RF noise. Further, the ratio of the diameter to the length of the plunger guide **22** is calculated to give the plunger guide **22** the characteristics of a waveguide at the noise frequencies involved. As such the plunger guide **22** limits RFI radiation.

More specifically, in order to meet existing specifications covering electromagnetic interference, the total emission from the equipment must be below 80 db from 40 to 1,000 MH_z. It can be shown that where the operating wave length λ is much much greater than the cut-off wave length λ_c, the attenuation L caused by a wave guide of radius r and length d may be approximated by the formula

$$L = 54.5 \frac{d}{\lambda c} db$$

Where $\lambda_c = 3.4(r)$

It is normally assumed that the emission from any one source should be less than 100 db in order to meet the existing specifications. Practical dimensions for a plunger guide **22** may be approximately

$$r = 0.50 \text{ cm.}$$
$$d = 4.0 \text{ cm.}$$

From the foregoing formula it can be seen that for the dimensions selected

$$\lambda c = 3.4(r)$$
$$= 3.4(0.5)$$
$$= 1.7 \text{ cm}$$

and $L = 54.5 \frac{4}{1.7} = 128\ db$

Accordingly, for a high degree of radiation supression the length of the plunger guide **22** should be equal to or greater than four times its diameter.

The flexible membrane **64** in the preferred embodiment is a silicone rubber sheet approximately 25 to 30 durometer hardness. The gasket completely isolates the switches contained in the second compartment from the outside environment and prevents damage to the switches and other printed circuitry which might otherwise be caused by water and moisture.

The keyboard enclosure including the cover **36** and the bottom channel **40** can be formed using a welded construction to make the assembly extremely rugged and not subject to failure due to shock and vibration. Thus it can be seen that we have provided by our invention an electromechanical keyboard which is suited for use in military equipment.

The scope of the invention should not be restricted to the configuration illustrated in FIGS. **1** or **2**. Many variations will become apparent to those skilled in the art after reading the specification. Accordingly, it is to be understood that the foregoing disclosure relates to only preferred embodiments of the invention and numerous modifications and alterations may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. An electromechanical keyboard comprising:

a. a first compartment having a perforated top, a bottom and side walls

b. means for mounting a plurality of pushbutton operated plungers on said bottom such that said pushbuttons extend through the perforations in said top;

each of said pushbutton operated plungers comprising;

a plunger rod;

a cup-shaped pushbutton having a bore formed in the bottom surface of said cup of a diameter slightly less than the diameter of said rod so as to create a press fit therebetween when said rod is inserted into said bore;

a cylindrical guide member secured to said rod, abutting the bottom surface of said cup-shaped pushbutton and extending beyond the rim of said cup-shaped pushbutton;

a tubular member having internally extending shoulder at one end thereof and an inside diameter slightly larger than the diameter of said cylindrical guide member to permit reciprocal movement of said guide member and rod within said tubular member when said pushbutton is depressed; and

a return spring surrounding said rod and disposed between said guide member and said shoulder;

c. a second compartment having a perforated top, a bottom and side walls;

d. means for mounting a plurality of pin-plunger type electrical switches within said second compartment such that said pin-plungers are aligned with the perforations in the top of said second compartment; and

e. a continuous flexible membrane disposed between the bottom of said first compartment and the top of said second compartment; and

f. means for securing said first compartment in a juxtaposed position with respect to said second compartment such that said plungers are in alignment with the perforations in the top of said second compartment.

2. A pushbutton operated plunger comprising:

a. a plunger rod

b. a cup-shaped pushbutton having a bore formed in the bottom surface of said cup of a diameter slightly less than the diameter of said rod so as to create a press fit therebetween when said rod is inserted into said bore;

c. a cylindrical guide member secured to said rod abutting the bottom surface of said cup-shaped pushbutton and extending beyond the rim of said cup-shaped pushbutton;

d. a tubular member having internally extending shoulder at one end thereof and an inside diameter slightly larger than the diameter of said cylindrical guide member to permit reciprocal movement of said guide member and rod within said tubular member when said pushbutton is depressed; and

e. a return spring surrounding said rod and disposed between said guide member and said shoulder.

3. Apparatus as in claim **1** wherein said membrane is a silicone rubber sheet approximately 25 to 30 durometer hardness.

4. Apparatus as in claim **2** wherein the length of said tubular member is at least four times its diameter.

5. An electromechanical keyboard comprising:

a. a first metal compartment having a perforated top, a bottom and side walls;

b. plunger guide means for mounting a plurality of pushbutton operated plungers on said first compartment bottom such that said pushbuttons extend through the perforations in said top;

each of said pushbuttons comprising;
a body and a hollowed-out portion surrounded by a skirt;
a tubular shaft guide within said hollowed-out portion and extending beyond the rim of said skirt;

c. a plurality of plunger rods, each plunger rod passing through an associated plunger guide and secured to an associated pushbutton for permitting reciprocal movement of said shaft guide in said plunger guide;
d. a second metal compartment having a perforated top, a bottom and side walls;
e. means for mounting a plurality of electrical switches within said second compartment and in alignment with the perforations in the top of said second compartment;
f. a continuous flexible membrane disposed between the bottom of said first compartment and the top of said second compartment; and,
g. means securing said first compartment in a juxtaposed position with respect to said second compartment for aligning said plunger guides with the perforations in the top of said second compartment.

6. The electromechanical keyboard of claim 5 wherein each of said plunger guides has the characteristics of a wave guide for providing to transmission therethrough from said second compartment to said first compartment of noise signals of frequencies from 40 MH_z to 1,000 MH_z an attenuation of at least 80 db.

7. A pushbutton operated plunger, comprising:

a. a plunger rod;
b. a pushbutton comprising;
a body and a hollowed-out portion surrounded by a skirt;
a tubular shaft guide within said hollowed-out portion and extending beyond the rim of said skirt;
means for securing said plunger rod to said body and through said shaft guide;

c. a tubular plunger guide having an internally extending shoulder at one end and an inside diameter of a length extending to the other end and an outside diameter at said other end for permitting reciprocal movement of said plunger guide within said skirt and over said shaft guide;
d. a spring surrounding said plunger rod and disposed within the inside diameter of said plunger guide and between said shaft guide and the internally extending shoulder of said plunger guide when said plunger rod is secured to said body for permitting reciprocal movement of said shaft guide and said plunger rod within said inside diameter and said internally extending shoulder, respectively, of said plunger guide.

8. The pushbutton operated plunger of claim 7 wherein said length is at least four times said inside diameter giving said plunger guide the characteristics of a wave guide for providing to transmission therethrough of noise signals of frequencies from 40 MH_z to 1,000 MH_z and attenuation of at least 80 db.

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