(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 099 427**
A1

(12) # EUROPEAN PATENT APPLICATION

(21) Application number: **82303631.4**

(51) Int. Cl.³: **H 01 H 13/70**

(22) Date of filing: **09.07.82**

(43) Date of publication of application:
01.02.84 Bulletin 84/5

(84) Designated Contracting States:
AT BE CH DE FR GB IT LI LU NL SE

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(54) **Keyboard.**

(57) A moldable, impulse operation synthetic resin keyboard, and a method of fabricating the same, are provided wherein the keyboard achieves essentially standard, tactile feel and feedback, mechanical N-key rollover protection, and precise, reliable output. The preferred embodiment of the keyboard includes a synthetic resin base plate having a plurality of elongated, cantilever mounted flippers, along with a plurality of elongated, laterally spaced, inwardly and opposedly extending, pivotal, key-supporting arms. Upon depression of a key, the associated flipper is deformed until a release point is reached, whereupon the flipper is disengaged, allowing the flipper to quickly return to its rest position. A keyboard output is developed as the flipper, during overtravel thereof past its rest position, strikes a signal-generating assembly. An alternative embodiment of the keyboard includes a plurality of depressible keys mounted on respective upright synthetic resin flaps designed to collapse upon key depression and engage and move an underlying, resilient, U-shaped shifting member; the member in turn engages and shifts another U-shaped resilient element which supports one or more upstanding encoding posts. When the U-shaped element reaches a cocked position it is disengaged from the shifting member and allowed to snap back toward the original rest position thereof independently of subsequent return movement of the key and shifting member. The snap back motion is sensed and a corresponding key output signal developed.

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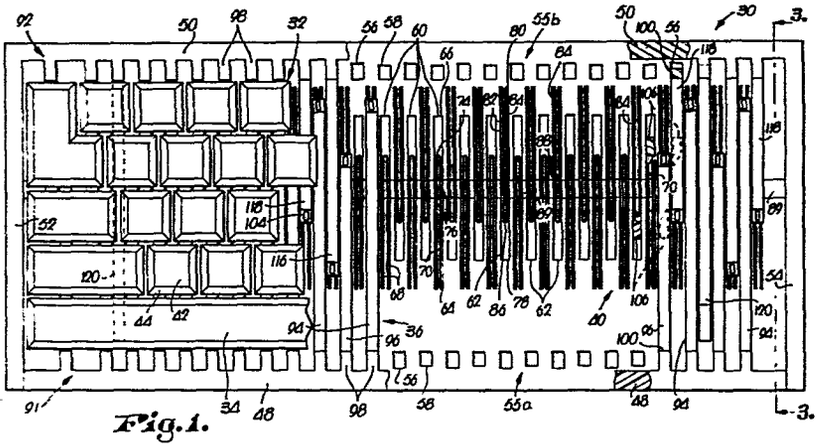


Fig. 1.

KEYBOARD

Background of the Invention

1. Field of the Invention

The present invention is concerned with an improved, low cost keyboard preferably formed of moldable synthetic resin material and which has a substantial degree of mechanical N-key rollover protection and other necessary features making the keyboard applicable for a wide variety of uses. More particularly, it is concerned with such a keyboard having a momentary impulse output operation, standard tactile feedback and the ability to handle high speed inputs without difficulty.

2. Description of the Prior Art

Keyboards are most commonly associated with typewriters and have until recent times developed in parallel with typewriter evolution. However, with the advent of the electronic age, a new generation of keyboards suitable for use as instruction keys for electronically activated devices has evolved. These keyboards have a wide array of uses, only one of which is to input electronic typewriters.

In the present state of the art, there are basically three types of keyboards. In one variety, electronic output in the form of electrically encoded signals to a companion or remote device is employed. In another type of keyboard, mechanical output movements are used which trip or activate leverages or linkages in either totally mechanical machines (e.g., manual typewriters) or electric machines such as electric typewriters. The principal

distinguishing feature between these two types of keyboards is the form of output, i.e., mechanical movement or electric signal.

A third type of general keyboard construction can be thought of as a hybrid between the electronic and mechanical units. In this form, a mechanically induced movement is read electronically by one of various kinds of transducers, and the reader outputs the detected movement in the form of signals of an electronic nature.

While it is true that the keyboard art is old and well developed, the relatively recent proliferation of electronic devices that require operator instruction has caused the manufacturing of keyboards to grow at an enormous rate. Keyboards are required in all sizes, configurations, colors, shapes, tilts, slants, legends, codings, key strokes and depths. Despite this industry growth, or perhaps as a result thereof, no one keyboard or variety of keyboard has emerged as clearly superior. This is primarily due to the operational or cost limitations inherent in the various keyboard constructions, as well as the difficulty of modifying the same for particular purposes.

For example, in the case of full keystroke keyboards, the depth of the keyboard structure becomes a problem in many cases. The standard key switch plunger arrangement or mechanical leverage linkage consumes a considerable depth, because of the structural constraints encountered in developing a proper key stroke (approximately 3/16 of an inch) with acceptable key wiggle, direct depression travel, proper chassis and mounting cannister for either the key switch plunger or the leverage that

attaches to the key stem. This is addition to the height of the key top itself necessitates a rather large, bulky overall keyboard structure. Because of the foregoing problems, full stroke keyboards are generally limited to conventional typewriters or input/output devices, and are not used on other types of equipment. Manifestly, the problem of providing a full stroke keyboard with minimum depth has limited the market potential of prior full stroke keyboards.

Virtually all known keyboards with key stroke capability require separate key tops. This is a fundamental requirement of the plunger or lever structure used as the key top support. The present industry standard for key tops on reliable equipment is double injection molded synthetic resin key tops. In this form, the key tops are first molded in one color of synthetic resin and an inner shell space is allowed for a second color injection that results in key legending being injected completely through the outer key shell. This process is inherently expensive in many ways. For example, it requires two complete injection runs for manufacture of the keytops, using expensive molding equipment which cannot be altered except at great expense. The double molding operation also results in a key top that is of substantial thickness and comsumes a considerable amount of material.

The primary use of full stroke keyboards is in graphics and typewriting, including computer and CRT units. However, the bulk of the potential market for typewriter and printer equipment has grown accustomed to the tactile feel of conventional electric typewriters. These devices have feedback

as a consequence of their design and mechanical construction. Tactile feedback in this context refers to a slight pressure increase required to depress a key through the initial range of key stroke, followed by a breakaway at about two-thirds of the stroke depth that is felt by the operator. This breakaway change from one pressure to a lighter pressure is not mimicked in any electronic keyboard in common usage, and accordingly this latter type of keyboard is deficient in this respect. In order to fully meet market demand and appeal to an already trained public, a keyboard form should include tactile feedback. Moreover, the amount of feedback should be variable without signficant or costly manufacturing changes, in order to meet differing uses.

With touch typing at high speed on a conventional typewriter keyboard a phenomenon occurs which is referred to as "rollover." While typing at high speed, one key is in initial stages of depression before the priorly depressed key is released, and in some cases there could be as many as four keys simultaneously in various stages of depression, bottom out or upward travel. There are two ways to handle this problem that are in common use, i.e., mechanical blocking or filtering, or electronic scanning or logic analysis. Typical electric typewriters with keyboards use the technique of mechanical filtering. In this scheme some form of continuous chain of elements is configured in such a way that only one key lever at a time can pass through the chain. In this manner, no two keys can be in a position to interrupt or actuate a mechanical movement simultaneously. Because of the relatively high tolerance requirements of such

systems, they are inherently expensive, can actually retard the speed of the typist, and present maintenance problems in that they can become gummed up and sticky over time. The typical electronic keyboard on the other hand solves the problem in an electronic way. Normally, a keyboard matrix of the key switch positions is scanned at high frequency. The first switch to be activated is entered into memory and the second switch is then entered while the output from the first switch is ignored or blocked and so forth until "N-keys" are depressed. For this reason electronic keyboards require a substantial amount of logic circuitry, the relative amount of sophistication of the decoding and "N-key" analysis and speed of information scanning being in direct proportion to the cost of the board.

Another absolute necessity in connection with keyboards is that of reliability, i.e., the life or number of cycles which can be expected from the keyboard, and within a given number of cycles, the number of misses or fault signals that occur. The most expensive and reliable keyboards on the market today are so-called "Hall effect" keyboards. In these units key depression closes a switch which is magnetically sensed, and only a breakdown in the mechanics of the switch cannister or chassis can effect reliability of such a device. However, Hall effect keyboards are inherently very expensive by virtue of the many electronic components required, and particularly the relatively high electronic power supply requirements.

In short, it will be appreciated that the various keyboards of the prior art each possess a number of outstanding attributes, but all are

plagued by one or more serious deficiencies. Accordingly, there is a real and heretofore unsatisfied need in the art for a simple, low cost keyboard having the combined properties of full stroke capability, tactile feedback, N-key rollover protection, minimum depth, and a high degree of reliability.

Summary of the Invention

The present invention is broadly concerned with a keyboard, and a method of fabricating the same, which overcomes the problems noted above. The keyboard is manufactured almost entirely from low cost synthetic resin materials for ease of fabrication and cost reduction. The keyboard includes a plurality of separate, depressible keys, means for developing a keyboard output corresponding to depression of particular keys, and structure operably coupling the keys and the output means.

In the preferred embodiment of the invention, a keyboard is provided having a plurality of keys with an elongated, generally horizontally extending support arms secured to each key respectively. Certain of the arms extend in a first direction, whereas others of the arms extend in a second direction different than (preferably generally opposed to) the first direction. The respective arms are mounted for pivotal movement thereof about generally horizontal axes spaced from the associated keys. In this fashion, the keys can be accommodated within a relatively narrow space, while at the same time providing the desirable keyboard "feel" and feedback of conventional typewriter keyboards.

The key-supporting arms of the preferred embodiment include an engagement surface which, upon depression of the associated key, engage and deflect a resilient, synthetic resin element such as a flipper provided beneath each key in the keyboard base. The respective flippers are mounted in a cantilever fashion on the keyboard base with the free or operating ends of the flippers extending beneath the corresponding engagement surfaces. During depression of a key and consequent downward deflection of the associated flipper, the latter is deformed and experiences an increase in potential energy. The engagement surface and flipper end are cooperatively configured such that, near the bottom of the key stroke, the flipper is detended from the engagement surface and is allowed to rapidly shift or spring upwardly toward its original rest position. However, during this return travel, the flipper overtravels to a certain extent before returning to its rest configuration.

Output from the keyboard in accordance with the preferred embodiment is developed through the use of an elongated synthetic resin strip coated with a conductive material such as silver or silicon conductive rubber which is disposed transversely relative to the respective key-supporting arms and located to be engaged by the flippers during the described overtravel movement thereof. An elongated resistive wire is positioned above the conductive strip, in such location that the flipper serves to push the conductive strip into engagement with the resistive wire for a very short "impulse" period during the overtravel motion of the flipper. Such contact between the conductive strip and resistive wire completes an

electrical circuit, and apparatus such as an analog/digital voltage converter is coupled to the strip and resistive wire for determining the magnitude of resistances developed through the wire. A predetermined resistance corresponds to each key and associated flipper, and in this fashion a precise determination can be made of which of the keys has been depressed. The output from the voltage converter is directed to utilization circuitry associated with the overall typewriter, printer or CRT.

In an alternative embodiment of the invention, each key element is in the form of an elongated, resilient, U-shaped synthetic resin strip with an upstanding nib on one end thereof and with the other end being secured against translatory movement. A second elongated, resilient U-shaped member is disposed about the first strip and has a nib thereof for engaging the free end nib of the first strip, along with a key-engaging knee portion beneath the associated key. When the key is depressed, the second U-shaped element is pulled forwardly which in turn shifts the first U-shaped element in a similar direction by virtue of the engagement between the respective nibs. During such shifting. the potential energy level in the first resilient strip is increased until a cam-like disengaging surface forming a part of the keyboard structure is reached. At this point the surface is engaged, the nibs are separated, and the first U-shaped element is allowed to "snap back" toward its original position.

The alternative embodiment includes one or more upstanding encoding posts carried by the first U-shaped strip and, during the "snap back"

sequence, these posts engage one or more corresponding, transversely extending, synthetic resin encoding strips in order to flex the latter. Such flexure in turn moves respective upright arms operatively engaged by the encoding strips, and such arm movement is sensed or read in order to develop the keyboard output signal.

The key array of the alternative embodiment is preferably formed of synthetic resin material and includes an integral synthetic resin base sheet cut to present a plurality of upstanding, individual flaps, with respective key tops secured to the flaps. Lines of weakness are formed in the key-supporting flaps such that, when a downwardly directed force is applied to the keys, the supporting flaps collapse downwardly. Upon release of the key, the resilience of the flaps, along with the resilience of the underlying shifting strip, cooperatively return the key to its normal rest position. Preferably, the lines of weakness in the respective flaps are formed so that, upon depression of the keys, the associated flaps form operating projections which engage the knee portions of the associated underlying shifting elements for moving the latter.

In fabrication of the preferred embodiment, a keyboard blank is molded which includes a base member and a first set of elongated arms, with structure pivotally coupling the first arms to the base along one margin thereof. A key is further secured to each arm. A second set of arms is then positioned in opposed, facing relationship to the first arms, and the first and second arms are shifted toward one another until the arms are generally parallel to the base, and are pivotal

about respective axes. This involves intercalating respective arms, and captively locking each arm so that it travels only through a predetermined key strok arc.

