United States Patent

Hunt et al.

[15] **3,679,038**

[45] **July 25, 1972**

[54] ELECTRICAL CIRCUIT FOR IMPACT CONTACT KEYBOARD

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[52] **U.S. Cl.** **197/98,** 197/19

[51] **Int. Cl.** **B41j 5/08**

[58] **Field of Search** 197/107, 19, 98; 235/145

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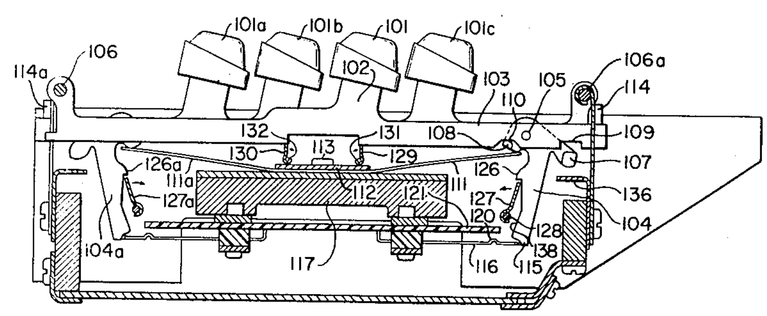
[57] **ABSTRACT**

A keyboard is disclosed which produces a signal in response to the depression of a selected key lever. In response to the depression of the selected key lever, a resilient spring contact is deflected away from a relatively fixed contact and released. The resilience of the resilient spring contact causes said spring contact to return towards the relatively fixed contact and make a momentary closure therewith. In response to the momentary closure, an electrical signal is produced during the charge time of a capacitor in series with the closing contacts. The capacitor is so chosen that it will be substantially fully charged in response to the closure of the contacts and no additional signal will result in the event that there should be any contact bounce or multiple closures thereof. An actuating pawl for actuating the resilient contact spring is attached to the key lever and a single spring is used to bias the actuating pawl and the key lever to their at rest positions. A bail which may be selectively positioned in cooperative relationship with a projection on the actuating pawl may be used to lock the key levers against actuation. A frame member is employed to pivot the pawl near the end of the down stroke of the key lever and thereby release the resilient contact spring. The cited frame member, the pawl and the key lever coact to provide a down stop limit for the key lever. Alternate selective means may be provided for locking selected key levers against actuation. In the structure shown, selected key levers are pivoted from a forward position while other key levers are pivoted from a rearward position. The circuit of the cited capacitor is designed to assure discharge of the cited capacitor well within the cycle time of operation of a given key lever.

5 Claims, 7 Drawing Figures



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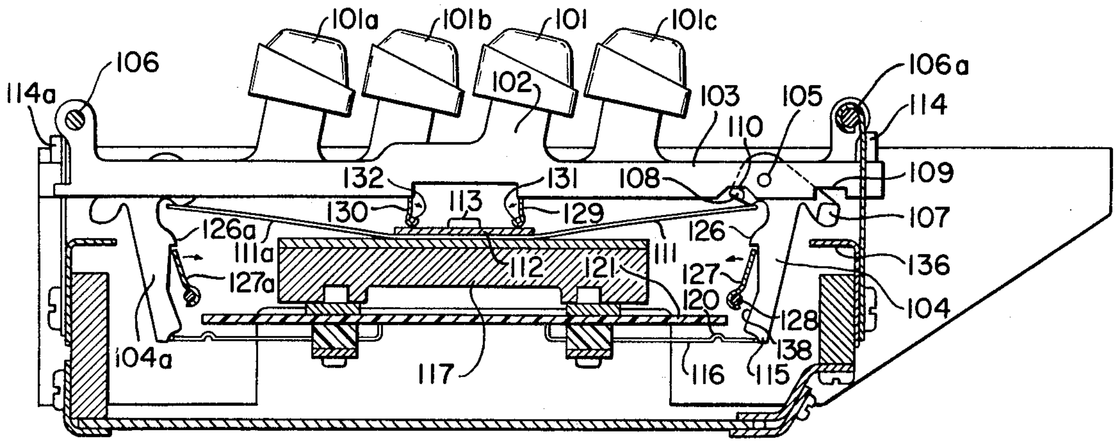

