July 20, 1965 B. G. GARDINEER, JR 3,196,219

KEYBOARD HAVING A STRETCHABLE SINUOUS CONTACTING MEMBER

Filed June 29, 1962 3 Sheets-Sheet 1

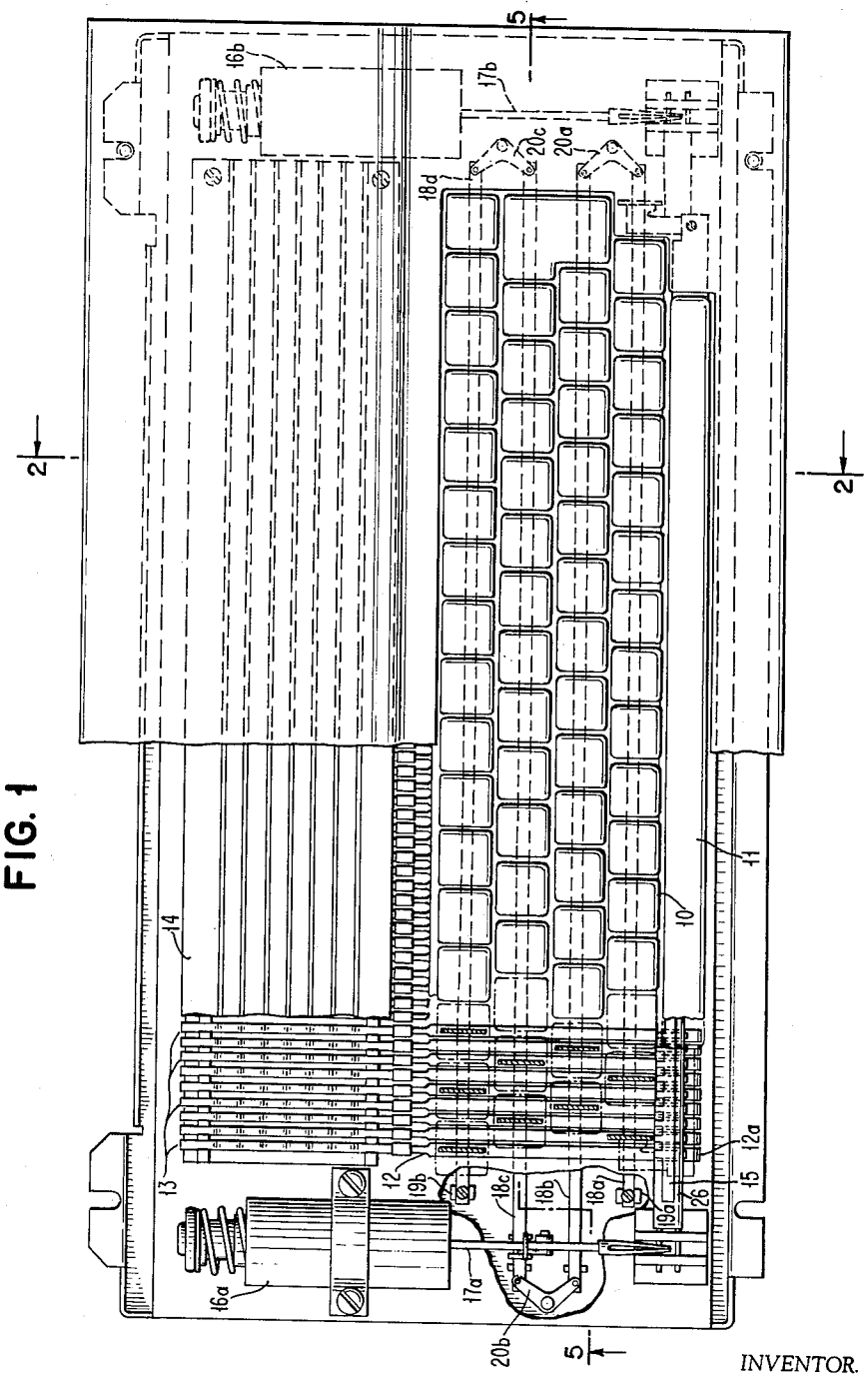


FIG. 1

INVENTOR.
BAYARD G. GARDINEER, JR.