Brief Description of the Drawings

Figure 1 is a top view of a keyboard in accordance with the invention, with parts broken away for clarity and certain parts being illustrated in section;

Fig. 2 is a fragmentary, irregularly broken away and partially in section front view of the keyboard depicted in Fig. 1;

Fig. 3 is a vertical sectional view taken along line 3-3 of Fig. 1;

Fig. 4 is a view similar to that of Fig. 3, but illustrating the juxtaposition of the key-supporting arms and their underlying flippers, and with the limits of a key stroke arc illustrated in dotted lines on one of the keys;

Fig. 5 is a view similar to that of Fig. 4, but illustrating the configuration of one of the keys during the initial stages of depression thereof;

Fig. 6 is a view similar to Fig. 5, but illustrates the configuration of a depressed key prior to release of the associated flipper;

Fig. 7 is a view similar to Fig. 6, but illustrates the configuration of a flipper during overtravel movement thereof back to its original rest configuration;

Fig. 8 is a view similar to that of Fig. 7, but illustrates a key having a longer arm than that of Fig. 7, with a key being in its rest position;

Fig. 9 is a fragmentary bottom view of Fig. 5, during the initial stages of key stroke depression and consequent flipper engagement;

Fig. 10 is a fragmentary bottom view of Fig. 6, illustrating the configuration of the key arm and flipper just prior to release of the flipper;

Fig. 11 is a fragmentary bottom view of Fig. 7, depicting the return travel of the flipper;

Fig. 12 is a somewhat schematic fragmentary view illustrating the preferred output assembly for developing a keyboard output;

Fig. 13 is a vertical sectional view taken along line 13-13 of Fig. 12;

Fig. 14 is a vertical sectional view taken along line 14-14 of Fig. 12;

Fig. 15 is a vertical sectional view taken along line 15-15 of Fig. 12;

Fig. 16 is a vertical sectional view illustrating a preferred method of fabrication of a keyboard in accordance with the invention, with a keyboard blank being formed in a separable mold;

Fig. 17 is an enlarged, fragmentary vertical sectional view illustrating formation of a key letter in one of the key tops of the blank depicted in Fig. 16;

Fig. 18 is a top view of a completed key, shown with a letter formed therein;

Fig. 19 is a somewhat schematic view illustrating the steps involved in formation of a keyboard from the blank depicted in Fig. 16;

Fig. 20 is a vertical sectional view illustrating a multiple part, separable mold used in forming a synthetic resin keyboard blank;

Fig. 21 is an essentially schematic view

illustrating the steps involved in formation of a completed keyboard using the blank produced from the mold of Fig. 20;

Fig. 22 is a fragmentary top view partially in section and with parts broken away illustrating a keyboard in accordance with an alternative embodiment of the present invention;

Fig. 23 is a sectional view taken along line 23-23 of Fig. 22 which illustrates the configuration of the keyboard and the internal operating components thereof;

Fig. 24 is a sectional view taken along line 24-24 of Fig. 22 and depicts the operation of the keyboard when an individual key is depressed;

Fig. 25 is a sectional view taken along line 25-25 of Fig. 22 which illustrates the momentary impulse "snap back" operation of the keyboard;

Fig. 26 is a vertical sectional view taken along line 26-26 of Fig. 23;

Fig. 27 is a sectional view taken along line 27-27 of Fig. 1;

Fig. 28 is a fragmentary side elevational view illustrating a laminated synthetic resin sheet used in forming the key tops of the keyboard structure;

Fig. 29 is a schematic view illustrating the first vacuum forming operation in the fabrication of the key top structure;

Fig. 30 is a schematic view illustrating another step in the production of the key top structures wherein the formed key tops are partially die cut;

Fig. 31 is a fragmentary view of the formed, partially die cut key top sheet;

Fig. 32 is a fragmentary top view illustrating

a die cut base sheet used in the fabrication of the key set;

Fig. 33 is an enlarged, fragmentary view of a pair of adjacent key top-supporting flaps, with the lines of weakness of the respective flaps being illustrated in phantom;

Fig. 34 is a sectional view taken along line 34-34 of Fig. 33 which further illustrates the flap construction; and

Fig. 35 is a schematic view illustrating the connection of the respective key top-supporting flaps and the preformed key top structures.

Description of the Preferred Embodiment

Turning now to the drawings, a keyboard 30 is depicted in Figs. 1 and 2, and broadly includes a plurality of keys 32 arranged in respective rows, along with an elongated, spanning, depressible spacing bar 34. The keyboard further has means referred to by the numeral 36 for supporting the keys 32 for individual, selective depression thereof, and means 38 (see Fig. 12) for developing a keyboard output related to the depression of particular keys. Structure 40 beneath the keys 32 is employed for operably coupling the keys and the output means 38 so that, upon depression of particular keys, a corresponding output is developed.

In more detail, each of the keys 32 is preferably formed of synthetic resin material and presents a slightly concave, uppermost finger-engagement surface 42 along with a depending, circumscribing skirt 44. The majority of the keys are essentially square in plan configuration as best seen in Fig. 1, whereas certain of the keys are oblong or L-shaped, as is conventional in

present day keyboards.

The key-supporting means 36 includes a substantially planar, apertured base 46 which is rectangular in plan configuration, along with a pair of spaced, opposed, marginal front and rear walls 48 and 50, and upright, spaced, marginal sidewalls 52, 54.

The base 46 is provided with two series 55a and 55b of apertures 56 and 58 respectively adjacent and extending along the length of front and rear walls 48 and 50. It will be noted in this regard that the apertures 56, 58 alternate along the length of each wall 48, 50, and that the apertures 56 are somewhat longer than the apertures 58. In addition, it will be observed that the apertures along the length of front wall 48 are laterally offset relative to the apertures along the length of rear wall 50. The significcance of these features will be made clear hereinafter.

The base 46 is also provided with a series of alternating, elongated, rectangular slots 60 and 62 therethrough which are located between the walls 48, 50. A slot 62 is provided and is in alignment with each aperture 56, 58 in the row 55a thereof proximal to front wall 48; likewise, a slot 60 is provided with and is in alignment with each aperture 56, 58 in the row 55b thereof proximal to front wall 48.

Referring specifically to Fig. 1, it will be seen that each slot 60 is defined by a front wall 64 and a rear wall 66 along with spaced, opposed sidewalls 68. An elongated, rearwardly extending, resilient, deformable flipper or element 70 is secured to the front wall 64 of each slot 60

in a cantilever fashion by means of a short, thin connection strip 72 (see Fig. 4). The free or operating end 74 of each element 70 is between the sidewall 68 and spaced from the rear wall 66. Finally, a notch 76 is provided in the upper surface of element 70 as depicted.

Each slot 62 is similar to the slots 60 and is defined by a front wall 78, rear wall 80, and spaced, opposed sidewalls 82. An elongated, resilient, deformable flipper or element 84 is secured to rear wall 80 of each slot 62 and extends forwardly toward front wall 78. Here again, the elements 84 are cantilever mounted to their respective mounting walls by means of short connection strips. The free or operating end 86 of each element 84 is spaced from the front wall 78, and the upper surface of each element 84 is notched as at 88. Notches 89 are provided in the upper face of base 46 between the slots 62 and in alignment with the element notches 76, 88, so that the notches 76, 88 and 89 cooperatively define an elongated channel extending between sidewalls 52, 54. Finally, the upper surfaces of the notched regions of the elements 70, 84 are peaked as at 90 (see Figs. 12-15).

As best seen in Fig. 1, the front walls 64 of the slots 60 are closer to the apertures 56, 58 adjacent front wall 48, than are the front walls 78 of the slots 62. By the same token, the rear walls 80 of the slots 62 are closer to the apertures 56, 58 proximal to rear wall 50, than are the rear walls 66 of the slots 60. Also, it will be seen that the respective elements 70, 84 respectively associated with each slot 60 or 62 are cantilever mounted and extend in opposite

directions relative to one another. However, the notches 76, 88 provided in the element 70, 84 are in alignment with one another for purposes to be made clear.

The key-supporting means 36 further includes two sets 91 and 92 of elongated key arms respectively pivotally coupled to the walls 48, 50. Set 91 includes alternating longer and shorter arms 94 and 96 which are oriented in laterally spaced relationship along the length of wall 48. The longer arms 94 are located directly above the apertures 58, whereas the shorter arms 96 are located directly above the apertures 56. As best seen in Fig. 1, each of the arms 94, 96, extends over a portion of an associated slot 62 and element 84 therein. Referring to Figs. 1-3, it will be seen that each of the arms 94, 96 are pivotally connected to the upper margin of wall 48 by means of a thin, synthetic resin hinge portion 98. A depending leg 100 extends from the end of hinge portion 98 remote from wall 48, and has a lowermost dog 102 thereon. The dog 102 is inserted and captively retained within the adjacent, associated aperture 56 or 58 directly beneath the hinge portion 98. An elongated arm 94, 96 extends from the leg 100 above dog 102 to a point for supporting a key 32. To this end, the ends of the arms 94, 96, are provided with upstanding frictional connector 104 for receiving and supporting an associated key 32.

A depending retainer 106 is secured to each arm 94, 96 and extends downwardly therefrom and is received within the associated underlying slot 62 in order to prevent significant lateral wiggle of the arms and their supported keys.

Specifically, the retainer 106 fits in the open portion of the underlying slot 62 between the extreme free end of the element 84 and front wall 78.

A beveled flipper-engaging member 108 is also provided with each arm 94, 96, directly inboard of the retainer 106. The member 108 includes a substantially triangular bottom wall 110 disposed partially above the end 86 of the element 84, an upright planar sidewall 112, and a beveled, substantially planar sidewall 114. The importance of this construction will be explained hereinafter.

The set of arms 92 is operatively coupled to rear wall 50 such that the arms 116, 118 thereof are laterally spaced apart and extend toward front wall 48. Here again, the longer arms 116 alternate with the shorter arms 118; and the longer arms 116 are disposed over and operatively coupled with an aperture 58 in set 55b, whereas the shorter arms 118 are disposed over and coupled to an underlying aperture 56.

The arms 116, 118, are coupled to their associated wall 50 in a manner identical to that described in conjunction with the arms 94, 96 of set 91. That is to say, a hinge portion 98 and depending leg 100 having a dog 102 are provided for each arm, with the dog 102 being inserted within the associated aperture 56 or 58 for the arm. Likewise, each of the arms 116, 118 includes a depending retainer 106 received within a slot 60 between the free end of the element 70 therein and the defining front wall 64. Finally, each of the arms 116, 118 includes an element-engaging member 108 which is identical to that described in connection

with the arms 94, 96, both in the structure thereof and in disposition relative to the associated underlying elements 70.

Again referring to Fig. 1, it will be seen that the longer arms 116 support the row of keys closest to front wall 48; whereas the shorter arms 118 support the next inboard row of keys. Thus, the arms 94, 96 of set 91 extend in an opposed direction relative to the arms 116, 118 of set 92. Also, the arms are intercalated so that arms from set 91 alternate with arms from the opposing set 92.

Spacing bar 34 is supported for up and down movement thereof by means of a pair of elongated, spaced apart arms 120 which extend from rear wall 50 forwardly to a point just adjacent front wall 48. The arms 120 are pivotally mounted for movement about a horizontal axis so that the bar 34 moves in the conventional fashion.

Output means 38 (see Fig. 12) includes an elongated, resilient, synthetic resin strip 122 having a conductive coating of conductive rubber 124 on the upper face thereof. The strip 122 is mounted within the channel defined by the aligned notches 76, 88 and 89. It will thus be appreciated that the strip 122 extends above and transversely relative to the longitudinal axes of the respective elements 70, 84, and below the arms 94, 96 and 116, 118.

The output means 38 further includes an elongated, resistive wire 126 preferably formed as so-called "Nichrome" material. The wire 126 is located slightly above and extends along the length of the strip 122. A plurality of spaced apart tubular insulators 128 are provided on wire

126 and respectively straddle the underlying elements 70, 84. The insulators 128 divide the output means 38 into a plurality of spaced electrical contact switch zones, each zone is comprised of a portion of the wire 126 and the respective underlying portion of the strip 122. The elements 70, 84 each include a contact switch area configured for selectively engaging the associated switch zone of the output means 38 directly above the respective element 70 or 84. Electrical signal generating means comprising an analog/digital voltage converter 130 provided with a suitable reference voltage source (not shown) is operatively coupled to the wire 126 and conductive coating 124 such that, when one of the elements 70, 84 moves in a manner to engage its associated switch zone, the strip 122 is pushed into momentary, impulse contact with wire 126, and a characteristic resistance corresponding with the element (and thereby the associated key) is developed and sensed. An output cable 132 is coupled to appropriate utilization circuitry (not shown) forming a part of the overall typewriter.

Referring again to Fig. 1, it will be seen that the arms 94 support keys 32 in the row thereof furthest from wall 48. By the same token, the shorter arms 96 support the keys forming the second row thereof spaced from rear wall 50.

The operation of keyboard 30 can best be understood from a consideration of Figs. 4-11. In the ensuing discussion, the operation of keyboard 30 during depression of a particular key 32a supported by one of the arms 118 will be described; it will be understood, however, that the operation of the remaining keys is identical in all material respects.

At the outset (see Fig. 4) it will be appreciated that, in the rest position of key 32a, the arm 118 extends generally horizontally relative to the base 46, and is pivotally movable by virtue of the associated hinge portion 98. In addition, the dog 102 is disposed within the underlying aperture 56 adjacent rear wall 50. The orientation of dog 102 within the aperture 56 thus limits the extent of pivotal movement of the arm 118. The limits of this pivotal movement are illustrated in Fig. 4 by means of respective sector lines 134 and 136 which define the predetermined arc of travel of the arm 118 and, consequently, the key 32a. In addition, it will be seen that the pivot axis for arm 118 is elevated above the longitudinal axis of the arm, and lies in a horizontal plane (depicted by line 138 in Fig. 4) which intersects the predetermined arc of travel of the key. It has been found that the described orientation of the pivot axis for the respective arms give a "feel" to the user which closely simulates conventional typewriter keyboards.

In any event, upon initial depression of the key 32a (see Figs. 5 and 9), the engagement surface 110 on the member 108 comes into contact with the upper surface of free end 74 for the underlying element 70. Continued downward movement of the key under the influence of finger pressure serves to deform and deflect the end 74 of the element 70 (see Figs. 6 and 10) downwardly, with the effect that the potential energy of the resilient element is increased, along with its resistance to further deflection.