FIG. 1

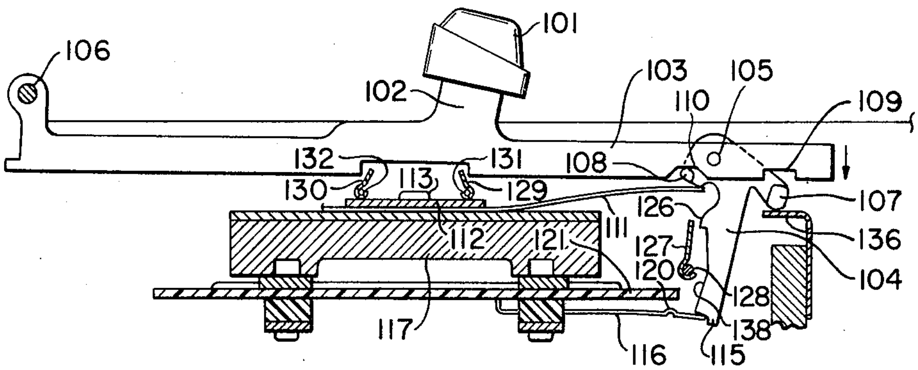

FIG. 2

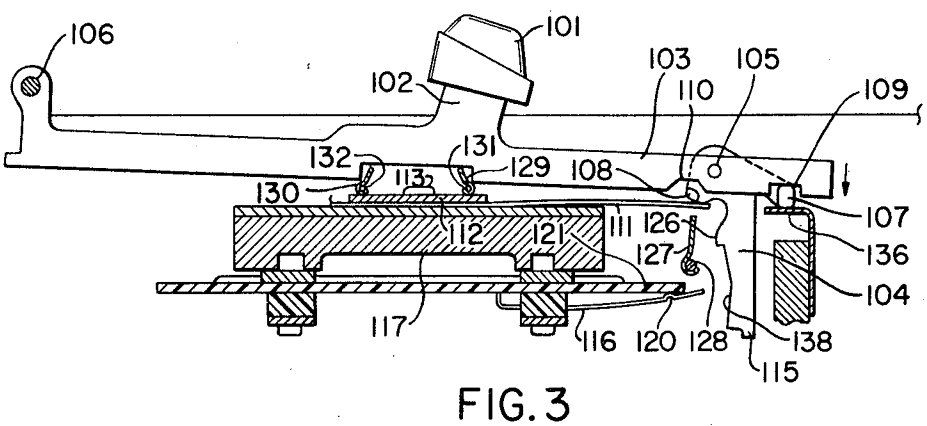

FIG. 3

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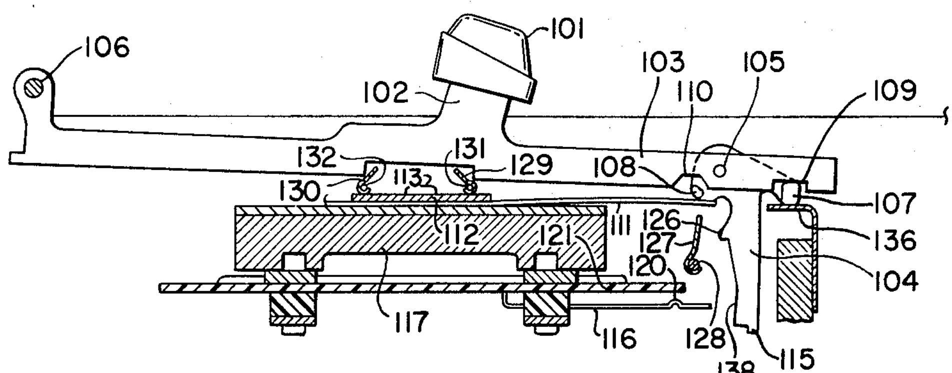

FIG. 4

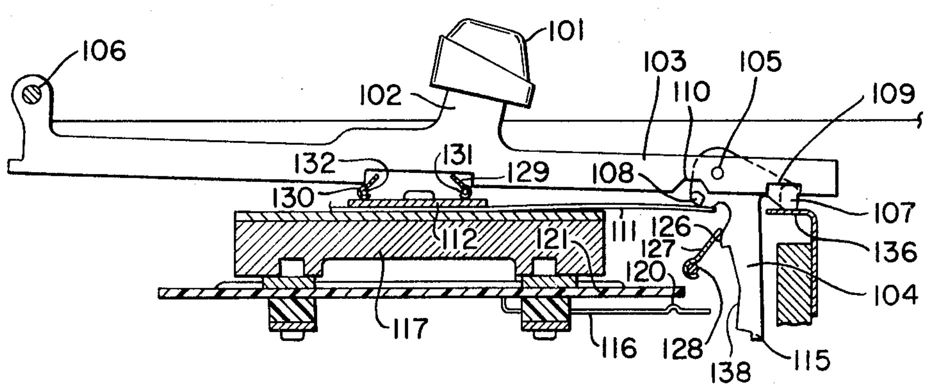

FIG. 5

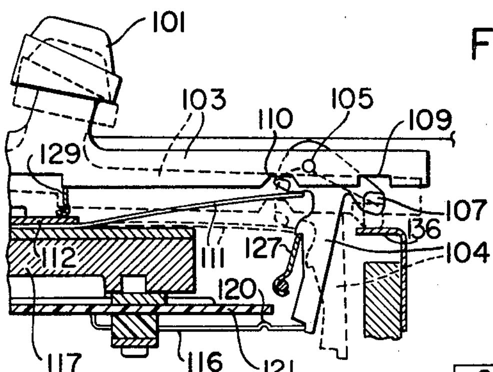

FIG. 6

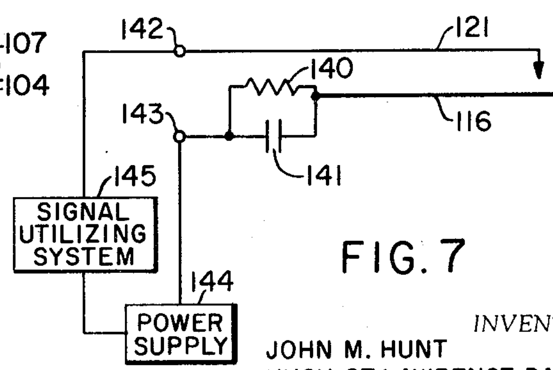

FIG. 7

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ELECTRICAL CIRCUIT FOR IMPACT CONTACT KEYBOARD

CROSS REFERENCE TO RELATED APPLICATIONS

The present application and that of W. C. Ahrns, D. F. Sweeney, and H. St. L. Dannatt Ser. No. 58,638 filed July 27, 1870 and entitled Pawl Actuator and Locking Mechanism for Impact Contact Keyboard and that of H. St. L. Dannatt Ser. No. 58,639 filed July 27, 1970 and entitled Impact Contact Keyboard have similar disclosures and are assigned to the same assignee as the present application.

BACKGROUND OF THE INVENTION

The present invention relates to keyboard mechanisms and, more particularly, to such mechanisms which respond to manual or mechanical manipulation for entering data into machines which may reproduce, record, transmit and/or otherwise process the entered data. A wide variety of data processing machines use keyboard mechanisms for entering alphanumeric characters, symbols, and functional-control items of data information into the machine. Familiar examples of such utilization of keyboard mechanisms include the ubiquitous typewriter, adding machine, calculator, cash register, graphic arts machines, and input controls to computers. Some keyboards are mechanically coupled to the machines that they control, while others are electronically coupled. For example, the common portable typewriter employs a mechanical coupling between the manually operated key lever and the type bar which prints the selected character on the document held by the platen. Keyboards coupled to computers usually provide input information to the computer in the form of electrical signals uniquely indicative of the data to be entered and therefor, such keyboards are electrically, and not mechanically, coupled to their associated data processing machines. It is not unusual for a manually operated keyboard to be capable of generating both electrical signals and mechanical signals in response to the manipulation of individual key buttons of the keyboard. A typical example of the latter type is disclosed in U.S. Pat. No. 3,327,828 issued on June 27, 1967, to Hugh St. Lawrence Dannatt and assigned to the same corporate entity as the present invention.