BY Robert E. Sandt

AGENT

July 20, 1965 B. G. GARDINEER, JR 3,196,219

KEYBOARD HAVING A STRETCHABLE SINUOUS CONTACTING MEMBER

Filed June 29, 1962

3 Sheets-Sheet 2

FIG. 2

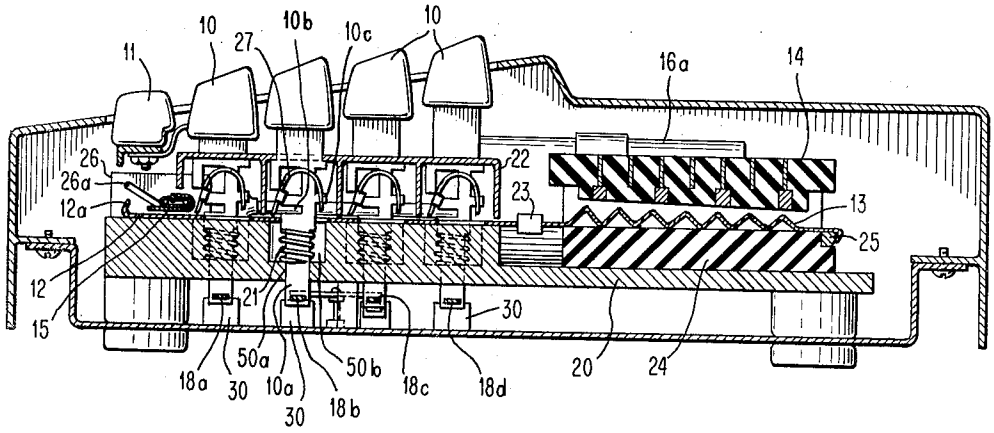


FIG. 3

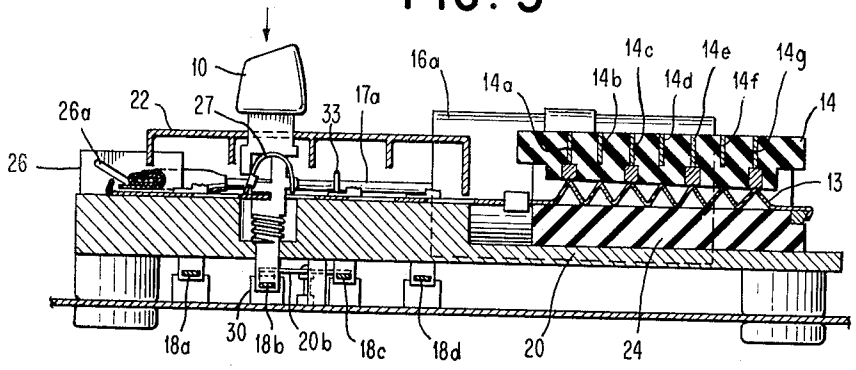
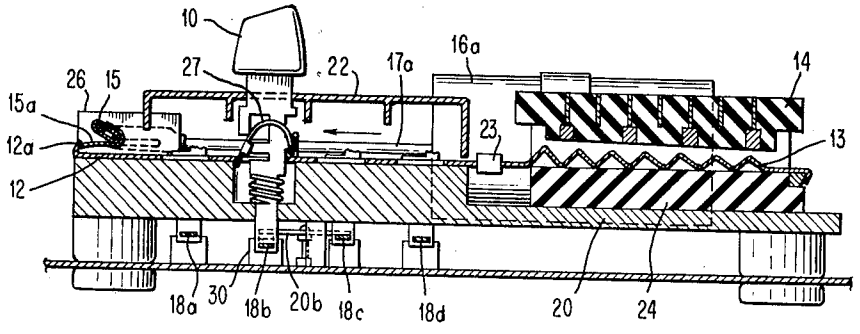