By virtue of the pivoting action of the

element-engaging member 108 and the surface 110 thereof, a point is reached where the surface 110 passes out of engagement with end 74 of element 70. This can best be understood from a consideration of Figs. 9-11, wherein a line 140 has been applied which corresponds to the innermost extent of the member 108 prior to depression of the key 32a. As such depression proceeds, the surface 110 pivots away from the end 74 of the element 70 until, as seen in Fig. 11, the element 70 is completely disengaged from the surface 110.

When such disengagement occurs, the deformed and deflected element 70, because of the resilient nature thereof, springs back upwardly at a very high rate of speed toward its rest position (see Figs. 7 and 11).

During such return movement of the element 70, the element overtravels the original starting or rest position thereof, and, during such overtravel, engages with a momentary impact the underside of the strip 122. As best seen in Figs. 12 and 15, this overtravel movement serves to push or propel the strip upwardly till the conductive coating 124 thereon comes into a momentary pulse-type engagement with the resistive wire 126. Such impulse movement is facilitated by virtue of the peaked nature of the element at the region of the notch 76 therein, which is indicated by the reference numeral 90. In effect, the peaked sections, in conjunction with the conductive rubber coated strip 122, cause an arcuate portion of the strip to orthogonally contact the circular in cross section wire 126; such cross point contact creates a relatively high mechanical stress region at the contact point which is de-

sirable to establish a firm, yet momentary contact pressure between the components. Further, it will be observed that contact between the strip 122 and wire 126 at multiple points is prevented by virtue of the straddling insulators 128 respectively disposed on opposite sides of the element 70.

When the zone of strip 122 directly above the element 70 is caused to engage wire 126, a circuit coupled with the converter 130 is established from the converter 130 through the portions of the coating 124 and wire 126 electrically between the converter and the contact point. The converter 130 senses the magnitude of the electrical resistance developed in the involved portion of the wire 126 during such circuit closing, and delivers a suitably corresponding electrical output (e.g., a binary encoded character code) to the cable 132. It will be appreciated in this regard that the element 70, when it closes the electrical circuit as described, presents to the converter 130 a unique, predetermined resistance magnitude corresponding to the key 32a so that the converter 130 will provide an appropriate distinctive output signal corresponding to the key 32a. By the same token, each of the remaining elements 70, 84, and their associated keys, have a unique resistance magnitude respectively associated therewith, so that the device 130 can output a proper distinctive signal in each case.

Method of Fabricating the Preferred Embodiment

Referring now to Figs. 16-19, a preferred method of fabrication of a keyboard in accordance with the preferred embodiment of the invention is illustrated. In Fig. 16, a mold 142

is illustrated having a base section 144, an upper section 146, and a pair of separate comb-like elements 147. The mold 142 is employed to form a blank 148 used in the fabrication of a completed keyboard 30. The blank 148 includes a base 46 having respective sets 55a and 55b of apertures 56, 58 along spaced margins thereof, along with front and rear walls 48, 50 secured to the base margin along respective lines of weakness 150, 152. Each aperture 56, 58, includes a flexible section 153 at the inner face thereof permitting insertion of a corresponding dog 102 in the final fabrication process. In addition, the base 46 is molded to include all of the other described structure, e.g., the slots 60, 62 and flipper elements 70, 84. The arm sets 91, 92 are respectively secured to the margins of the walls 48, 50 remote from the base 46, and these arms are configured as described above. In addition, a pair of elongated spacer bar-supporting arms 120 are provided for the bar 34.

Respective keys 154 are integrally attached to the outermost end of each of the described arms. As best seen in Figs. 16 and 17, the arms are secured to their associated keys 154 along one margin of the skirt thereof. A removable die block 156 is inserted through the upper mold section 146 and into each separate key 154. The die blocks 156 have, on their innermost ends, structure for forming informational indicia openings in the keytops. A separate filler block 157 extends through the section 146 and into spacer bar 34 as shown. Thus, during the molding process, letters or other appropriate indicia are formed in the upper surfaces of the keys by virtue

of the presence of the die blocks.

It will be understood that a blank 148 can be fabricated using mold 142 and conventional injection molding techniques. When the initial injection is completed, the die blocks 156 are removed from their associated opening and keys, and a filler material 158 (see Fig. 17) of a different colored synthetic resin than that forming the main body of the blank is placed within each key body. A secondary block 160 is placed within the associated openings in section 146 and the keys 154, in order to press the material 158 into the indicia openings left by the die blocks 156. This serves to fill such openings and give a completed key top bearing the appropriate indicia thereon. Fig. 18 illustrates a completed key bearing the letter "A".

In fabrication procedures, the blank 148 is placed on a work surface, and the walls 48, 50 turned upwardly relative to the base along the lines of weakness 150, 152 (see Fig. 19). The next step involves pivoting the respective arms of each set 91, 92 thereof downwardly until such arms are generally horizontal and parallel with base 46. At this point, the dog 102 associated with each arm is inserted within the underlying base aperture 56 or 58 (such being facilitated by the presence of the flexible sections 153), so that the arm is captively held for pivotal movement along a predetermined arc, as hereinabove explained. During such movement of the arms, they are intercalated as explained, and are oriented over the corresponding elements formed in the base 46. The final steps in the fabrication process involve shifting the arms 120 downwardly and

interconnecting the same with the transversely extending spacer bar 34. The output means 38 can then be installed in the blank 148 in order to give a completed keyboard.

Figs. 20-21 illustrate a similar molding process for the production of a two-part blank 162. In this instance the mold 164 includes a pair of side-by-side interfitted base sections 166, 167, 168, along with a pair of upper sections 170, 172. A pair of elongated comb-like elements 173 are also provided, along with respective elongated inserts 173a. The blank 162 is molded to present a base 46 having a sidewall portion 48 secured thereto along a line of weakness 174. One set of arms 91 are secured to the end of wall 48 remote from base 46. The latter includes the aperture sets 55a and 55b, as well as the other described structure of the base including the slots, elements and flexible sections 153. The second set of arms 92 is also formed within mold 164 as a separate element between the upper portion of base section 168 and the lefthand face of upper base sections 172. The arm set 92 includes the sidewall 50 secured thereto, and the sidewall 50 and the margin of base 46 remote from wall 48 are provided with appropriate connectors 176, 178. The arm set 92 includes the elongated arms 120 and spacer bar 34. It will be seen that the apparatus of Fig. 20 serves to mold the respective arm sets 91, 92 in an intercalated condition so that upon final fabrication this procedural step is eliminated.

The keys 154 are formed simultaneously with the respective arms of each set 91, 92, as in the case of the embodiment of Figs. 16-19. Here

again, die blocks 180 bearing the appropriate key indicia, and filler block 181, are initially positioned within the mold sections 168, 170 as illustrated, so that the keys, when formed, include the appropriate indicia openings in the upper surfaces thereof. The respective keys 154 are completed as illustrated and described in connection with Figs. 17-18, i.e., use of a material 158 having a different color than that of the main body of the keys 154.

The fabrication technique involves connecting the wall 50 to the margin of base 46 remote from wall 48, through use of the connectors 176, 178. The final step involves pivoting of the respective arm of the sets 91, 92 until such arms (which are already intercalated) are oriented as hereinabove described.

Description of an Alternative Embodiment

Turning now to Figures 22-35, a keyboard 220 in accordance with an alternative embodiment of the invention is illustrated. Broadly speaking, the keyboard 220 includes a set 222 of individual, depressible keys 224, output means 226 for developing a keyboard output corresponding to the depression of particular keys 224, and structure referred to by the numeral 228 for operably coupling the keys 224 and the output means 226. A support assembly including a base member 230 and a housing 232 also forms a part of the overall keyboard 220.

Key set 222 includes an integral synthetic resin base sheet 234 formed of a suitable tough, resilient material such as one of the well known polycarbonate resins. The sheet 234 is backed by a layer 236 of structural backing ma-

terial such as a high density polyethylene. As best seen in Fig. 24, the sheet 234 and layer 236 are supported atop base member 230; moreover, the rearward end of the sheet and layer are disposed within housing 232, and the extreme rearmost edge is beveled as at 238. The importance of this beveled surface, which extends the full width of the sheet and layer at the rearward end thereof, will be explained hereinafter.

A plurality of respective pairs of upright, somewhat triangularly shaped flaps 240, 242 are cut from the sheet 234 and layer 236, as best seen in Fig. 23. Preferably, the flaps are at right angles to one another. In addition, each of the flaps is configured to present a total of three vertically spaced, transversely extending lines of weakness 244, 246 and 248 therein, such that the lines present in effect fold or hinge lines across the body of each of the flaps 240, 242. It will also be observed that the layer 236 is cut at the region of the lines 244-248 to present respective, transversely extending, triangular in cross section relieved areas or recesses 250, 252 and 254.

A separate key top 256 is secured to each respective pair of upright flaps 240, 242. Each key top 256 includes an uppermost, concave finger depression top wall 258, as well as a depending continuous sidewall 260 so that the key top presents an open-bottom, hollow configuration. Each of the key tops is formed from synthetic resin material identical with that of the base member, i.e., an outermost integral sheet 262 of polycarbonate material backed with a layer 264 of a high density polyethylene.

Again referring to Fig. 23, it will be seen that each of the key tops 256 is adhesively secured to the uppermost triangular portions of the flaps 240, 242. Further, and as will be explained in detail hereinafter, each of the flaps are configured for collapsing downwardly when a downwardly directed force is applied to the associated key top in order to effect depression of the key; in addition, the nature of the materials used in the flaps 240, 242, as well as the configuration thereof, helps to return the key to its upright position illustrated in Fig. 23, when the key is released.

The keyboard output device 226 is disposed within housing 232 and includes a plurality of elongated, resilient, spaced apart encoding strips 264 which are respectively secured to the sidewalls of housing 232 by appropriate connectors 266. Each of the strips 264 is slightly longer than the distance between the points of connection thereof, and the importance of this feature will be made clear hereinafter. In the embodiment illustrated, a total of nine separate encoding strips 264 are depicted (eight information bit strips, and one parity coding strip). In preferred forms, the strips would be formed of a suitable synthetic resin material such as mylar.

A plurality of laterally spaced, encoding strip-engaging pegs 268 depend from the top wall of the housing 232. As best seen in Fig. 23, the pegs 268 are arranged in respective, spaced apart pairs, the spacing between individual pegs of each pair defining an engagement and flexure region 270 for the adjacent encoding strip 264. The number of regions 270 along the length of each

encoding strip is equal to the number of keys in the key set 222.

A sensing apparatus 272 is also provided within housing 232 and forms a part of the overall keyboard output device. The sensing apparatus in the illustrative form depicted includes a microswitch assembly 274 having a total of nine separate signal generating devices or microswitches, one for each of the encoding strips 264. A pair of spaced apart upright stabilizers 276 are provided for engaging each transversely extending strip 264, and a switch arm 278 forming a part of the microswitch associated with the particular enclosing strip 264 is located between the adjacent stabilizers 276. In the rest or null signal position of the strips 264, the slack or extra length of the strip referred to above is taken up at the region of the associated stabilizers and switch arm. That is to say, in their rest positions the strips are drawn taut by being threaded between the corresponding stabilizers and switch arms, and short, arcuate sections 280 are drawn in the strips between the stabilizer pairs.

The coupling structure 228 includes, for each key 224, a first, elongated, resilient U-shaped element 282 having one end 284 thereof secured to the top wall of housing 232. The free end of element 282 is configured to present a downwardly extending nib 286, and a forwardmost beveled surface 88. The element 282 is preferably formed of mylar or other suitable synthetic resin material having good resilience qualities, and supports a number (even or odd depending upon the code system employed) of upstanding strip-engaging and flexing posts 290, such posts forming a part

of the overall encoding device. In the rest position of the elements 282, the posts 290 are located between respective strips 264 (see Fig. 23) but are closer to the rearmost adjacent strip.

A second U-shaped resilient synthetic resin member or element 292 is also provided for each key, and serves as a means for shifting of the associated element 282 in a manner to be described. Each element 292 is disposed about the corresponding element 282 and includes an end 294 secured above the end 284 of element 282 (see Fig. 23). An upstanding nib 296 is provided on the element 294 and is located for interengaging with nib 286 of element 282. The forward or free end of each element 292 extends beneath the associated key 224. At the region of key 224, an upstanding knee portion 298, somewhat in the form of an inverted "V", is provided which extends into the aperture in the base sheet presented by the upstanding integral flaps 240, 242. Referring to Fig. 27, it will be seen that the base member 230 is configured to present respective elongated channels 300 which receive and guide the elements 292 during axial shifting thereof.

The operation of keyboard 220 can best be understood from a consideration of Figs. 23-25. Fig. 23 illustrates the keyboard with certain of its keys in the rest positions thereof, i.e., not depressed. In this orientation, it will be seen that the nibs 286, 296 are adjacent each other, and that knee portion 298 extends up and has the rearward leg thereof adjacent the lowermost portion of flap 242 between the lines of weakness 244, 246.

When a downwardly directed force is

applied to top wall 258 of a selected key 224, the following occurs. First, the respective flaps 240, 242 collapse upon themselves as viewed in Fig. 24, this being permitted by virtue of the orientation of the lines of weakness 244, 246 and 248, as well as the recesses 250, 252 and 254. As a result of such collapsing movement of the flap 242, an operating projection 302 is formed, made up of the portions of the flap 242 between the lines 244, 246 and 248. As the flap 242 collapses and forms the projection 302, the adjacent leg of knee portion 298 is engaged with the effect that the lowermost portion of the element 292 is shifted forwardly or leftwardly as viewed in Fig. 24. During such movement, the engagement between the nibs 296, 286, causes the element 282 to likewise be pulled forwardly or leftwardly. By virtue of the resilient nature of the element 282, such physical translatory movement of the free end of the element in effect serves to deform the element and increase the potential energy thereof. The nib 286 and free end of the element 280 are drawn forwardly until the surface 288 comes into contact with the beveled surface 238. At this point the camming action developed between the surfaces 238, 288, serves to separate or disengage the nibs 286, 296. As a consequence of this disengagement, the element 282 quickly "snaps back" in a rightward direction as viewed in Fig. 35 to a point where the posts 290 carried by the element momentarily engage and flex the associated encoding strips 264. During such "snap back" motion, the strip 282 travels at a speed which is orders of magnitude greater than the speed of travel of the key during depression thereof, and the overtravel of the

strip past its neutral or rest position creates the mechanical signal through flexure of the strips 264. Because of the nature of the strip 282, and the cocking and disengaging thereof as explained, the total length of time involved in engaging and flexing the associated strips 264 is quite small, and the actual effective signal duration developed at the end of strip flexure is in the range of microseconds. It will be appreciated that the very high return speed of travel of the strip 282, and the extremely short signal duration, are developed using only the force derived directly from manual depression of the associated key; no motors or the like are employed.