As new developments were made on machines such as the typewriter, they became more sophisticated and it was necessary to design improved keyboard mechanisms, too. In general, such mechanisms were not required to respond at a rate any faster than they could be manipulated by an expert typist. Such rate rarely approached the order of approximately 15 operations per second, except for the typing of a short sequence of familiar characters. However, techniques were developed for operating a keyboard in response to data read from a stored medium, such as a punched tape, a punched card, or a magnetic tape. Since modern electronic techniques permitted the reading of such data at a greatly increased rate, it was desired to produce machines which would respond more rapidly. As a result, in recent years, considerable effort has been devoted to producing machines which have a reduced response time. Other developments, including the ability to multiplex signals from a plurality of keyboards over a common channel to a plurality of receiving instrumentalities, required further refinement and sophistication of the keyboard design. Accordingly, many innovations and developments have been devised together with specialized keyboards for specialized purposes.

The keyboard of the present invention finds particular utility in an application wherein it is desired to produce individual signals at a relatively high rate and wherein the electrical signal responsive to the operation of any particular key lever may be a signal of relatively brief duration. Such key boards find particular utility in systems wherein alphanumeric data and/or control signals are transmitted from the keyboard to the utilization device in the form of electrical signals and wherein it is desirable that such signals be of relatively brief duration and have an essentially square wave pattern. Such utilization devices are well known to those skilled in the related arts and do not form a part of the present invention and therefore, will not be further disclosed or discussed herein, except insofar they may interact with the structure of the present invention.

Keyboards which were directly and physically associated with the utilization device provided the operator with tactile, visual and audible feedback, which consciously and/or subconsciously indicated to the operator the successful completion of the desired result. That is, when an operator depresses a particular key button in an ordinary typewriter, she is able to feel the motion of the key lever, see the printed character and hear the impact of the type bar on the document supported by the platen. A proficient typist relies upon these tactile, audible, and visual feedback signals to pace her typing and thereby rapidly produce an accurate typewritten page, having a minimum number of errors and with a minimum number of malfunctions of the machine. When electric typewriters were invented, it was possible to produce the printed character with a much shorter stroke of the key lever. Operators who had been familiar with the relatively long stroke of manually operated typewriters first felt a loss of the tactile sense with the keyboard. However, as they became accustomed to the reduced stroke of the keyboard, they regained the sense of comfort and security of the tactile feedback. Actually, such keyboards provided a good tactile feedback as a result of the sudden change in pressure on the key button in response to the actuation of mechanically coupled components.

When keyboards were developed for use in producing electrical signals, the operator was frequently deprived of the tactile feedback. However, the visual and audible feedback usually sufficed. In subsequent machines, a free standing keyboard was used which generated electrical signals which were transmitted to remote areas. Accordingly, the operator of such keyboards was deprived of any visual or audible feedback indicative of the satisfactory operation of the keyboard. Furthermore, such keyboards provided little, if any, tactile feedback. Operators who have attempted to use such keyboards have found that their error rate is greatly increased and their speed reduced. This is believed to be the result of the fact that no signal is given to the operator indicative of the successful and satisfactory completion of the desired result.

SUMMARY OF THE INVENTION

The present invention relates to the structure of a keyboard used for controlling a remote device. A particular feature of the keyboard resides in its ability to communicate with the operator through the tactile senses to provide a definite sense of accomplishment of the desired result. This communication or rapport between machine and operator is produced by providing what is sometimes called a "breakaway" feel. More specifically, a definite, albeit a light, finger pressure is required to depress a given key lever. Shortly before the key lever reaches its lower limit of depression, there is a sudden reduction in the resistance to depression. This sudden change in pressure provides an eminently satisfactory feedback signal which indicates to a subconscious sense of the operator that the mission has been satisfactorily performed and that the machine is prepared for the next command. The breakaway feel is provided by the coaction of a cantilevered spring pressing upon a pivoted pawl and in which the pivoted pawl is pivoted away from the cantilever spring shortly before the key lever reaches the bottom position of its stoke. The sudden disengagement of the pawl from the cantilever spring reduces the upward pressure on the key lever and thereby provides the desired "breakaway" feel. The mentioned cantilever spring is part of a contact pair which is normally open. However, when the cantilever spring is released, the energy stored in said cantilever spring causes it to make an electrical contact with a relatively stationary contact member and thereby produce an electric signal. Because of the velocity of the cantilever spring at the time it makes the before-mentioned electrical contact,

there is a possibility that there may be multiple closures. Circuit means are therefore provided which filter out any multiple closures and provide a single signal to the associated equipment controlled by the keyboard.

Another feature of the structure resides in the fact that the structure is so designed that the rows of the keyboard have a nearly equal key dip. The nearly equal key dip is provided by pivoting the key levers for the forward rows at the rear of the machine and pivoting the key levers for the rear rows at the front of the machine.

Another feature of the structure resides in a means for locking the keyboard against further manipulation. Alternate means are also provided for locking selected key levers against manipulation.

The structure of the present invention provides a convenient and compact keyboard with a desirable silhouette and minimum front-to-rear dimension. The keyboard may be readily mass produced and requires a minimum amount of adjustments and the most modern components and techniques may be employed in its manufacture.

In keyboards of the class presently under consideration, it is desirable to provide an electrical signal indicative of the specific key lever operated which is independent of the characteristic manipulation of the operator. More specifically, the output signal must not be related to the velocity of key lever movement or the period of time between key lever depression and release. Accordingly, it is an object of the present invention to provide a structure which produces uniform output signals which are independent of the originating manipulations.

In machines of the class under consideration, it is important that only one output signal be produced in response to the manipulation of a key lever. Inasmuch as it is desired that the output signal be a very brief signal measured either in milliseconds or microseconds, there is a chance that the contact which originate the signal may bounce during closure and thereby provide multiple closures with a corresponding multiple output signal.

It is another object of this invention to provide a structure which produces a single output signal irrespective of the fact that the originating contacts may bounce and have multiple closures.