FIG. 4



July 20, 1965 B. G. GARDINEER, JR 3,196,219

KEYBOARD HAVING A STRETCHABLE SINUOUS CONTACTING MEMBER

Filed June 29, 1962

3 Sheets-Sheet 3

FIG. 5

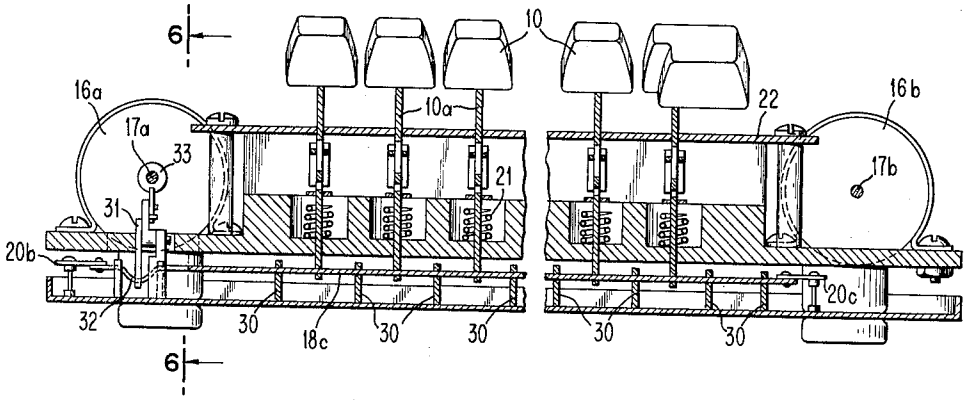


FIG. 6

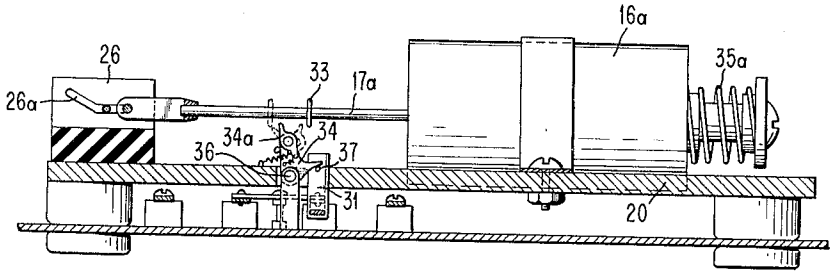
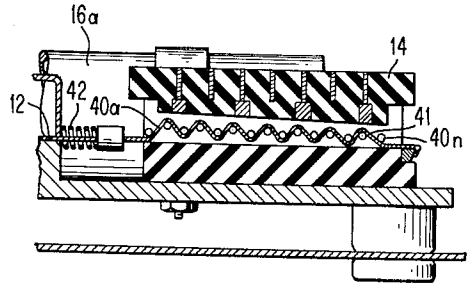


FIG. 7



United States Patent Office 3,196,219 Patented July 20, 1965

3,196,219

KEYBOARD HAVING A STRETCHABLE SINUOUS CONTACTING MEMBER

Bayard G. Gardineer, Jr., Peekskill, N.Y., assignor to International Business Machines Corporation, New York, N.Y., a corporation of New York

Filed June 29, 1962, Ser. No. 206,319
4 Claims. (Cl. 200—5)

This invention relates to circuit controllers, and more particularly to an improved keyboard for selectively effecting multiple interconnections between conductors and for insuring the discrete depression of one only of a group of keys.

In the electrical switching art and more particularly in multiple key-operated switches arranged in a keyboard configuration, it is desirable that the switches be arranged in close adjacency to permit rapid interplay of the operator's fingers among the keys. So, too, must the action of the switch-actuating keys be positive, yet light to the touch, so as not to hamper the manual dexterity of the operator. Other desirable features include the latching of the key selected for operation and interlocking of the individual keys of a group to prevent concurrent depression of more than a single key. Coupled with the foregoing functional desiderata, certain electrical and economic considerations also contribute to a successful keyboard design. Because of the lightness of touch required, it is frequently difficult to achieve a contact pressure sufficient to produce adequate electrical conductivity and eliminate arcing. To further insure reliable operation and prevent the accumulation of insulating corrosive deposits, switches are frequently designed to provide a wiping action between the contact members to dislodge any deleterious deposits. Wherein multiple circuit connections are to be effected by a single key depression, the necessary design criteria are frequently antithetic, or at least give rise to a complex or expensive apparatus. Wherein human communication with digital data processing installations are contemplated, a keyboard whose circuit connections are key groupings may be readily interchanged is also a desirable construction. Such a universal keyboard having the necessary functional and electrical characteristics should also be economical to fabricate, as a data processing complex necessarily requires a great number of remotely disposed information generating terminal locations which are readily accessible to personnel within a business establishment.