Further, the disengagement of the nibs 286, 296 gives a positive tactile feedback at the key 224. Upon such disengagement, the pressure required to further depress the key is lessened, thereby giving an indication that the keying operation is completed.

Each of the strips 264 engaged and flexed by the posts 290 creates a corresponding output signal through the microswitch assembly 274. Specifically, the flexing of the respective strips pulls the associated arcuate region 280 thereof taut, with the effect that the engaged switch arm 278 is shifted slightly and actuated. This in turn creates an output signal at the microswitch, and the totality of signals from the assembly 274 for each key depression can be read and processed using conventional electronic circuitry (not shown) for this purpose. It will be understood in this respect that an individual pattern of engagement between the posts and strips will be provided for each key 224. Depression of a particular

key, therefore, will actuate a specific combination of different pluralities of the microswitches, and a distinguishable electricl signal will thereby be generated for each key. Each microswitch can be used in any of a variety of combinations of the nine switches available such that at least some of the microswitches will be part of more than one combination.

When the depressed key 224 is released, the flaps 240, 242 and the element 292 cooperatively serve to raise the key top back to its original starting position. Thus, the element 292 shifts rightwardly as viewed in Figs. 23-25 back to the original rest position thereof, and serves, with the assistance of the resilient flaps 240, 242, to quickly elevate the key. It will be observed in this respect that depression of a selected key 224 serves to develop an output signal corresponding to the letter or symbol of the key, and that only a single, momentary impulse is developed, which cannot be repeated until the key is released and redepressed. Specifically, when the element 282 is cocked and released and the impulse delivered to the appropriate strips 264, the element 292 cannot return to its original starting position until the key is released. These operational characteristics give the keyboard 220 a high degree of N-key rollover protection. This results from the fact that the output-creating movements being read are momentary, small, impulse movements that can occur only once per key depression. Because of the microsecond period during which the signals are developed in the present keyboard, it is highly unlikely from a statistical standpoint that the operator will create overlapping output signals.

Attention is next directed to Figs. 28-35, which illustrate the preferred manner of construction of the key set 222. As illustrated in Fig. 28, the key top structure is fabricated from a starting sheet 304 made up of an integral, thin polycarbonate sheet 306 laminated to a relatively thick, high density polyethylene backing 308. In this regard, a particular feature of the preferred method is that the sheet 306 can be back printed with desired letters, numbers or other symbols prior to lamination with the backing 308. This gives virtually unlimited flexibility in producing the key top structure at minimum cost, inasmuch as the use of costly and difficult to modify injection molds is completely eliminated. Further, because the marking of the key structures is achieved through a simple printing or photographic process, any color or style of letter or the like can be employed.

The next step involved in the key top manufacture involves molding of the laminated sheet 304 to present the key top structures in a desired pattern, i.e., with concave top walls 258, and continuous sidewalls 260. This can be accomplished in any known manner, such as by the vacuum forming procedure schematically illustrated in Fig. 29.

The next step involves die cutting of the formed sheet to substantially separate each of the hollow, open-bottom key top structures 256 from the starting sheet 304. This is done using a conventional die cutting apparatus 310 for this purpose, with blades designed to essentially separate each key top from the sheet 304, while leaving small connection regions 312 in each case.

The base member forming a part of the key set 222 is initially formed separately from the key top sheet. Referring to Fig. 22, it will be seen that the laminate made up of the base sheet 234 and backing layer 236 is first die cut to present respective flaps 240, 242, and to cut the beveled rearward edge 238. It will be noted in this respect that in plan configuration the flaps are substantially triangular in shape.

In the next step the respective lines of weakness 244, 246 and 248 are made in the sheet, along with the recesses 250, 252 and 254 (see Fig. 34). (If desired, the recesses can be molded into the starting sheet.)

In the final step of key set manufacture, the flaps 240, 242 are adhesively secured to the inner surfaces of the depending sidewalls of corresponding key tops 256. During the final connection of these components, the key tops 256 are completely separated from one another by severance of the regions 312, so that the key tops are independent of one another and operatively secured to the underlying flaps 240, 242. An exemplary connection apparatus 314 is illustrated in Fig. 35.

The apparatus 314 includes a first sheet-supporting plate 316 having a series (one for each key of the ultimate set) of upstanding elements 318 terminating in uppermost, tapered, key-supporting blocks 320. The apparatus also includes a second plate 322 having a series of upstanding, spaced apart, somewhat inverted L-shaped members 324 presenting an uppermost horizontal die surface 326 and a vertical flap engaging face 328. The overall apparatus further includes a plate 330

having a series of elongated, spaced apart fingers or bars 332. Each of the bars 332 presents a recess 334 along the length thereof, and, as will be explained, serves as a tab punch die during use of apparatus 314. Finally, the overall apparatus has a cooperating upper member 336 which receives the preformed key top structures and allows seating thereof against the upper margins of the respective flap pairs. The upper member 336 carries a series of tab punches 338 and 340, and is formed along the underside thereof to present a series of key-receivng recesses 342.

In the use of apparatus 314, the plate 330 is removed, along with upper member 336, an secondary plate 322 is shifted leftwardly from its Fig. 36 position to a point where the upright lateral faces of adjacent elements 318 and L-shaped members 324 are in contact. At this point the base sheet depicted in Fig. 32 is placed on the horizontally extending stretches of the members 316, with the respective flap pairs extending upwardly in engagement with orthogonal faces of the upright portions of the members. In the next step, the secondary plate 322 is shifted rightwardly to its Fig. 36 position, such that the faces 328 of the member 234 engage one of the flaps of each flap pair and press the same firmly against the corresponding elements 318. The multiple-bar plate 330 is next passed over the base sheet and between key rows such that the side faces of the bars engage adjacent upright flaps and press the latter against the proximal faces of the elements 318. At this point, by virtue of the faces 328 of the members 324, as well as the bars 332, both flaps of each respective flap pair are securely

held in place against a croresponding element 318. Note in this respect that the uppermost triangular portions of the respective flaps extend above the upper surface of the plate 330.

In the next operational step, glue is applied to the outer surfaces of the flap upper margins, and the preformed sheet 304, located in conforming relationship within the upper member 336, is placed atop the plate 330 with each recessed key top structure receiving a corresponding tapered block 320 (see Fig. 35). An adhesive connection is thus formed between the upper triangular portions of each flap pair and an associated key top.

The shiftable tab punches 338, 340 are next separated to sever the respective key tops from the remainder of the sheet 304, so that each key top is independently connected to a separate flap pair. The apparatus 314 is then disassembled, and the resultant key top structure removed.

It will be apparent to those skilled in the art that the keyboard structure of the present invention possesses a number of advantages not heretofore available in any single unit. For example, the disclosed keyboard has minimum depth which is in effect the sum of the chassis thickness and the desired key stroke. The upper extent of the key tops can occur at a point just above the key stroke minimum or it may be at whatever height is desired for a given application. This minimum depth with full key stroke capability is in itself a considerable advantage. At the same time however, the structure of the key set with upstanding flaps gives the individual keys good stability in torsion with relative flexibility in

folding or collapsing such that when depressed the keys will travel in a stable and essentially linear path without unacceptable side sway or wiggle. This is true even if the key is depressed off center or at an angle to its designed line of depression travel. Further, these results are accomplished in an inexpensive, easily manufactured construction.

The key top structure is also highly advantageous in that it is not limited either by the cost complexity of present key tops, or in the color, shape or indicia desired thereon. In sharp contrast to prior key sets, the present construction can be made at a fraction of the cost and in a form that is ideally suited for mechanized, high volume fabrication.

As noted above, tactile feedback is inherent in the present keyboard design. Further, the amount of feedback can be increased or lessened as desired through the simple expedient of employing materials of different resilience for the U-shaped elements.

It will also be observed that N-key and rollover filtering is handled mechanically by virtue of the momentary impulse characteristic of the output device of the invention. Such relatively minor mechanical movements at the encoding strips require neither circuitry, circuit boards or special and elaborate logic systems. Additionally, the elimination of circuit boards and complex wiring normally associated with key switches further reduces the basic cost of the keyboard, and allows for a wide variety of key encoding and key top positions with minimal tooling investments. It is believed that no prior keyboard has ever

been devised that mechanically creates a direct momentary inpulse movement which is rollover and N-key protected. Further, it is believed that it is novel to accomplish these functions with structure which at the same time provides tactile feedback.

The present keyboard serves to encode impulse mechanical movements at the coding chamber where a matrix exists which can be quickly modified and adjusted to produce any desired encoding at the key without expensive retooling. This is to be contrasted with typical keyboards which are coded either mechanically or electrically. In either case, the coding is done once for any given keyboard and is thereafter limited to the mechanical hardware or encoder circuitry selected.

Typical mechanical encoding through coding bars not only limits the quickness of response (by virtue of the mass of the code bars), but also fixes the code to a given mechanical form (tooling limits) and is subject to false output from anomalies in vibration from the keyboard. The penchant of certain known typewriters to automatically type a hyphen symbol if they keys are vibrated in a certain way is the result of this phenomenon. The flexible encoding strips of the present keyboard allow for extremely rapid impulse movements and response, but because of the very low mass of the synthetic resin encoding strips, vibration phenomena are all but eliminated.

In the keyboard of the invention, the ends of the encoding strips are read or sensed. This reading is of a small mechanical movement caused by the flexure of the strips as described. It will be apparent in this regard that virtually any reliable form of sensing small momentary

movement can be used, including direct mechanical actuation from the encoding strip. Hence, the present keyboard can be linked up to a strictly mechanical or electric device for reading purposes. By way of example, photoelectric, Hall effect, capacitance, contact or strain sensors can be employed. Further, a number of readers or sensors required is limited to the number of encoding strips, and unlike electronic keyboards a key switch or reader is not required at each key. Because of this, high quality reading or sensing can be provided at very low cost. Finally, due to the flexure movement employed, there are virtually no parts to wear out or become fouled. It is believed that the present keyboard has less maintenance and wear problems than the typical key switch assembly of an electronic keyboard, and far less than that of a typical lever keyboard.

All of the above factors ultimately relate to the reliability of the present keyboard. The reliability of any keyboard that is equipped with quality readers or sensors is limited basically by the useful life of the relevant mechanics, and the latter is closely related to stresses, tolerances, and number of required parts. By virtue of the very simple design and low number of parts, the keyboard hereof can be manufactured to meet or exceed the reliability and useful life of any known keyboard, and at a significantly lower cost.

CLAIMS

1. A keyboard, comprising:

a plurality of keys;

shiftable means supporting said keys for individual, selective depression thereof;

an engagement surface operably coupled and shiftable with each of said keys;

an elongated, deflectable, resilient flipper associated with each key and having a striking portion and a rest position;

selectively actuatable means for generating an electrical output signal upon striking thereof and located adjacent said flipper striking portions;

means mounting each of said flippers for engagement thereof by the engagement surface coupled with said associated key, upon depression of the associated key, in order to shift said striking portion of said flipper away from said signal-generating means;

structure for releasing each of said flippers from the engagement surface coupled with the associated key, when the striking portion of the flipper has been shifted away from said signal-generating means a predetermined distance,

each of said flippers being constructed and arranged for, upon said release thereof, rapidly and freely shifting the striking portion thereof toward said signal-generating means in a manner to overtravel the rest position of the flipper and thereupon strike and actuate said signal-

generating means, and for thereafter shifting said flipper back to the rest position thereof after said striking and actuation of the signal-generating means, the duration of contact time between said flipper striking portions and said signal-generating means being independent of the duration of depression of the corresponding keys,

said shifting of said flipper striking portion upon said release of the flipper being independent of any subsequent movement of the corresponding key.

2. A keyboard, comprising:

a plurality of keys;

means supporting said keys for selective depression and return movement thereof, including--

an elongated, generally horizontally extending arm secured to each key respectively,

at least certain of said arms extending in a first direction,

others of said arms extending in a second direction different than said first direction; and

means mounting each of said arms for pivotal movement thereof about generally horizontal axes spaced from the associated key, and

means for developing a keyboard output corresponding and in response to depression of particular keys.

3. A keyboard as set forth in Claim 2, said mounting means comprising:

a pair of spaced, opposed, upstanding sidewalls respectively located adjacent the ends of said certain arms and said other arms remote from the secured keys;

pivotal connection structure pivotally securing the adjacent arm ends to said sidewalls; and

means for limiting the pivotal travel of each of said arms to a predetermined arc.