It is another object of the present invention to provide a new and improved keyboard mechanism which overcomes one or more of the disadvantages and limitations of prior art mechanisms.

It is yet a further object of the invention to provide an improved keyboard mechanism posessing high versatility for numerous and diverse applications, combined with consistent dependability over prolonged periods of operation, and one which enables a very easily and simplified change to be effected to modify the coding of data information transmitted in response to a keyboard manipulation.

It is another object of the invention to provide a new and improved keyboard structure which will generate an electrical signal having a minimum duration and a clean make and break operation in response to a keyboard manipulation.

It is another object of the invention to provide a structure wherein the nature and duration of the output signal responsive to the manual manipulation of an individual key lever is independent of any idiosyncrasies of the manual manipulation.

Other and further objects and advantages of the present invention will appear as the detailed description thereof proceeds in the light of the drawing forming a part of this application and in which:

FIG. **1** is a side elevational view in cross-section, illustrating a keyboard mechanism employing the present invention in a particular form;

FIGS. **2** through **6** are fragmentary side elevational views illustrating particular constructional and operational details of the keyboard mechanism at various stages of the manual manipulation thereof; and

FIG. **7** is a portion of the electrical circuit associated with the keyboard mechanism.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now more particularly to the drawing and specifically to FIG. **1**, there is shown therein a cross-section of a keyboard in which the invention is incorporated. The illustrated keyboard is one which is suitable for producing signals indicative of alphanumeric characters and/or functional signals. Such a keyboard typically has four rows of keys with several keys in each row. However, it should be understood that the principles disclosed may be employed in a keyboard having a greater or lesser number of keys and/or rows.

Consideration will now be given to key button **101** and the structure associated therewith. It should be understood that similar structures are associated with key buttons **101***a*, **101***b*, and **101***c*. That is, the structures for key buttons **101***a* to **101***c* differ from that of key button **101** by minor changes in a few physical dimensions but not in operating characteristics or function. Key button **101** is attached to an upstanding arm **102** on a key lever **103**. Coupled to the key lever **103** is an actuating pawl **104** which is pivoted on the key lever **103** at pivot point **105**. The key lever **103** is in turn pivoted on pivot wire **106** which is rigidly supported by a frame member (not shown). In a similar manner, keybutton **101***c* is also associated with a key lever similar to that of **103** and which is also pivoted on pivot wire **106**. However, key buttons **101***a* and **101***b* are associated with key levers which are similar to key lever **103** except that these key levers are pivoted on a pivot wire **106***a*. That is, if key buttons **101** and **101***c* are in the rows which are closer to the operator, then it may be said that key buttons in these rows are pivoted about a pivot wire **106** at the rear of the keyboard; while the key levers associated with key buttons **101***a* and **101***b* are pivoted about a pivot wire **106***a* near the front of the keyboard.

The actuating pawl **104** which is pivoted at pivot point **105** on key lever **103** may conveniently be made of a molded plastic part having substantially parallel planes in the plane of the drawing except for stop projection **107** and limit projection **108**. The projections **107** and **108** on actuating pawl **104** will limit the amount of possible angular pivotal motion of actuating pawl **104** about pivot **105** by contacting the key lever **103** at points **109** and **110**, respectively. A comb spring having individual tines for coacting with each actuating pawl has a tine **111** which coacts with actuating pawl **104** and urges pawl **104** to rotate in a clockwise direction about pivot **105**. The comb spring including tine **111** is suitably secured by bar **112** and bolt **113** to the frame member **117**. Tines **111***a* at the rear of the keyboard coact in a similar manner with actuating pawls **104***a*.

p The force of spring tine **111** acting on actuating pawl **104** will be transmitted to key lever **103** and thereby urge key lever **103** to be pivoted in a counterclockwise direction about pivot wire **106**. The extent of the counterclockwise rotation of key lever **103** is limited by up stop **114** which constitutes an elongated member secured to the frame and which coacts with each of the key levers **103** which are pivoted at the rear. A similar up stop **114***a* is provided at the rear of the machine for the key levers which are pivoted at the front on pivot wire **106***a*. The up stops **114** and **114***a* may be made of suitable sound deadening material. The pawl **104** has an extention **115** which engages cantilever contact spring **116** and thereby limits the extent of the clockwise rotation of actuating pawl **104** about pivot point **105** in response to the force applied by the spring tine **111**. That is, extension **115** engages contact spring **116** prior to the position of clockwise angular rotation wherein limit projection **108** of pawl **104** might contact the key lever **103** at point **110**. The primary use of limit projection **108** is to limit the angular pivotal motion of pawl **104** as the pawl **104** together with its associated key lever **103** is assembled into the machine. There is an individual cantilever contact spring **116** associated with each actuating pawl **104**. Or, phrased differently, there is an individual cantilever spring **116** associated with each key button **101**.

Each cantilever contact spring **116** has a contact **120** which will make an electrical contact with contact member **121** when the cantilever contact spring **116** is deflected away from contact member **121** by actuating pawl **104** and released. That is, when contact spring **116** is released after having been deflected away from contact member **121**, the contact spring **116** will restore towards its rest position and overshoot this position as a natural consequence of the energy stored in the contact spring **116** as a result of its deflection. Separate electrical circuits are brought out from cantilever contact spring **116** and contact member **121**. These circuits for each key lever **103** are connected in a suitable manner to provide unique electrical signals indicative of the actuated key button **101**. Such circuits and technique do not form a part of the present invention and are well known and widely used and therefore, no specific form of circuitry is disclosed herein, except as will be mentioned in connection with FIG. 7. Obviously, appropriate insulating means are provided to insulate the cantilever contact spring **116** from its associated contact member **121** and from all the similar members associated with each of the other key buttons **101**a, etc., and the frame members.