In view of the foregoing functional, electrical and economic desiderata, it is an object of this invention to provide an improved manually operated keyboard which is readily interchanged to effect different circuit connections and key-interlock patterns.

A further object is to achieve a keyboard design with the foregoing attributes, wherein a light key pressure effects a reliable electrical connection by removal of corrosive deposits on the contact members by a rubbing movement of the members.

Another object of the invention is to provide an improved manually operated electrical keyboard wherein the electrical connections are selectively effected by a sinuous metallic strip which in a relaxed position has a maximum amplitude of sinuous convolutions which contact the conducting members to effect the circuit connection and in a tensioned position, the amplitude of the convolutions are reduced so as to break contact with the circuit conductors.

Yet another object of the invention is to provide a keyboard having an interlock mechanism for preventing the concurrent depression of a plurality of keys, and for latching the operated key in depressed position comprising a laminar elongated strip fixed at both ends and having a length such that a single bight only is permitted to be formed so as to preclude the depression of two keys which would require the formation of two bights.

A final object is to achieve a structure in accordance with the foregoing objects that occupies a minimum of space and is inexpensively fabricated.

The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of preferred embodiments of the invention, as illustrated in the accompanying drawings.

In the drawings:

FIG. 1 is a plain view of the keyboard with portions thereof broken away.

FIG. 2 is a transverse sectional view taken along the line 2—2 in FIG. 1.

FIG. 3 shows the key action of a single key in FIG. 2.

FIG. 4 shows the resetting of the operated key of FIG. 3.

FIG. 5 is a longitudinal section taken along the line 5—5 of FIG. 1.

FIG. 6 is a transverse section taken along the lines 6—6 of FIG. 5.

FIG. 7 shows an alternate construction of the contactor.

When, as in the keyboard embodying the principles of this invention, a keyboard is intended to generate coded electrical signals for the remote control of any piece of apparatus, it is necessary to provide certain interlocks within the keyboard to prevent the operator from causing a faulty operation of the controlled apparatus. An operator may, for example, manipulate the keyboard in any one or more of the following operations: (a) hold a key depressed for several cycles of operation of the controlled machine, (b) key at varying times with respect to the machine cycle, (c) seek to depress two keys simultaneously or, (d) seek to operate two keys in succession more rapidly than the controlled apparatus can respond. As will be explained in detail, each of these operations is prevented by the structure of this keyboard.

Although in FIG. 1 the keyboard is shown as having the layout of a typical typewriter keyboard with four rows of keys and a space bar beneath, it is quite obvious that the keys may be disposed in any convenient array and need not be limited to the conventional typewriter functions. Since any arbitrary instructional significance can be assigned to coded signals, the keyboard could equally well be employed for the remote interrogation of a central reservation system and the ticketing of space therein.

Since the operation of all keys in the keyboard is identical, the detailed structure of only one key need be examined in detail. In FIG. 1 each key **10**, and the space bar **11** coacts with an individual slide **12** such that the depression of a key trips the slide **12** to move upward and cause a contactor **13** to engage a circuit board **14** which overlies all of the contactors **13** and provides different circuit outputs for each key. Since a six bit data code is employed, the keyboard is capable of accommodating sixty-three different controls, and the circuit board has conductors arranged in all of the combinations of six things, except the absence of all bits. The keys **10** are so spaced in their respective rows, and the rows staggered with respect to one another such that the slides **12**, of which nine of the total sixty-three are shown, are equally spaced. Each of the slides **12** has an upturned tab **12***a* at the bottom end thereof, and a common reset bail **15** overlies the slides and coacts with the tabs to reset any of the operated slides when the solenoids **16***a* and **16***b* are energized, the solenoids being connected to the bail by push rods **17***a* and **17***b*. As will be explained, this reset action resets the slides **12** to remove the contactors **13** from contact with the circuit board **14**, even though a key **10** may be held depressed, and a slide thus reset cannot

be tripped until the key 10 is allowed to return to its non-depressed position and depressed for a second time. Thus, a code signal cannot be repeatedly transmitted by holding a key depressed.