4. A keyboard as set forth in Claim 3, said axes lying in horizontal planes which intersect said arcs.

5. A keyboard, comprising:

a plurality of keys arranged in at least two proximal rows;

means supporting said keys for selective depression and return movement thereof, comprising --

an elongated, generally horizontally extending arm secured to each key respectively and having an engagement surface thereon,

first arms secured to the keys of one of said rows extending in a first direction,

second arms secured to the keys of another of said rows extending in a second direction generally opposed to said first direction;

means mounting said first arms for independent pivotal movement thereof about a first axis spaced from the keys secured to the first arms and above the first arms, and for limiting the pivotal movement of the first arms to a predetermined first arc, said first axis lying in a first horizontal plane which intersects said first arc; and

means mounting said second arms for independent pivotal movement thereof about a second axis spaced from the keys secured to the second arms and above the second arms, and for limiting the pivotal movement of the second arms to a predetermined second arc, said second axis lying

in a second horizontal plane which intersects said second arc;

means for developing a keyboard output corresponding to the depression of particular keys; and

structure operably coupling said keys and output means, comprising --

an elongated, deflectable, resilient flipper for each of said arms and having a rest position;

means mounting first flippers associated with said first arms in a cantilever fashion with the free ends of the first flippers extending to a point for engagement by said surfaces on the first arms, when the keys mounted on the first arms are depressed, in order to deflect the first flippers;

means mounting said second flippers associated with said second arms in a cantilever fashion with the free ends of the second flippers extending to a point for engagement by said surfaces on the second arms, when the keys mounted on the second arms are depressed, in order to deflect the second flippers; and

structure for releasing each of said first and second flippers from the corresponding engagement surfaces when the flippers have been deflected a predetermined amount, and for thereafter permitting the flippers to return to a rest positions thereof,

said output means including apparatus for sensing the movement of said flippers.

6. In a keyboard:

an elongated output member having a plurality of spaced electrical contact switch zones along the length thereof;

a plurality of elements respectively associated with said switch zones, each of said elements having a contact switch area thereon configured for engaging the associated switch zone of said member;

means mounting said elements adjacent said output member with the switch areas of the elements being normally spaced from said associated switch zones;

means for selective movement of said elements such that the switch areas thereof contact the associated switch zones, said output member including structure for generating a respective electrical output signal in response to the contact of each of said element switch areas and the corresponding switch zones, said moving means including--

means for selectively shifting each of the element switch areas away from the corresponding associated switch zones, comprising a manually depressible key for each element, and means operably coupling each key and its corresponding element;

structure for releasing said element switch areas after the same have been shifted away a predetermined amount,

each of said element switch areas being configured and arranged for return

shifting back toward said associated switch zone and impact engagement of the associated switch zone, said return shifting and impact engagement being independent of the duration of depression of the corresponding key; and

means operably coupled to said output member for determining which of said switch zones has been impacted.

7. A keyboard, comprising:

a plurality of separate, depressible keys;

means mounting said keys for individual, selective movement thereof through respective keystroke distances;

a resilient element associated with each key respectively;

means shiftably mounting each of said elements proximal to the corresponding key, with the elements each having and being biased toward a rest position;

shifting means operably coupled with each key for engaging and shifting the associated element against said bias and during said movement through the respective keystroke distance;

disengaging means for each key for disengaging said associated element from said shifting means prior to completion of said movement of the corresponding key through the respective keystroke distance, in order that said associated element will commence return movement back toward said rest position before the corresonding key travels the full keystroke distance, and such that said associated element will overtravel the rest position thereof before returning to its rest position; and

means for sensing said overtravel shifting of said elements, and for generating electrical output signals corresponding to said sensing, including--

a plurality of selectively actuatable devices for generating electrical

signals; and

means operably coupling each of said elements, upon said overtravel shifting thereof, with at least one of said signal-generating devices for actuation of the latter, at least certain of said elements being operably coupled, upon said overtravel shifting thereof, with respective, different pluralities of said first-mentioned plurality of signal-generating devices, whereby respectively distinguishable electrical signals will be generated for each key upon depression thereof.

8. The keyboard as set forth in Claim 7, wherein at least some of said signal-generating devices form a part of more than one of said respective, different pluralities.

9. A set of individually depressible keys for use in a keyboard and comprising:

an integral synthetic resin sheet cut to present a plurality of individual upstanding flaps; and

a plurality of keys respectively secured to separate flaps,

each of said flaps being configured for collapsing downwardly when a downwardly directed force is applied to the associated key for effecting depression of the key.

10. The key set as set forth in Claim 9, each of said flaps being provided with three, spaced, transversely extending fold lines for said collapsing and return movement thereof.

11. A keyboard, comprising:

a plurality of separately, manually depressible keys;

a resilient element associated with each key respectively;

means shiftably mounting each of said elements proximal to the corresponding key, with the elements each having a rest position;

shifting means operably coupled with each key for shifting the associated element in a first direction in response to manual depression of the corresponding key and using only the force developed through said manual depression thereof;

means for disengaging each of said elements from the corresponding shifting means therefore during said manual depression of the corresponding key, for permitting the disengaged element to freely travel in a second direction opposite said first direction to an extent that the disengaged element overtravels said rest position thereof before returning to its rest position, the speed of travel of each element in said second direction being substantially in excess of the speed of travel of the corresponding keys during said depression thereof;

means for sensing said overtravel shifting of said elements, and for generating electrical output signals corresponding to the sensing of said overtravel shifting of said elements, including--

a plurality of selectively actuatable devices for generating electrical

signals;

means for operably coupling each of said elements, upon said overtravel shifting thereof, with at least one of said signal-generating devices for actuation of the latter, at least certain of said elements being operably coupled, upon said overtravel shifting thereof, with respective different pluralities of said first-mentioned plurality of signal-generating devices, whereby respectively distinguishable electrical signals will be generated for each key upon depression thereof.

12. The keyboard as set forth in Claim 11, wherein at least some of said signal-generating devices form a part of more than one of said respective, different pluralities.

13. A keyboard, comprising:

a plurality of separate, depressible keys;

an elongated, resisilient, deformable element associated with each key respectively;

means mounting each of said elements proximal to the corresponding key, each of said elements having a rest position configuration;

means operably associated wtih each key for deforming and thereby increasing the potential energy of the associated element, in response to depression of the corresponding key, and for thereafter releasing the deformed, associated element and allowing the same to move and expend said increased potential energy, said movement including overtravel shifting of the element past said rest position thereof; and

means for sensing said overtravel shifting of said elements, and for generating electrical output signals corresponding to said sensing, including--

a plurality of selectively actuatable devices for generating electrical signals;

means for operably coupling each of said elements, upon said overtravel shifting thereof, with at least one of said signal-generating devices for actuation of the latter, at least certain of said elements being operably coupled, upon said overtravel shifting thereof, with respective, different pluralities of said first-mentioned plurality

of signal-generating devices, whereby respectively distinguishable electrical signals will be generated for each key upon depression thereof.

14. The keyboard as set forth in Claim 13, said coupling means including structure for actuating the corresponding signal-generating devices upon momentary impact of the coupling means, each of said elements being configured and arranged for momentary impact engagement with one or more of said coupling means during said over-travel shifting of the element.

15. The keyboard as set forth in Claim 13, said elements, in said rest positions thereof, are spaced from the corresponding signal-generating devices.

16. The keyboard as set forth in Claim 13, wherein at least some of said signal-generating devices form a part of more than one of said respective, different pluralities.

17. A keyboard output device for use with a keyboard having a plurality of individual, manually depressible keys for developing momentary output corresponding to the depression of particular keys and comprising:

a plurality of elongated, resilient spaced apart encoding strips;

linkage means operatively coupled with each key for, upon depression of the key, momentarily engaging and flexing one or more of said strips in a predetermined individual pattern for each key, the linkage means coupled with at least certain of said keys being disposed for momentarily engaging and flexing a plurality of said strips,

the duration of engagement time between said one or more strips and said linkage means for each key being independent of the duration of manual depression of the key; and

means for sensing the momentary engagement and flexure of said encloding strips, and for generating corresponding electrical output signals.

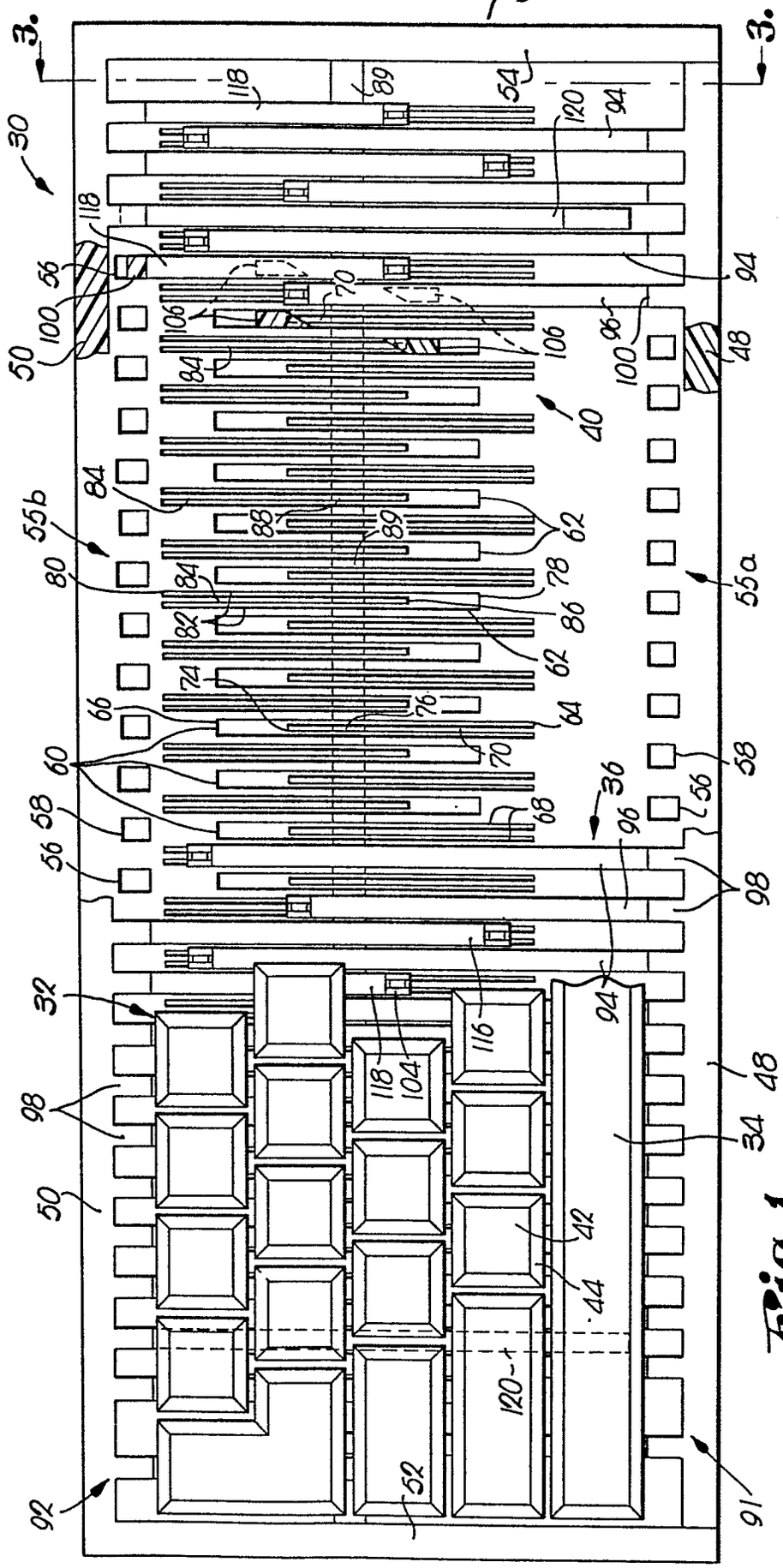


Fig. 1.

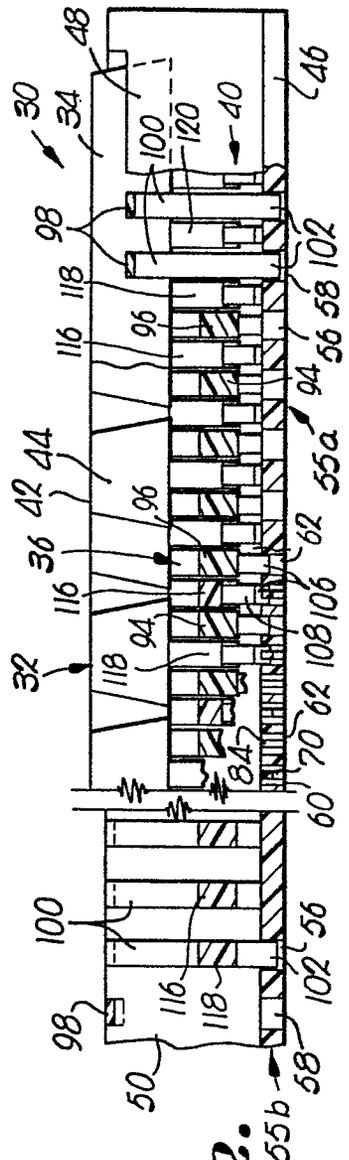
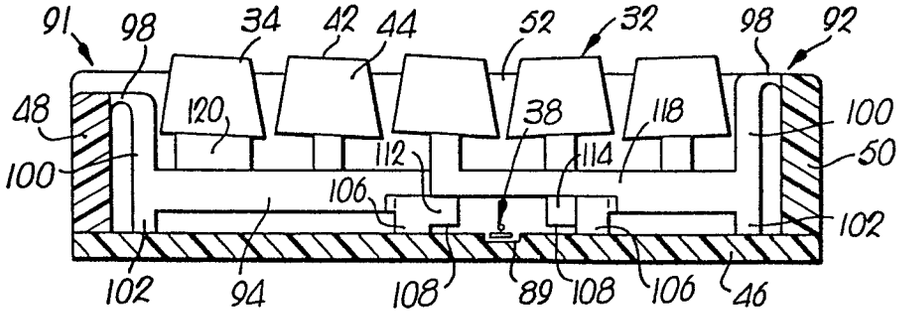


Fig. 2.

Fig.3.



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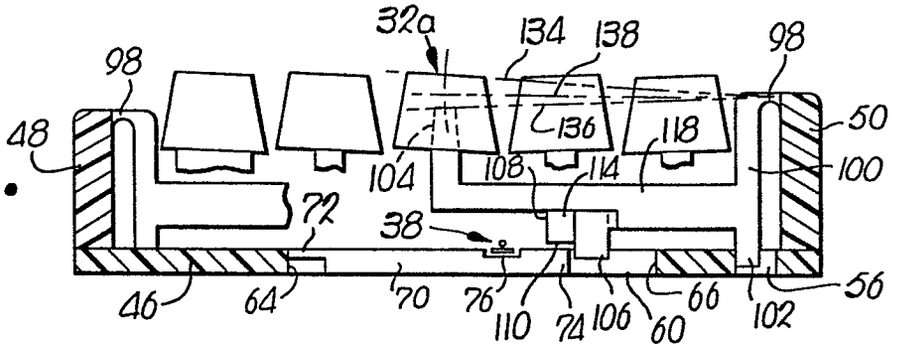


Fig.5.