Each actuating pawl **104** has a lock up projection **126** which is designed and disposed to be engaged by lock up bail **127**. The lock up bail **127** is an elongated bail which can engage all of the associated pawl lock up projections **126** on the pawls **104** at the front of the machine. A similar lock up bail **127***a* is provided at the rear of the machine for engagement with the pawl lock up projections **126***a* of the rear actuating pawl **104***a*. If any circumstances should make it expedient to do so, the lock up bails **127** and/or **127***a* could be notched in a manner so that the pawl lock up projection **126** of predetermined actuating pawls **104** would not engage the lock up bail **127**. Or, as an alternative, if circumstances made it desirable, the pawl lock up projection **126** could be eliminated from selected, predetermined actuating pawls **104**. Lock up bail **127** may be rotated a few degrees in a counterclockwise direction in response to the angular movement of pivot rod **128**. Lock up bail **127***a* may be selectively pivoted in a complementary manner and coincident with the pivoting of lock up bail **127**. Bails which may be pivoted in the manner described have been used for many years for locking and other functions in keyboards and related art machines. Accordingly, it is believed that the illustration of additional details relative to the construction and movement of such bails would only tend to complicate the drawing and obscure applicant's invention.

In certain keyboard applications, it is sometimes desirable to be able to lock selected key levers against use. To provide this facility, front and rear lock up bails **129** and **130**, respectively, are provided. The front and rear lock up bails **129** and **130** are similar to bail **127**, in that they are elongated bails traversing the width of the keyboard. The front and rear lock up bails **129** and **130**, respectively, may be selectively notched in a manner that will prevent said lock up bails **129** and **130** from locking selected key levers against manual actuation. The front and rear lock up bails **129** and **130** are not necessarily actuated in unison, although they serve similar functions. Obviously, they are rotated in complementary directions to produce their locking or unlocking functions. More specifically, front lock up bail **129** is rotated to its clockwise limit in order to provide a locking action, while rear lock up bail **130** is rotated to its counterclockwise limit to provide a lock up action. Conversely, the front lock up bail **129** is rotated to its counterclockwise limit to unlock all key levers over which it exercises control while rear lock up bail **130** may be rotated to its clockwise limit to unlock all key levers over which it excercises control. The front and rear lock up bails **129** and/or **130** may be actuated by either mechanical or electrical means as may suit the exigencies of the particular circumstances. Either of the front or rear lock up bails **129, 130** may lock any or all of the key levers such as key lever **103** out of operation, irrespective of whether the key levers are pivoted at the front or rear of the machine. The lock up bails **129** and **130** may be pivoted in response to the angular rotation of their associated pivot rods **131** and **132**, respectively. Techniques for producing the desired angular rotation of the pivot rods **131** and **132** are well known to those skilled in the applicable arts and therefore, such techniques are not disclosed nor described herein as such description would only complicate the drawing and add unnecessary detail to the specification and thereby obscure the invention.

It is well known that many keyboards have employed an interlock. An interlock may be defined as a means for preventing the simultaneous depression of two key buttons and/or the sequential operation of two key buttons in such a rapid sequence that the output signal is distorted. It is anticipated that the present keyboard will customarily be used without an interlock and therefore, no interlock is illustrated. However, it will be immediately obvious to those skilled in the applicable arts that if individual circumstances should require the addition of an interlock any of several varieties of well known interlocks could be added. In general, the nonuse of an interlock in the present keyboard is anticipated in view of the fact that the output signal generated in response to the manual manipulation of a key button **101** is of such a short duration that the probability of producing an overlap signal is too small to justify the addition of an interlock.

Frame member **136** constitutes a key lever down stop and is an elongated member extending the entire width of the keyboard. The elongated down stop member **136** is designed in comb fashion so that individual tines of the down stop **136** may be adjusted upward or downward by bending. As will be seen, as the present description continues, the down stop **136** will serve to limit the extend of the downward motion of the key lever **103** in response to the manual manipulation of key button **101**.

Various other frame, assembly, and support members are illustrated in FIG. **1**. It is believed that these members serve obvious functions in supporting the cited elements and that no further description of them is required in order to permit a full and complete comprehension of the functioning of the parts which, taken together, illustrate the preferred embodiment of the invention. Having set forth a description of a structure incorporating the present invention, the operation of the structure will now be described in detail.

Referring now more specifically to FIG. **1** of the drawing, it should be noted that the structure is shown in its at rest position with power disconnected. In the description which follows, the operation of key button **101** and its associated key lever **103** will be described. It should be born in mind that in a typical keyboard, built in accordance with the teachings of this invention, there would normally be several key buttons in the same row as that in which key button **101** is located. Since each of these would operate and function in an identical manner, it is only necessary to describe the operation of one of these key buttons. That is, the operation of any of the other key buttons in any of the other rows is so similar to the operation of key button **101** that it is believed that anyone who comprehends the operation of the components associated with key button **101** will immediately comprehend the operation of all of the components associated with any of the other key buttons. Any differences in operation reside in a left or right hand interchange. That is, as explained above, two of the rows of the key buttons have their respective key levers pivoted at the front of the machine while the remaining two rows of key buttons have their respective key levers pivoted at the rear of the machine.

As already indicated, the tine spring **111** acting upon actuating pawl **104** urges key lever **103** to pivot in a counterclockwise direction about pivot wire **106** until the extreme right end of key lever **103** contacts the up stop **114**. The same spring **111** also urges actuating pawl **104** to pivot in a clockwise direction about pivot point **105** so that the left face of pawl extension **115** is urged into contact with the extreme right end of cantilever contact spring **116**. There is a small clearance between the upper end of lock up bail **127** and the lower face of pawl lock up projection **126**. Any attempt to depress key button **101** will cause the last mentioned small space between the end of lock up bail **127** and the pawl lock up projection **126** to be closed. Further depression of key button **101** is not possible until lock up bail **127** has been pivoted counterclockwise on its pivot rod **128**. In a typical application, the lock up bail **127** will be held in the position shown in FIG. 1 until such time as the receiving equipment associated with the keyboard is in a condition to receive signals. Furthermore, if anything should occur at the receiving equipment that prevents it from accepting additional signals, the receiving equipment will transmit a signal back to the keyboard to cause lock up bail **127** to rotate to the position shown in FIG. 1 and thereby inhibit the operation of any additional key buttons **101**.

When the associated receiving equipment is prepared to receive signals from this keyboard, the lock up bail **127** will be pivoted in a counterclockwise direction. Such operation is relatively old in the art and a typical example of a similar operation may be seen in the cited U.S. Pat. No. 3,327,828. It should be understood, of course, that physical stops are provided which limit the angular motion of the lock up bail **127**.