The interlock for preventing multiple depression consists of a series of laminated bands, or ribbons, 18*a*, 18*b*, 18*c*, and 18*d* each of which threads an opening in the key shanks of a respective row of keys. The bottom band 18*a* is anchored in the block 19*a* fixed to the frame of the keyboard, and the band 18*d* is anchored to the block 19*b*, thus fixing the total effective length of the bands between the blocks 19*a* and 19*b*. The bellcranks 20*a*, 20*b*, and 20*c* join the ends of the bands and transmit the motion of any one band to all of the bands in the series connection. Each key shank is straddled by a fixed guide through which the band is also threaded, such that openings in the key stems and the fixed guides are aligned when the keys are in their non-depressed positions. The total effective length of the band between the anchor posts 19*a* and 19*b* is such that one, an done only, bight or bend in the band is permissible. Thus, only one key at a time may be depressed, and a special dummy key is provided to absorb the single bend when none of the functioning keys is depressed. This structure will be explained in greater detail with respect to FIGS. 5 and 6.

With reference to FIG. 2 the structure of the keyboard and the action of a typical key, slide, and contactor will be more readily understood. Each key 10 includes the usual key cap which is so shaped as to facilitate rapid finger movement and a key shank 10*a* having a rectangular cross section journalled for vertical sliding movement in the main frame 20 and the spaced sub-frame 22, with a compression spring 21 pocketed in a counter-bore 20*b* in the frame 20 and pressing against a shoulder on the key shank to bias the key upward. Both the frame 20 and sub-frame 22 have spaced openings to provide the necessary spacing for all of the keys. Each of the slides 12 is provided with a rectangular opening which is substantially the same width as the thickness of the key shank and slightly longer than the width of the shank in the region immediately above the spring 21. A slot 10*b* in the shank is of a thickness and depth sufficient to receive the slide 12 when the key 10 is depressed, so as to release the slide 12, and permit the contactor 13 to make contact with the circuit board 14. A leaf spring 27, having an elongated slot therein, straddles the key shank 10*a* and is fastened to a tab 10*c* by peening of the tab which fits in an additional opening in the spring 27. The spring 27 is necked down on its left end so that its width is slightly less than the width of the rectangular opening in the slide 12, and is provided with two bent-over ears which ride on the key shank 10*a* and prevent the spring from becoming mis-aligned therewith. The spring 27 acts as an interposer to prevent the slide 12 from being twice tripped upon continued depression of the same key.

The contactor 13 as was briefly explained, effects an electrical contact with circuit board 14 when the key 10 is depressed and the slide 12 moves to the right. As will be seen, the contactor 13 comprises a leaf spring preformed with a series of convolutions of equal-amplitude and pitch. This spring is hooked over a common electrical bus 25, as are all the contactors, and joined to the slide 12 by an insulating block 23. When the spring 13 is stretched as in FIG. 2, the pitch of the undulations is increased and the amplitude thereof decreased. Since each spring is bottomed in a separate groove in an insulating block 24, the change in amplitude of the undulations causes the peaks of the undulations to move in the vertical direction while the valleys remain tangent to the groove in the insulating block. When the spring is relaxed (as in FIG. 3), the peaks of the undulations make contact with the circuit board which is inclined slightly with respect to the bottoms of the groove in the insulating block 24. Embedded within the circuit board are seven

conductors 14*a* through 14*g* running the length of the keyboard. The first of these conductors 14*a*, projects through the lower surface of the circuit board and extends the length of the keyboard to coact with all of the springs 13 to provide a synchronizing or start pulse, conventional in telegraph type codes. The remaining six conductors have selective projections to the lower surface of the board in accordance with the desired code for each key. The codal combination illustrated is thus 010101, and the circuit connections effected in FIG. 2 is from the common bus 25 through the spring contactor 13 to the conductors 14*a*, 14*c*, 14*e*, and 14*g* in parallel.