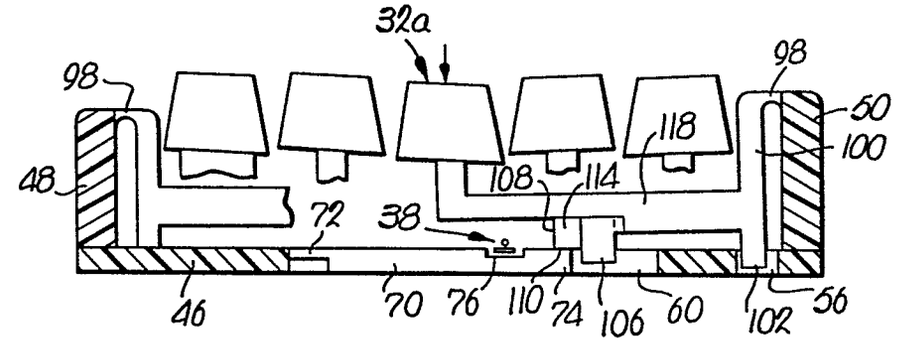


Fig.6.

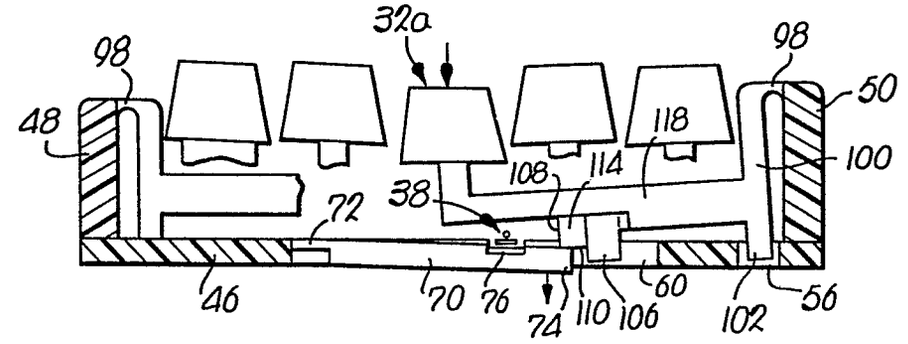
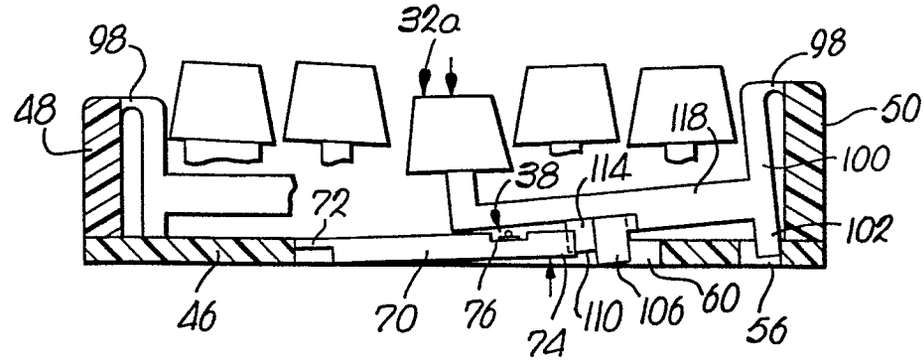


Fig.7.



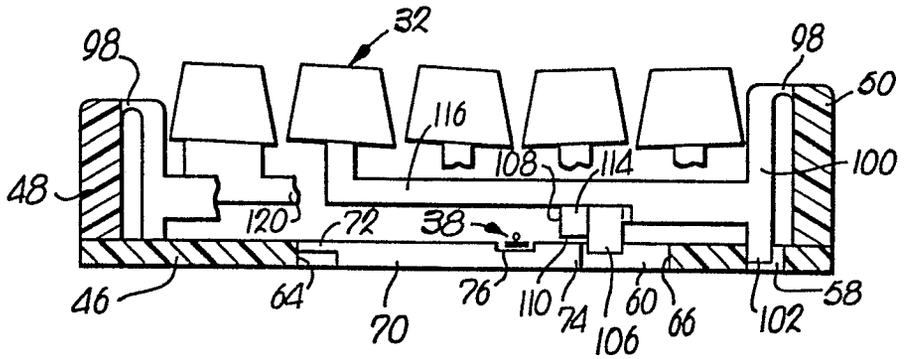
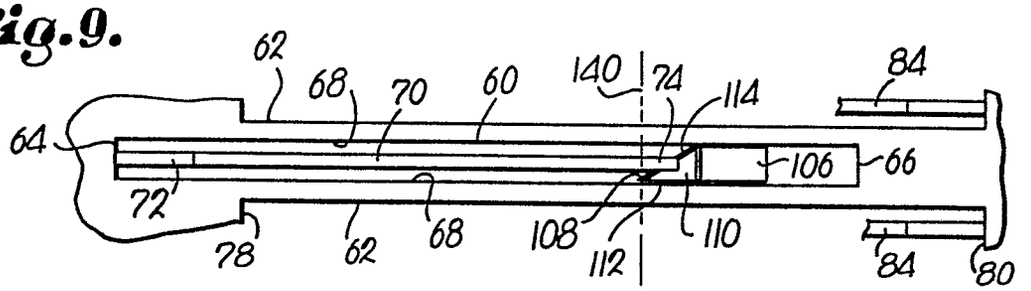


Fig.8.

Fig.9.



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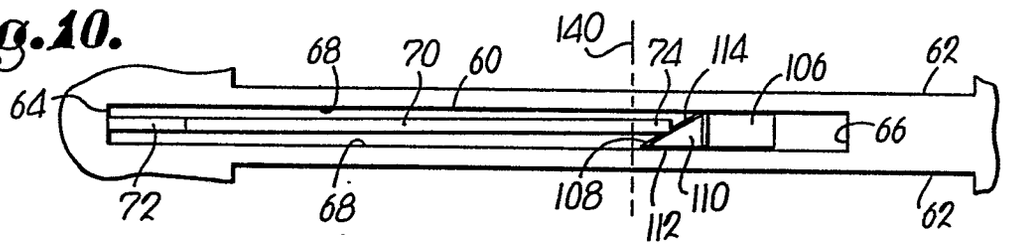

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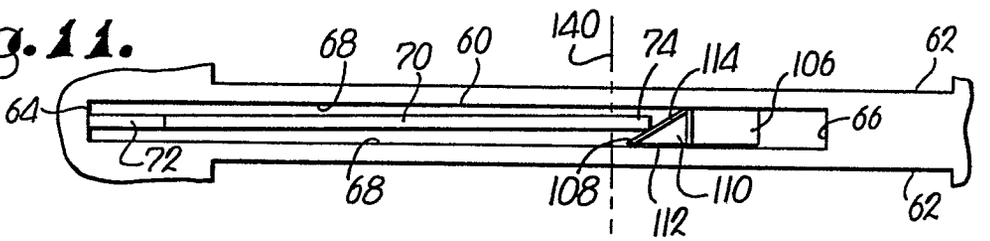

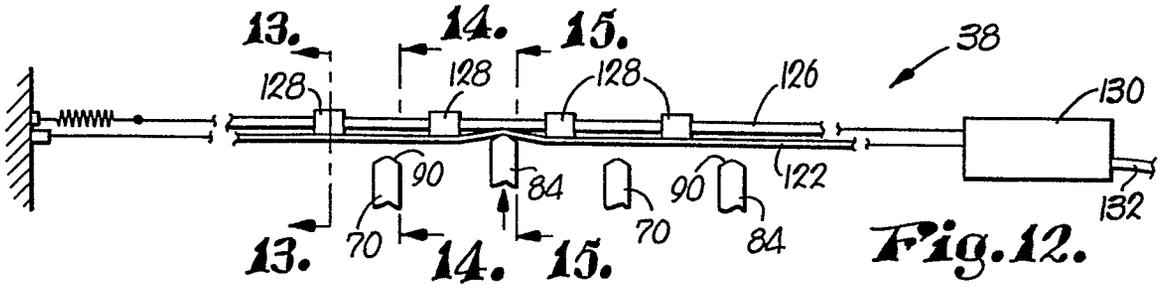

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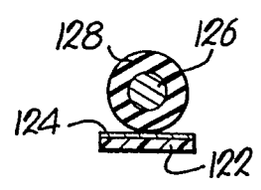
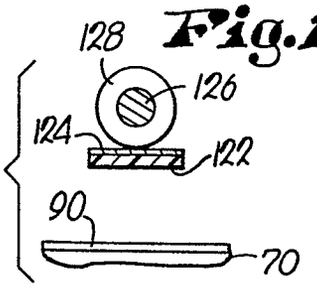
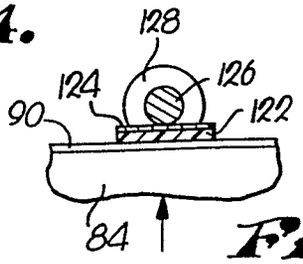


Fig.13.

Fig.14.





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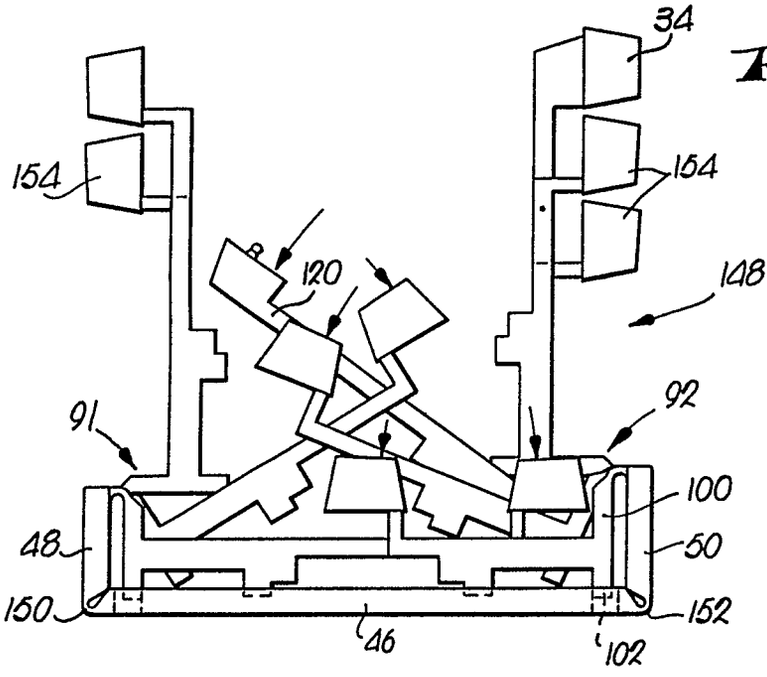

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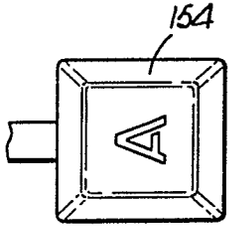

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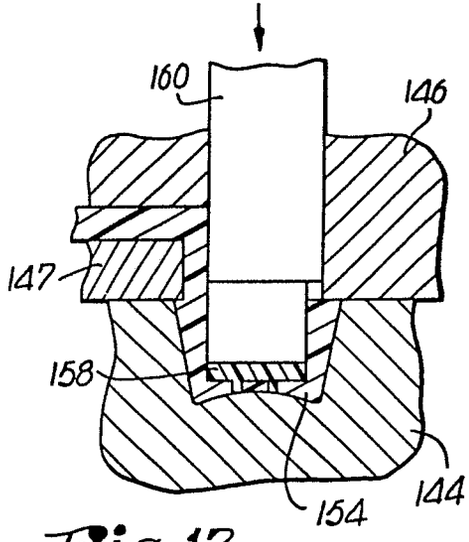

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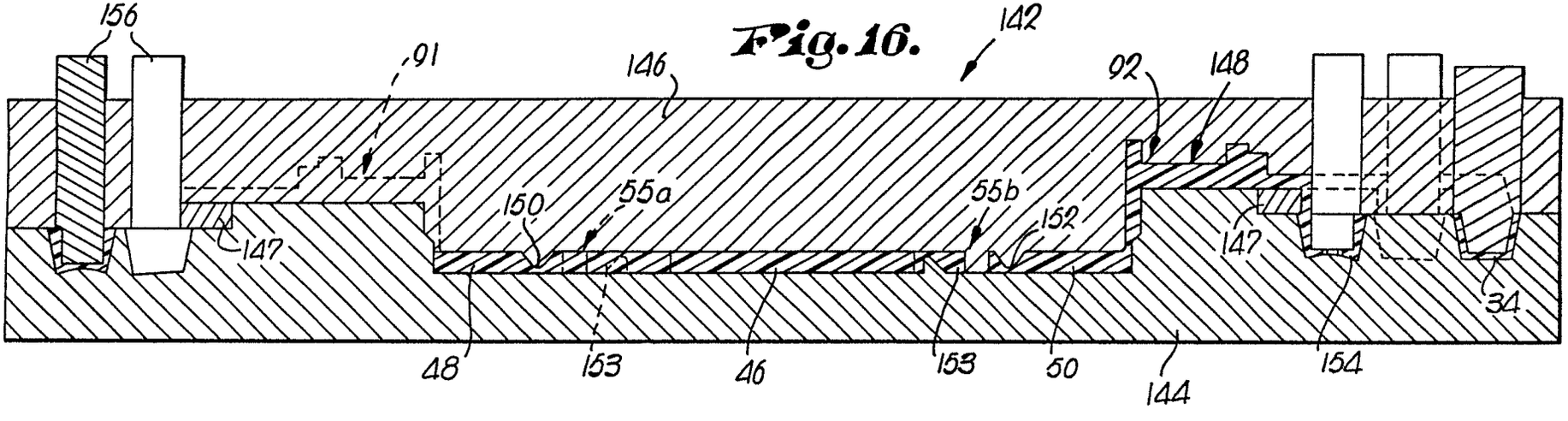