During normal operation, the lock up bail **127** will be in the position shown in FIG. 2 and in addition, it will be assumed that the front and rear lock up bails **129** and **130**, respectively, are also in the position shown in FIG. 2. Or as an alternative, if the front and/or rear lock up bails **129** and **130**, respectively, have been pivoted away from the positions shown in FIG. 2, it will be assumed that such bails are appropriately notched to allow the manual depression of key lever **103**.

FIGS. 2, 3 and 4 illustrate successive stages of operation and the position of various components during successive stages of the manual manipulation of key button **101**. Considering now more specifically FIG. 2, it will be observed that as key button **101** is manually depressed, the key lever **103** pivots about pivot wire **106**, thereby moving the front end of key lever **103** together with actuating pawl **104** in a downward direction. In response to the downward motion of actuating pawl **104**, the right end of cantilever contact spring **116** is deflected downward. The spring tine **111** provides a torque which urges the rotation of actuating pawl **104** in a clockwise direction about pivot **105**. The extent of clockwise rotation of pawl **104** is limited by the engagement of pawl extension **115** with the extreme right hand end of cantilever contact spring **116**. As may be seen from FIG. 2, the depression of key lever **103** causes actuating pawl **104** to be moved in a downward direction so that stop projection **107** will come in contact with down stop **136**. When stop projection **107** encounters down stop **136** and the key button **101** is depressed still further, the pawl **104** will be pivoted in a counterclockwise direction about pivot point **105** and against the spring force of the spring tine **111**. In response to the counterclockwise rotation of pawl **104**, the engagement between the lower end of pawl **104** and the right hand end of contact spring **116** will be broken.

Reference is now made more particularly to FIG. 3. As will be seen in FIG. 3, when the contact between the lower end of actuating pawl **104** and the right hand end of cantilever contact spring **116** is broken, the deflected contact spring **116** will move upward until contact **120** makes an electrical contact with contact member **121**. The electrical contact between contact **120** and contact member **121** will be relatively brief as cantilever contact spring **120** is at that time in an unstable condition and its spring force will tend to break the electrical contact. The dimensions and spring constants would normally be so selected that the deflected cantilever contact spring **116** will make only one electrical contact between contact **120** and contact member **121**, in response to the release of the deflected contact spring **116**. However, if desired, the design could be modified to introduce a number of excursions of contact spring **116** of sufficient magnitude to make a number of electrical contacts between contact **120** and contact member **121**.

As depression of the key button **101** continues after the release of deflected contact spring **116**, the down stop **136**, acting on the stop projection **107** of pawl **104**, will cause additional counterclockwise rotation of pawl **104**. However, in response to the continued depression of key button **101** and the resulting clockwise rotation of key lever **103**, the stop projection **107** will be trapped between the down stop **136** and the contact point **109** of key lever **103**. This action will limit the downward motion of the key button **101** and will provide a definite feeling that the key button has been depressed to the limit of its travel. The use of the stop projection **107** to limit the downward motion of the front end of the key lever **103** helps to reduce the noise of the actuation of the key board inasmuch as the pawl **104** and its associated stop projection **107** may be made out of a suitable sound-deadening material. The key button **101** may be held in a depressed position indefinitely, without affecting the output signal that is produced in response to the depression of the key button **101**. More specifically, the output signal responsive to the depression of key button **101** is produced by the actuation of cantilever contact spring **116** when it is released by the counterclockwise rotation of pawl **104** and such action is independent of the duration of depression of key button **101**. As may be seen the energy of deflected spring tine **111** will urge key lever **103** and associated key button **101** together with associated pawl **104** in an upward direction when the downward pressure is released from button **101**.

It has already been pointed out that the operator of the keyboard will feel a very definite and physical stopping action when the stop projection **107** is trapped between the down stop **136** and the contact point **109** on key lever **103**. In addition, another very definite and specific tactile signal is transmitted to the operator during the downward motion of the key button **101**. Experience has shown that the tactile signal about to be described is one of which the typical operator is not aware; and yet, the nonexistence of such signal tends to slow an operator and provide an insecure feeling that the equipment is not functioning properly. Accordingly, the feedback signal which is transmitted through the tactile senses is believed to be of great importance, although the ordinary operator is not even aware of its existence. Consider now the forces which urge an upward motion of the key button **101**. As the key button **101** is depressed, an upward force is applied by the tine of spring **111**. In addition, the deflection of cantilever contact spring **116** also produces an upward force. The amount of upward force is substantially proportional to the magnitude of downward deflection of the key button **101**. However, when the pawl **104** is pivoted counterclockwise by the interaction of stop projection **107** and down stop **136** sufficiently far that the contact spring **116** is disengaged from the pawl **104**, there is a very sudden and very abrupt change in the magnitude of the upward force applied to key button **101**. This abrupt and sudden change in the upward force applied to key button **101** provides the tactile feedback signal referred to herein above. That is, the sudden change in the upward force provides a subconscious signal to the operator that the purpose for which the key button **101** was depressed and has been accomplished and that the key button may be released and the same or some other key button operated. The action described herein is also sometimes referred to as a breakaway action. Such action is believed to be highly desirable and one which facilitates rapid, efficient, and accurate keyboard manipulation. Such feedback signals to the conscious and/or subconscious mind of the operator are believed to be of particular importance in those situations wherein the keyboard is employed to actuate a remote piece of equipment and the operator is not able to see or hear a character printed to provide a signal that the desired actuation has been achieved. In addition to providing the tactile feedback, an audible feedback is provided. The audible signal results from the release of contact spring **116** from the pawl **104** and the resultant collision as contact **120** on contact spring **116** hits contact member **121**. This sound, although of a very low lever, is sufficient to provide an audible signal indicative of the satisfactory and complete operation of the transmission of the desired signal in response to the depression of the key button **101**.