A complete cycle of operation of a single key starts with the elements in the position shown in FIG. 2 with the slide 12 to the left, the spring 13 extended and removed from contact with the circuit board 14. It is to be noted that the slide 12 is restrained from movement to the right by the key shank 10*a*, and the interposer spring 27 rests on the top of the slide 12. When the key 10 is depressed (FIG. 2), the slot 10*b* in the key shank is aligned with the slide 12, and it moves into the slot to release the slide for movement to the right under the tension of the spring contactor 13, which now contacts the circuit board 14 to provide the requisite electrical signals. When these signals have been utilized by the controlled apparatus, the solenoids 16*a* and 16*b* (FIG. 1) are energized to move the bail 15 to the left (FIG. 4), thus resetting the slide 12 and stretching the spring 13 to break its contact with circuit board 14. As was previously mentioned, the hole in the slide 12 is slightly longer than the width of the key shank 10*a*. The bail 15 has a slight overtravel so as to cause this clearance between the key-shank and the slide to provide an opening into which the interposer spring 27 fits (FIG. 4). If now the bail 15 releases the slide 12 while the key 10 remains depressed, the slide 12 is prevented from re-entering the slot 10*b* by the covering action of the interposer spring 27, and thus only a single transmission for each depression of the key 10 is possible. When the key 10 is manually released, the spring 27 is withdrawn from the hole in the slide 12 which then bears directly on the keyshank, and the parts return to the relative positions shown in FIG. 2.

Before proceeding with the detailed examination of the multiple key depression interlock mechanism, it is worthy to examine the details of the reset bail 15 and its coaction with the slides 12. As was mentioned, each of the slides 12 has an upturned tab 12*a*, which in fact is bent slightly back upon the slide so as to form a retaining pocket for coaction with the bail 15. This bail, rather than being a solid bar, has affixed thereto a combed leaf spring with a separate flat tooth for coaction with each separate slide 12. The bail 15 is guided for movement diagonally upward to the left by slots 26*a* in the blocks 26 at both ends of the bail. Thus, when a slide is tripped, as in FIG. 3, the bail 15 and its leaf is at the bottom of its travel and the leaf 15*a* seats in the pocket formed by the upturned tab 12*a*. As the bail moves diagonally upward, the leaf spring 15*a* flexes to maintain its contact with the slide which it is resetting. This flexibility also insures that the bail 15, by a slight amount of overtravel, will reset the slide 12. Those of the slides 12 that have not been tripped will not be engaged by the reset bail 15 as it moves diagonally upward, the slope of the slot 26*a* being such as to provide the necessary clearance. Thus, the reset bail is only required to react with one slide, thus materially reducing the power required of the reset solenoids 16*a* and 16*b*.

The flexible band key interlock that has previously been treated only sketchily will now be examined in detail. As was stated, each of the bands 18*a*, 18*b*, 18*c*, and 18*d* (FIG. 1) threads apertures in the key shanks of a respective row of keys. The motion of each of the bands is transmitted to the next row by the bellcranks 20*a*, 20*b*, and 20*c*, and the anchors 19*a* and 19*b* fix the total effective length of the bands. The serially connected bands