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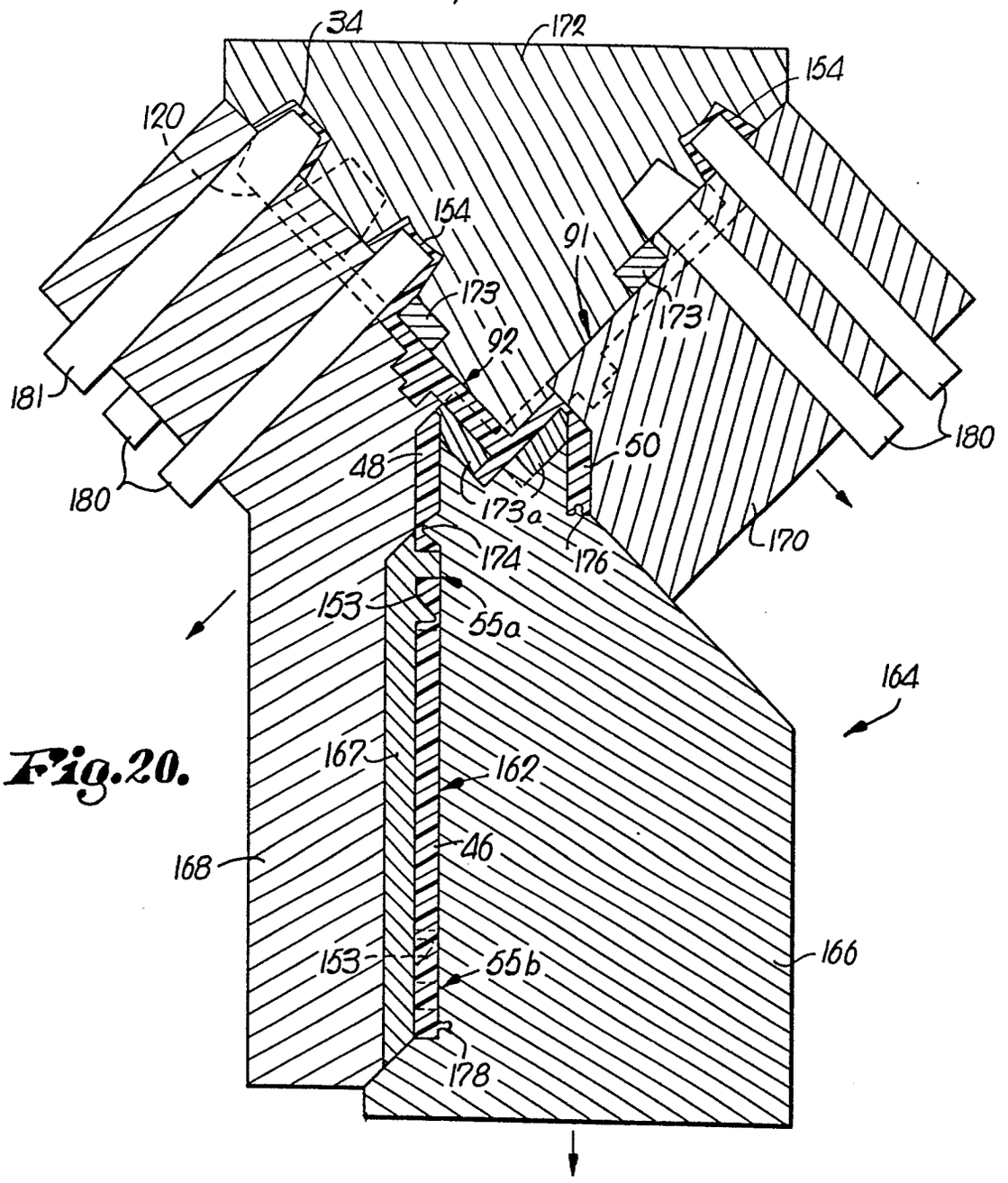
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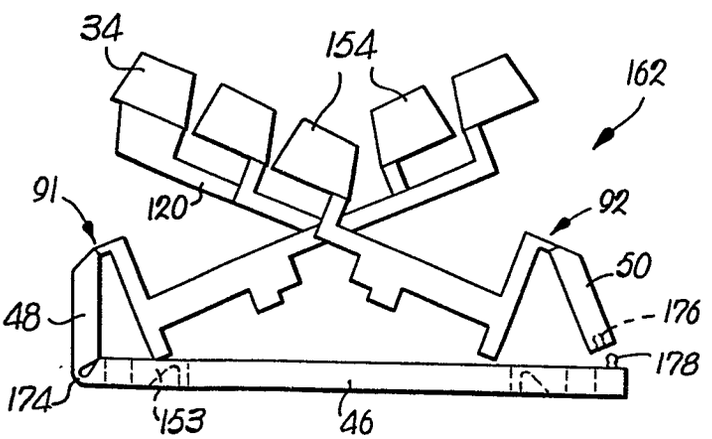
Fig.20.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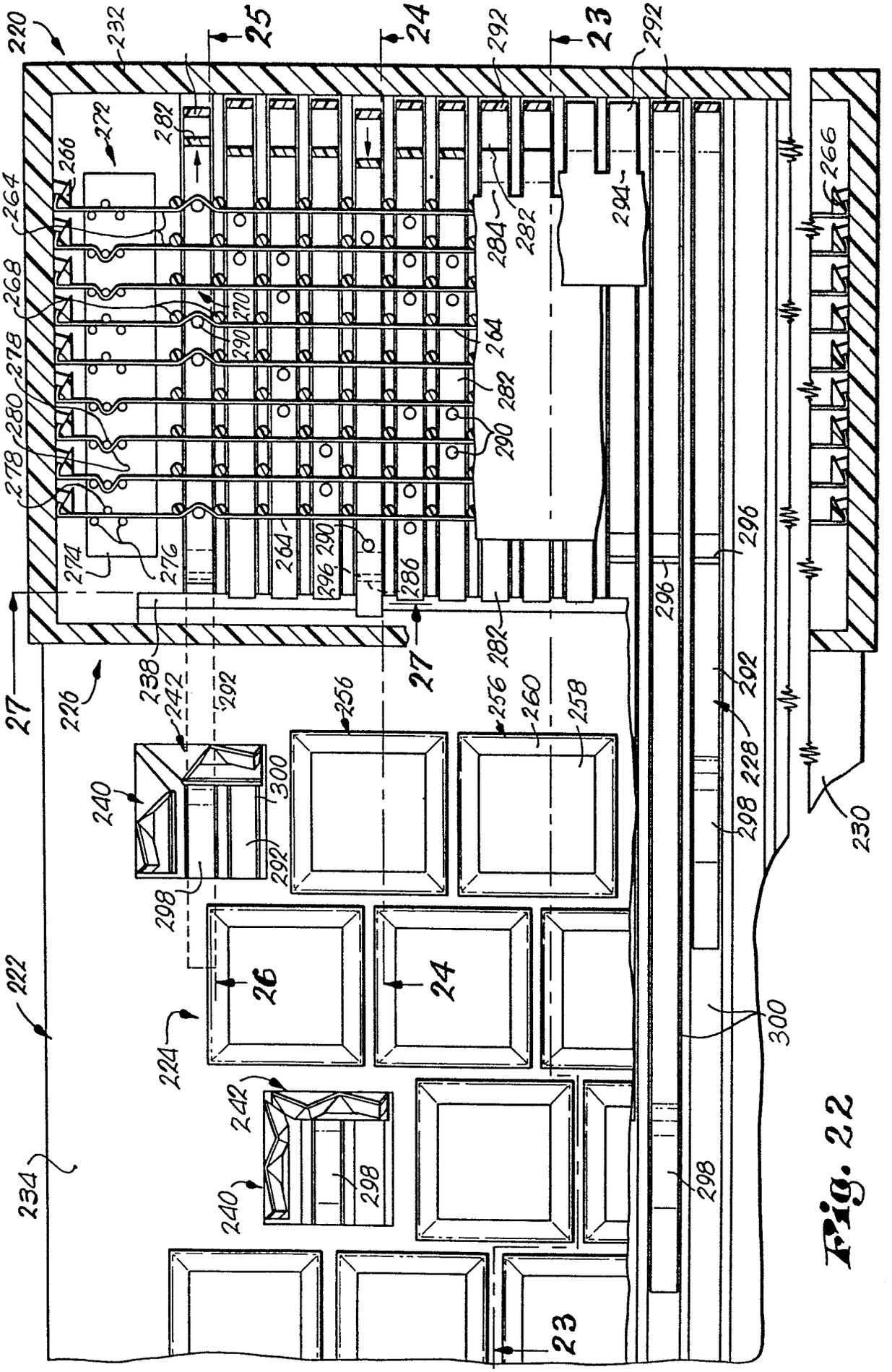
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Fig. 22

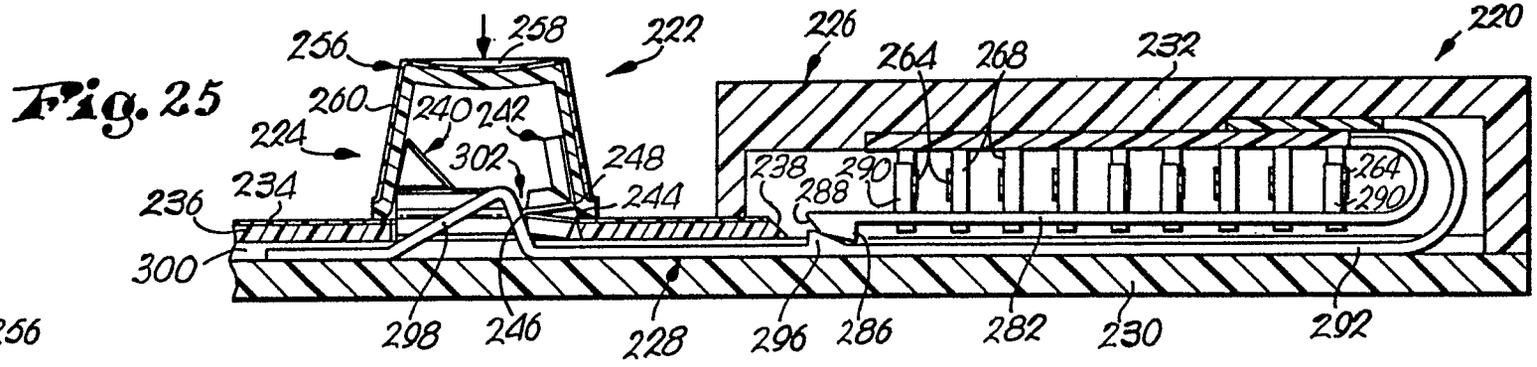
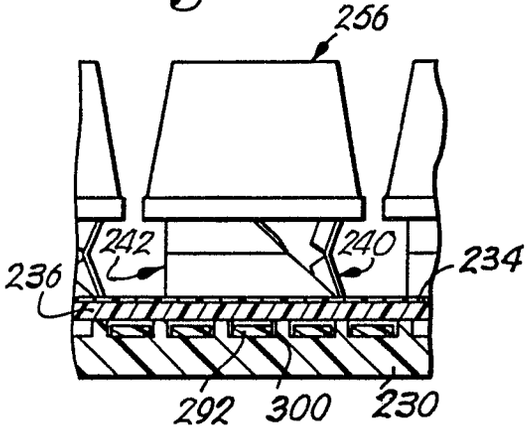