Referring now more specifically to FIG. 4, it will be seen that contact spring **116** is enabled to return to its normal position, irrespective of whether or not the key button **101** and the associated key lever **103** and pawl **104** have been restored to their at rest position. As long as the key button **101** is held depressed, the spring tine **111** will provide an upward force to restore the key lever **103** and pawl **104** to their at rest position when manual pressure is removed. As key button **101** is allowed to rise to its at rest position, the torque of spring **111** will urge pawl **104** to rotate about pivot **105** in a clockwise direction. The extent of the clockwise rotation of pawl **104** will be limited by the edge **138** of pawl **104** coming into contact with the extreme right hand end of contact spring **116**. As the key button **101** continues to rise in response to the force applied by spring **111** the edge **138** of pawl **104** will glide along the right hand end of contact spring **116**. The edge **138** of pawl **104** is so smooth that substantially no deflection of contact spring **116** is caused by the sliding contact. When the key button **101** rises sufficiently far, the pawl **104** will be allowed to pivot in a clockwise direction until the pawl extension **115** encounters the right hand end of contact spring **116**.

The limit projection **108** and contact point **110** on the pawl **104** and key lever **103**, respectively, are provided to limit the clockwise rotation of pawl **104** during assembly of the components. These parts do not enter into the actuation of the members during normal operation of the keyboard.

As indicated during the normal upward motion of key lever **103** in response to the force of spring tine **111** when finger pressure is removed from key button **101**, the edge **138** of pawl **104** will glide along the right hand end of the the resilient cantilever spring **116** and thereby limit the clockwise rotation of pawl **104** about its pivot **105**. If the associated receiving equipment should transmit a signal back to the keyboard indicative of the fact that no further signals should be transmitted from the keyboard to the associated receiving equipment the lock up bail **127** will be pivoted in a clockwise direction by the angular rotation of pivot rod **128** to which the lock up bail **127** is attached. The lock up bail **127** will thereby be placed under the pawl lock up projection **126** of all the pawls similar to pawl **104** which are then in their uppermost position. However, the lock up bail **127** cannot form a similar relationship with the pawl **104** associated with the key lever **103** which is depressed in response to the actuation of key button **101**. However, the lock up bail **127** will contact the left hand edge of pawl lock up projection **126** (See FIG. 5). The physical contact between the lock up bail **127** and the left hand edge of pawl lock up projection **126** of the actuated pawl will prevent the aforementioned contact between edge **138** of the pawl **104** and the right hand end of the resilient cantilever contact spring **116**. The contact between the lock up bail **127** and the pawl lock up projection **126** does not, in any sense, inhibit the return of the key lever **103** to its upward position in response to the force of spring **111**. The only difference is that the pawl **104** is inhibited, for a while, from making its initial clockwise rotation. When the key lever **103** has been raised a sufficient amount towards its upward position, the lower surface of pawl lock up projection **126** will rise above the upper surface of lock up bail **127** and the pawl **104** will pivot a few degrees in the clockwise direction. In response to the clockwise pivoting of pawl **104**, the associated key lever **103** will thereupon be locked against repeated actuation because of the engagement between the pawl lock up projection **126** and the lock up bail **127**. The foregoing demonstrates that the mere fact that one or more key levers may have been retained in their downward position does not inhibit the actuation of lock up bail **127** and the consequent locking of all other key levers against actuation.

The front and rear lock up bails **129** and **130**, respectively, are used for selectively locking predetermined key levers against actuation thereof. For example, during certain operations, it may be desirable to assure that only numeric symbols may be transmitted. In such a situation, one or the other of the lock up bails **129** and **130** will be notched in such a manner that when it is pivoted to the locking position, only key lever **103** associated with the numeric keys may be depressed. More specifically, considering FIG. 1 and front lock up bail **129**, it will be evident that if bail **129** is pivoted a few degrees in the clockwise direction, the top surfact of the bail **129** will be in close proximity to a portion of the under edge of key lever **103** and thereby inhibit the actuation of key lever **103** unless there is a notch in lock up bail **129**. With the structure so far described, a lock up bail **129** cannot be actuated to its locking position while one or more of the key levers which are to be locked is in a downward or depressed position. Normally, this limitation will not constitute an operational handicap. However, in the event that it is desired to actuate the locking bail **129** while one or more of the key levers **103**, which are to be locked against subsequent actuation, is in a downward position it would be possible to make the lock up bail **129** in such a manner that it has a plurality of individual teeth or tines, each of which constitute springs. That is, the lock up bail **129** would then be somewhat similar to the spring tines **111**. Accordingly, when the lock up bail **129** is actuated to the lock up position all tines of the bail **129** which are associated with key levers which are to be locked and which are currently in a upward position will enter the locking position. However, any tines of bail **129** which are associated with a key lever **103** then in a downward position will be flexed away from the locking position but will enter the locking position as soon as the associated key lever **103** is raised. Obviously, locking bail **130** could be constructed in a similar manner. The two bails **129** and **130** are provided in order to be able to selectively lock first and second different predetermined key levers out of operation.

As set forth herein above in greater detail, the depression of a selected key button **101** results in the deflection of a resilient spring contact **116** away from a relatively fixed contact member **121**. When the deflected resilient contact member **116** is released the resilience of the contact member **116** causes it to return towards the fixed contact **121** and make a momentary electrical closure therewith. As may be seen in FIG. 7, a parallel combination of a resistor **140** and capacitor **141** are connected in a series circuit with resilient contact spring **116**. The terminals **142** and **143** are coupled to a suitable source of power **144** and signal utilizing means **145** for transmitting a unique electrical signal to the receiving equipment which is indicative of the specific pair of contacts **116** and **121** which have closed. It should be understood that there is an individual pair of contacts **116** and **121**, together with their associated resistor and capacitor **140** and **141**, respectively, for each key button similar to key button **101**. A variety of suitable signal utilizing means **145** are well known to those familar with the art.

As indicated, the contact between resilient spring **116** and the fixed spring **121** may be quite brief, being measured in terms of milliseconds or microseconds. However during the brief period of contact, there is the possibility that there may be a multiple closure of the contacts as a result of a variety of physical phenomenon including the tendency of the moving contact **116** to bounce off the stationary contact **121** and/or the possible effect of an oxide film on the contacts or other foreign material on the contacts. Unless suitable precaustions are taken, the multiple closure of the contacts **116** and **121** might be interpreted by the receiving equipment as a plurality of signals rather than a single signal indicative of a predetermined alphanumeric character. Accordingly, in order to insure that a single signal is transmitted, the circuit of FIG. 7 is provided.