18*a*, 18*b*, 18*c*, and 18*d* may, therefore, be treated as a single band threading all of the keys to be interlocked, as if they extended along a common straight line. For the purposes of explanation of the interlock action, it will, therefore, be assumed that such is the case. As was previously stated, the total effective length of the interlock bands is such that one, and one only, dip or valley is permitted so that only one key at a time may be depressed. So as to guide the band between keys and define the shape of this valley, fixed guides 30 (FIG. 5) affixed to the keyboard frame structure are disposed between each of the keys 10, the guides 30 and the key shanks having apertures therein, all aligned when the keys are in the non-operated reset position, and through which the bands are threaded. Since one valley in the band 18*c* (or 18*a*, or 18*b*, or 18*d*) must always be present, provision must be made to absorb this valley or bight in the ribbon when all of the keys 10 occupy their reset position. Even though the multi-strands comprising any one of the ribbons will form a stable bight, and an unrestrained length could be provided to form a free bight, it is preferable to provide a mechanism to absorb the bight when the keys 10 are all reset. To this end, a dummy key 31 (FIG. 6), is provided, which key is guided for vertical sliding movement, but has no key cap or electrical function. If, as in FIG. 5, all of the keys 10 are in the reset position, the bight 32 in the ribbon 18*c* is absorbed by the dummy key 31, which is now down. If any one of the keys 10 is depressed, the ribbon 18*c* will be tensioned to straighten the bight 32, thus moving the dummy key 31 upward and permitting a new bight to be formed by the depression of the key 10. Since the depression of any key 10 releases its associated slide 12, which latches the thus depressed key down, and since only one bight can be tolerated, no other key can be depressed so long as any one of the keys 10 is depressed. There is no latching, however, of dummy key 31, so that it may be moved by depression of a key 10. To permit a successive one of the keys 10 to be operated, it is necessary to restore the previously operated key. Remembering that the solenoids 16*a* and 16*b* reset the slide 12 which brings the interposer spring 27 into play to prevent re-entry of the slide 12 into the notch in the key shank 10*a*, any depressed key 10 is free to return to its upward position upon the energization of the solenoids. This freedom to return continues until the operator removes his finger, whereupon the key will reset. In order to straighten the bight in the ribbon 18*c* as the key 10 restores, the action of the reset solenoids causes a downward bias on the dummy key 31. This action is achieved by a shouldered portion 33 on the push rod 17*a* which, when the solenoid 16*a* resets to the left (FIG. 6), trips over the bellcrank 34 without moving it, because of the broken lever action of the dog 34*a* pivoted to one arm of the bellcrank. On the return stroke of the solenoid (under action of spring 35*a*) the shoulder 33 picks up the dog 34*a* which is unyielding with respect to the bellcrank 34 for this direction of movement. The bellcrank 34 will, therefore, have a strong urge to rock in a clockwise direction on its pivot 36. By virtue of a pinned connection 37 to the dummy key 31, this urge will be translated to a downward bias on key 31. If the operator has removed his finger from a key 10, the key 31 will move downward to renew the bight 32 in the ribbon 18*c* and straighten the ribbon adjacent to the previously operated key 10, which will reset under the combined reaction of the ribbon and its individual return spring 21. If the operator continues to hold a key 10 depressed after the action of the reset solenoids 16*a* and 16*b*, then the dummy key 31 will continue to seek to form the bight 32 in the ribbon 18*c* until the operator removes his finger, and the bight 32 is, in fact, formed.

Thus, in summary, it has been explained how the permutation codes are generated by the coaction of the

sinuous spring 13 with the circuit board 14, and how the interposer spring 27 prevents the re-tripping of a slide 12 upon a continued depression of a key so as to prevent double transmission of a character for only a single key depression. So, also, has the interlock function of the multi-stranded ribbons 18 been explained in relation to the key reset function. Little has been said, however, of the action of the solenoids 16*a* and 16*b* except for their mechanical function. These solenoids must be energized following each key depression and at such time that operation of the remote device is insured. If the keyboard is used to generate serially coded signals, a local commutator would serially sweep the conductors 14*a* to 14*g* and only transmit signals to the line if the conductor 14*a* is the first to deliver a signal. Once a complete cycle of signals is transmitted, the same commutator would emit a control pulse to energize the solenoids. Although these circuits have not been shown, they are sufficiently well-known expedients to provide an understanding of the mechanical operation of the keyboard previously described.

A modification of the contactor structure is shown in FIG. 7. Here, instead of pre-forming the contactor with convolutions, a straight ribbon 41 is guided in a sinuous path over fixed guide pins 40*a* through 40*n* so as to provide the peak and valley configuration of the pre-formed contactor. Since the ribbon 41 seeks to become elongated rather than foreshortened, a compression spring 42 is provided to force the ribbon 41 in its convolute pattern as determined by the guide pins to effect circuit connections with the circuit board 14 as in the previously described embodiment.

Thus, there has been described a keyboard for generating coded electrical signals for the remote control of a code responsive apparatus, which keyboard provides necessary interlock devices for preventing the simultaneous depression of more than one key, as well as the repeat transmission of signals upon the continued depression of a key, together with devices for synchronizing the operation of the keyboard with the remote apparatus all in a simple and reliable mechanism.