Fig. 25

Fig. 26



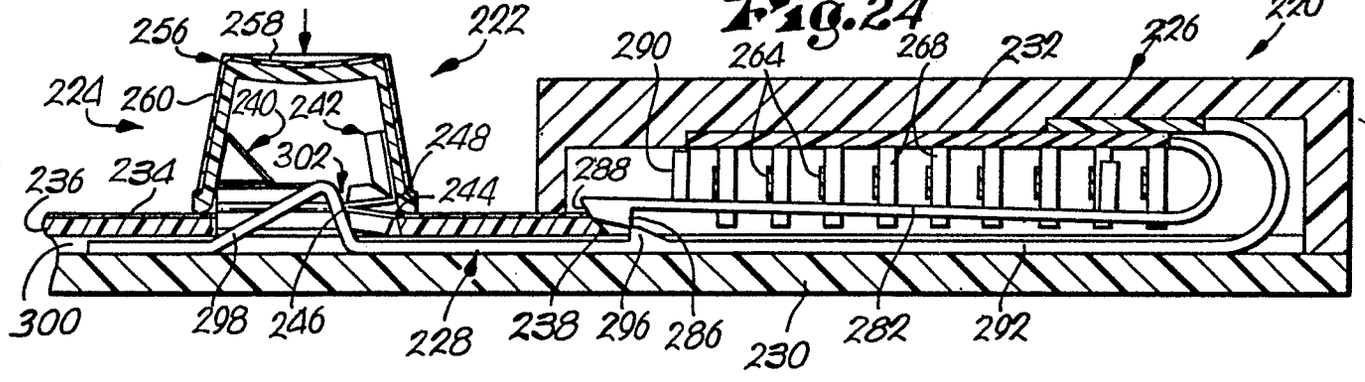


Fig. 24

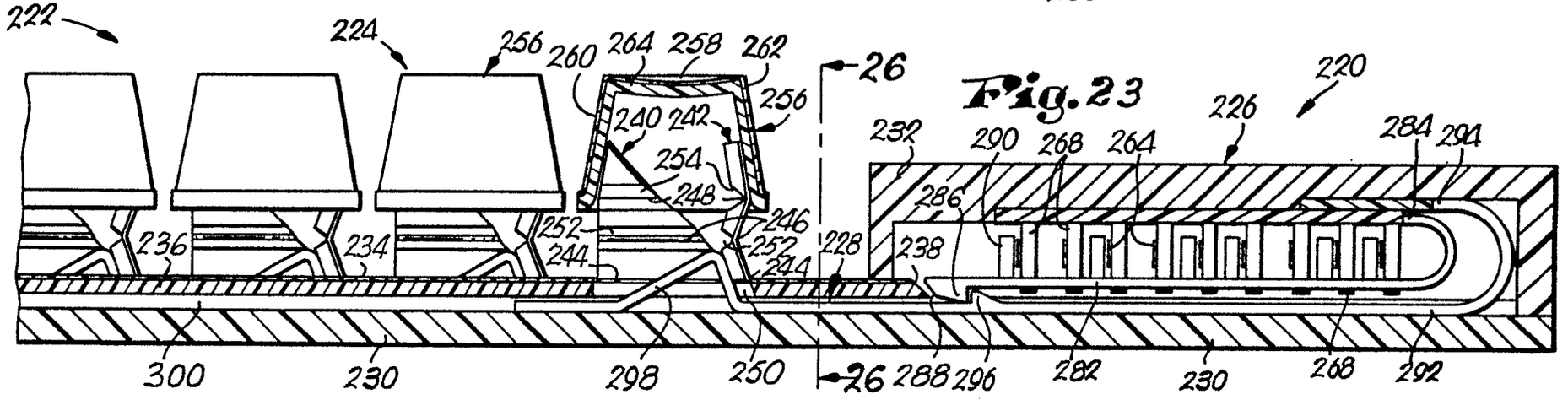


Fig. 23

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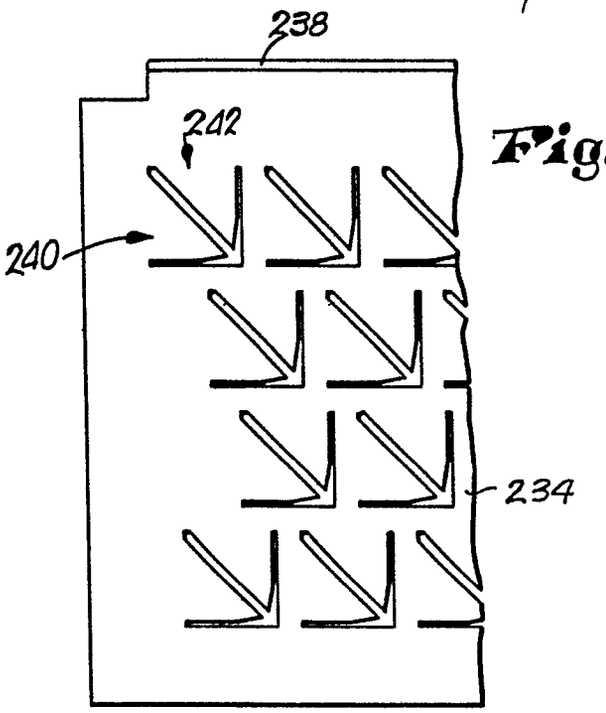


Fig.32

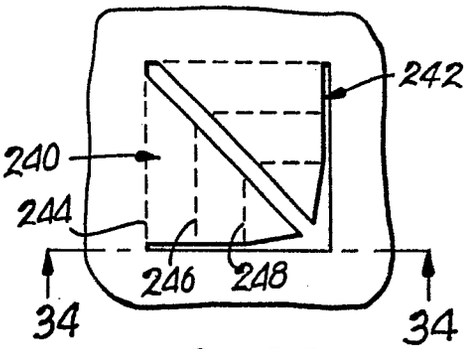
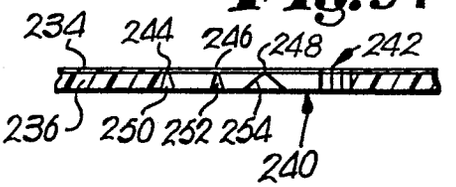


Fig.33

Fig.34



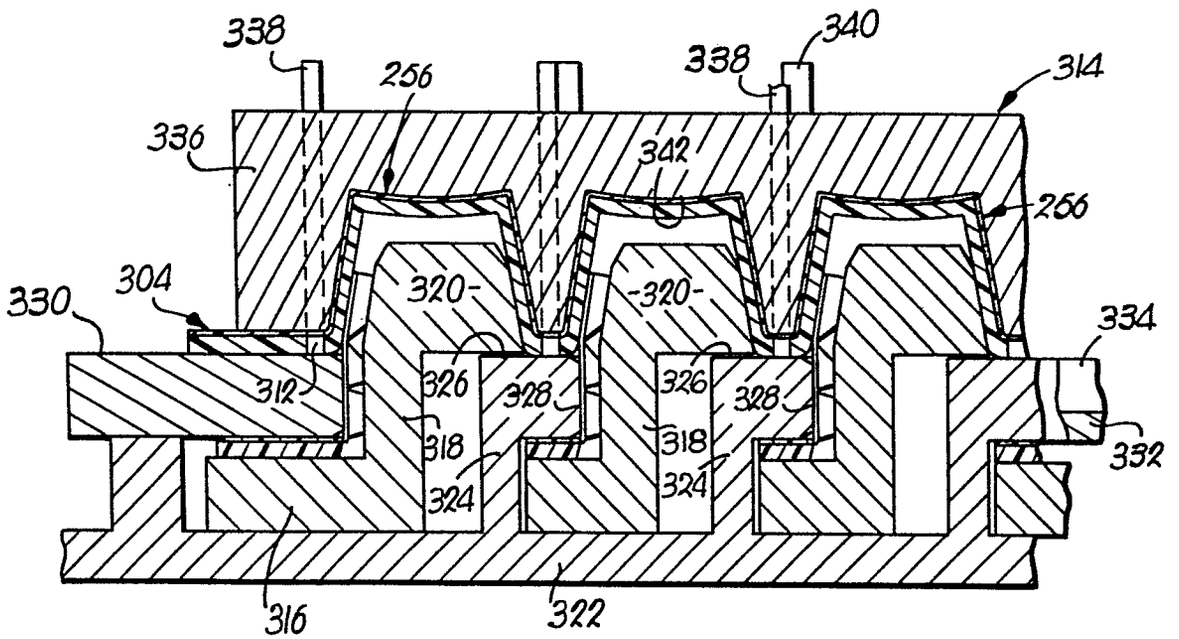


Fig.35

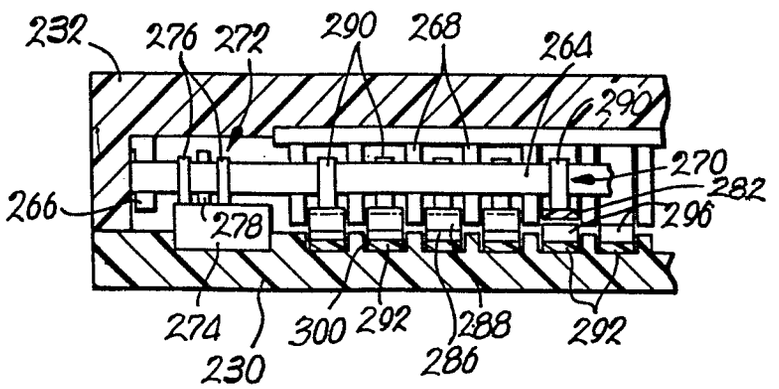


Fig.27

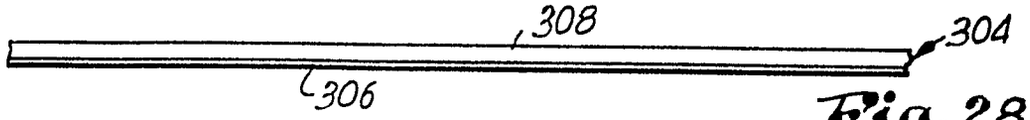


Fig.28

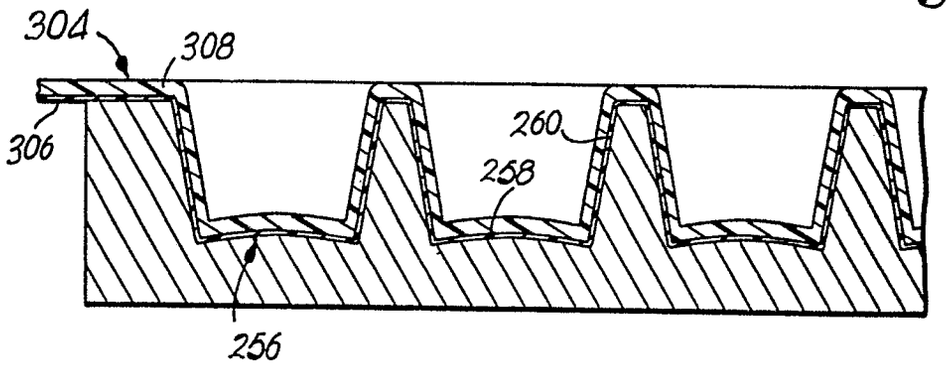


Fig.29

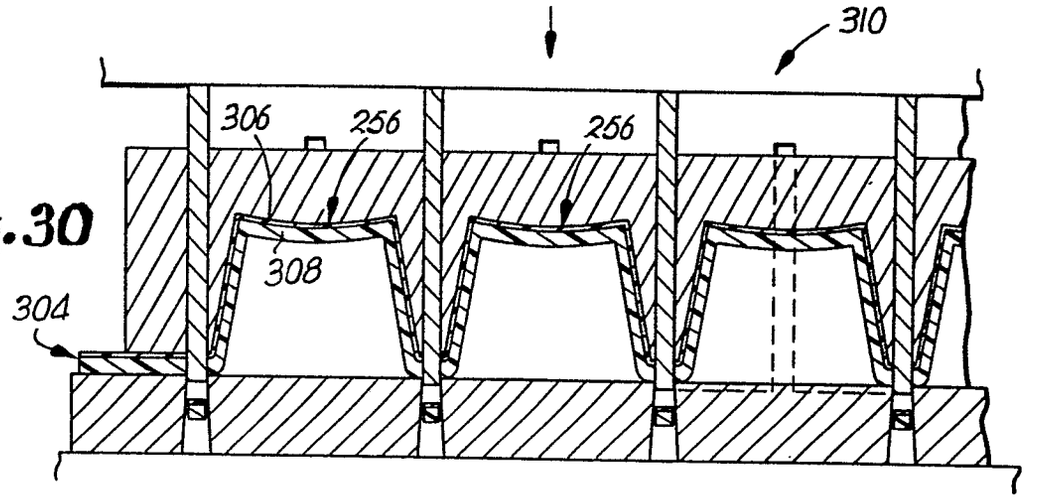


Fig.30

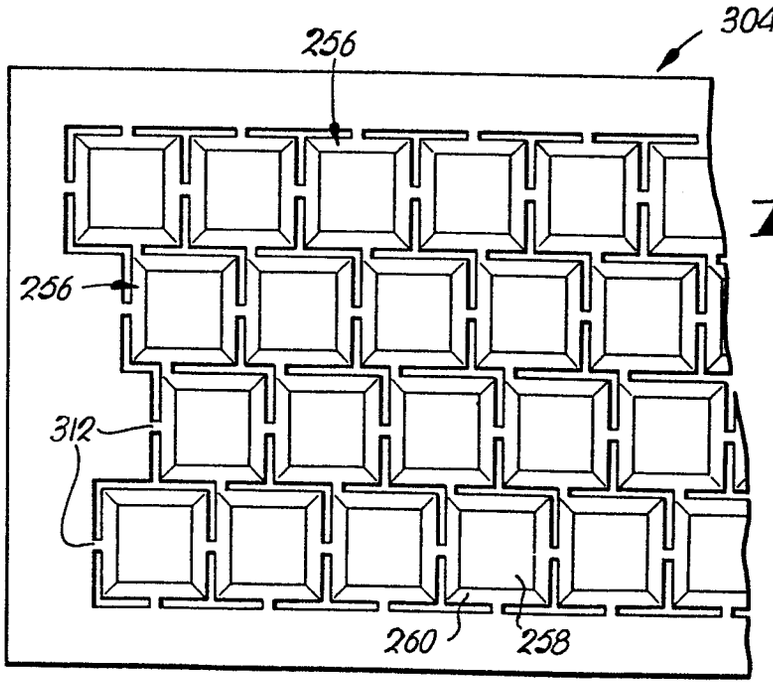


Fig.31

European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 82 30 3631

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
Y	US-A-3 472 974 (AUTOMATIC ELECTRIC LAB.) * Column 3, line 8 - column 4, line 65 *	1,2,4	H 01 H 13/70
Y	US-A-3 909 564 (A.M.P.) * Column 2, line 37 - column 3, line 6 *	1	
Y	GB-A-1 171 082 (F.P. WILLCOX) * Page 8, lines 24-80 *	1	
A	US-A-3 120 584 (WESTERN ELECTRIC COMPANY) * Figure 1 *	1	
			TECHNICAL FIELDS SEARCHED (Int. Cl. ³)
A	IBM TECHNICAL DISCLOSURE BULLETIN, vol. 23, no. 10, March 1981, pages 4548-4549, New York, USA N.K. PERKINS et al.: "Molded spring keyboard" * Pages 4548-4549 *	1	H 01 H 13/00
A	US-A-3 811 024 (ALCO ELECTRONIC PRODUCTS) * Figures 1,2 *	1	

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	31-03-1983	JANSSENS DE VROOM P.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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E : earlier patent document, but published on, or after the filing date
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EUROPEAN SEARCH REPORT

Application number

EP 82 30 3631

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)

L,E	US-A-4 359 613 (ENGINEERING RESEARCH APPLICATIONS) * Whole document *	1-14	

L,E	US-A-4 359 612 (ENGINEERING RESEARCH APPLICATIONS) * Whole document *	1-14	

TECHNICAL FIELDS SEARCHED (Int. Cl. ³)

The present search report has been drawn up for all claims

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