Considering now more specifically the effect of the circuit of FIG. 7. It will be assumed that successive strokes of individual key buttons, or the reactuation of a particular key button, will be separated one from the other by a period of time on the order of 50 milliseconds, minimum. The capacitor **141** is so chosen that when it is in a series circuit with the power supply **144** and the impedance of the signal utilizing system **145**, the capacitor **141** will be substantially fully charged in not over about 5 milliseconds or about 10 percent of the cycle time. That is, the time constant of the circuit is a relatively small portion of the cycle time and is smaller than the minimum first closure of the contacts **116** and **121**. Experience has shown that even though contacts may bounce or exhibit multiple closures, the minimum period of the first closure, for the structure under consideration, will be of the order of 5 milliseconds. Accordingly, the capacitor **141** will be able to be substantially fully charged during the time of the first closure. The spike of current which is created as the capacitor **141** is charged will provide the necessary intelligence signal to activate the signal utilizing system **145**. The resistor **140** will be so chosen that it will be able to discharge the capacitor **141** during a time interval which is appreciably less than the 50 millisecond cycle but appreciably more than the period between successive contact closures when there are multiple closures. Accordingly, a spike of current will be generated in response to the first closure of the contacts **116** and **121** and the capacitor **141** will be substantially fully charged. By this action, the appropriate electrical signal is transmitted. If the contacts **116** and **121** should open, the capacitor **141** will commence to discharge through the resistor **140**. However, if the contacts **116** and **121** do reclose, they will do so within approximately a few milliseconds and therefore, the capacitor **141** will have only a small portion of the energy stored therein discharged therefrom. Accordingly, the current which flows through capacitor **141** in response to a second closure of contacts **116** and **121** will be of a very small magnitude as compared with the initial current that flowed through capacitor **141** in response to the first current that flowed through capacitor **141** in response to the first closure of contacts **116** and **121**. The signal utilizing system **145** can readily be designed to distinguish between the relatively large current when the contacts **116** and **121** first close and the considerably smaller current in response to subsequent closures of contacts **116** and **121**. The difference in magnitude between these two currents may be of the order of at least five or ten to one.

For the structure and time illustrated and indicated in the preferred embodiment, it has been observed that typical values of 0.005 microfarads may be used for the capacitor **141** and 5 meg. ohms for the resistor **140**.

Circuit components such as flip-flops or other one-shot components might be used. However, the resistor capacitor technique disclosed herein is believed to offer economic advantages.

A variation of the circuit of FIG. 7 could be provided wherein the resistor **140** is not connected directly in parallel with the capacitor **141** but is bridged between terminal **143** and another spring contact (not illustrated) below contact **116** in such a manner that the deflection of contact **116** will cause it to complete an electrical circuit to discharge the capacitor **141** prior to the time that the pawl **104** released the deflected spring **116** to engage relatively fixed contact **121**. In this alternate arrangement, there is substantially no discharge of the capacitor **141** between multiple closures of contacts **116** and **121**, assuming, of course, that the spring **116** is not bouncing with such amplitude that it is able to make successive contacts with the spring contact (not illustrated) below spring **116**. A structure built in accordance with the provisions of this modification will produce output signals having an even greater ratio between the initial spike of current and any subsequent signals which may result from multiple closure of the contacts **116** and **121**. Unless the increased ratio is required to

satisfy some conditions at the receiving equipment, it is believed that the keyboard can be made economically in the manner first described. Also, the hypothecated resistor would have to have a lower value to discharge the capacitor more quickly.

While there has been shown and described what is considered at present to be the preferred embodiment of the invention, modifications thereto will readily occur to those skilled in the art. It is not desired, therefore, that the invention be limited to the embodiment shown and described, and it is intended to cover in the appended claims all such modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. In a keyboard mechanism wherein movement of a key lever from a nonoperative to an operative position generates an electrical pulse signal, which pulse signal is transmitted to signal utilization equipment that is remote from the operator of said keyboard mechanism or separate from such operator to the degree that there is no indication to the operator that said movement of the key lever to an operated position has generated the electrical pulse signal, the combination comprising:
   a. a first electrical contact member;
   b. a resilient electrical contact member supported as a cantilever parallel to and spaced apart and electrically insulated from said first electrical contact member for making at least one electrical contact with said first contact member for a first period of time when said resilient contact member is selectively deflected away from said first contact member and released;
   c. key lever means for selectively deflecting and releasing said resilient contact member once per cycle of operation of said key lever means, which key lever means can be operated in repeated cycles at intervals spaced apart no less than a second period of time;
   d. a source of d.c. potential for providing electrical energy in a circuit completed in response to the making of said electrical contact between said contact members;
   e. an impedance network for controlling the electrical characteristics of an electrical pulse signal to said signal utilizing system when said source of d.c. potential, said impedance network, said first contact member and said resilient contact member are connected to the signal utilizing system in a series circuit in response to the closure of said electrical contact members, the values of said impedance network being predetermined so that closures of the electrical contacts subsequent to said first closure of the contacts in one cycle of operation of the key lever means produces electrical pulse signals substantially less in amplitude than the first electrical pulse signal.

2. The combination as set forth in claim **1** wherein said impedance network comprises a parallel combination of a resistor and capacitor having predetermined values.

3. The combination as set forth in claim **2** wherein said impedance network has a time constant which is at least as great as said second period of time.

4. The combination as set forth in claim **2** wherein said series circuit has a time constant which is no less than said first period of time.

5. The combination as set forth in claim **2** wherein the values of the resistor and the capacitor are so determined that the capacitor will remain substantially fully charged in the interval of time between the first closure of the contact members and any closures of the contact members subsequent to the first closure during a single cycle of operation of the key lever means to insure that the subsequent electrical pulse signals are significantly less in amplitude than the first electrical pulse signal and that during said second period of time the capacitor is substantially discharged through the resistor.

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