While the invention has been particularly shown and described with reference to preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. In a manually operated electrical switching device for effecting electrical interconnection between circuit conductors the combination of,

(a) a serpentine strip fabricated of an elastic electrically conductive material and preformed with a succession of joined sinuous convolutions having substantially constant amplitude and wavelength,

(b) a pair of plates spaced apart a distance slightly less than the unrestrained amplitude of the convolutions in said strip, the said strip being disposed between the said plates,

(c) a plurality of separate electrical circuit conductors each disposed in one of said plates in juxtaposition with a respective peak of the convolutions in said strip, to establish an electrical interconnection of said conductors,

(d) and means for selectively stretching said strip to reduce the amplitude of said convolutions so as to separate said strip from the said conductors to break the electrical interconnection of said conductors by the said strip.

2. In a multiple key keyboard an interlock mechanism for preventing the concurrent depression of more than one key comprising,

(a) a plurality of keys each individually depressible from a non-actuated to a fully actuated position, each having a shank with an aperture therein so spaced

in said shank that all of the apertures are aligned when the keys occupy the non-actuated position;

(b) a plurality of fixed guides, one between each successive pair of keys, and each having an aperture so disposed that the apertures in all of the guides are aligned with the apertures in said key shanks when the keys occupy their non-actuated position;

(c) a flexible multi-stranded ribbon threading all of the apertures in said guides and said key shanks;

(d) means anchoring the ends of said ribbon at positions separated by a distance equal to the shortest distance between the ends of said ribbon when the ribbon is flexed in a single bight by the full depression of only one of said keys to said fully actuated position.

3. In a multiple key keyboard, means for preventing the repeated operation of a device controlled by depression of a key in the keyboard upon prolonged depression of the key, comprising,

(a) a manually operable key depressible from a reset position to an active position, and having a key shank with a re-entrant slot therein,

(b) a slide having an aperture through which said shank projects, and slidably mounted for movement perpendicular to the direction of movement of said key shank along a line which is mis-aligned with said slot in said key shank when said key occupies said reset position,

(c) spring means biasing said slide towards said key in such direction that said slide will enter said slot in said key shank when said key is depressed to its active position,

(d) mean connected to said slide and operable responsive to movement of said slide into said slot in said key shank for effecting an electrical circuit connection,

(e) a leaf spring resiliently affixed to said key shank and normally covering said slot in said key shank and having a configuration in which the end thereof overlies said slide when said key is in said reset position and said spring is in a non-stressed condition,

(f) and reset means for moving said slide out of said slot in said keyshank whereby said leaf spring will cover said slot to prevent the re-entry of said slide upon the release of said reset means.

4. A manually operable keyboard for selectively effecting the electrical potentialization of a different combination of electrical conductors for depression of each of the keys of the keyboard comprising,

(a) a plurality of individual key members disposed in a plurality of spaced rows, the rows being staggered with respect to one another such that each of the keys has a unique spacing in a direction parallel to the rows, each key having a key shank with a re-entrant slot therein and mounted for individual vertical depression from a reset to an active position,

(b) a plurality of slides, one for each key, mounted for sliding movement perpendicular to the movement of said keys each having an aperture therein through which the shank of the key associated therewith passes, the slides being mis-aligned with the slots in the key shanks when the keys are in their reset position and aligned therewith when said keys are in their active position,

(c) a plurality of electrical contactors fabricated of elastic electrically conductive material preformed with a series of joined convolutions having a substantially constant amplitude and wavelength,

(d) means connecting each of said contactors between a different one of said slides and a common anchor such that each of the contactors is stretched so that the amplitude of the convolutions is decreased and the pitch increased from the preformed condition,

(e) a pair of plates disposed on opposite sides of said contactors and spaced apart a distance slightly less than the amplitude of the convolutions in said contactors in their relaxed status but greater than the amplitude of said convolutions in said contactors in the stretched condition of said contactors,

(f) a plurality of electrical conductors disposed in one of said plates and having a different combination of projections depending therefrom for each different contactor, the projections being so spaced and arranged that the said contactors will coact therewith when said contactors are released by a key depression to assume their relaxed status,

(g) means for resetting any of the released slides,

(h) means for preventing the depression of more than one key at a time,

(i) and means interposed between each of said key shanks and its associated slide, and operative responsive to the resetting of said slide for preventing the re-entry of said slide into said slot while said key remains depressed.

References Cited by the Examiner

UNITED STATES PATENTS

2,320,774	6/43	Flynt	200—5
2,953,649	9/60	Deighton	200—5

ROBERT K. SCHAEFER, *Acting Primary Examiner.*