Feb. 6, 1973 D. B. JACKSON ET AL 3,715,023

CAM-AND LINKAGE ARRANGEMENT FOR SIMULTANEOUS MOVEMENT OF MULTIPLE KEYSTEMS CONNECTED TO A COMMON KEY

Filed Aug. 7, 1970 2 Sheets-Sheet 1

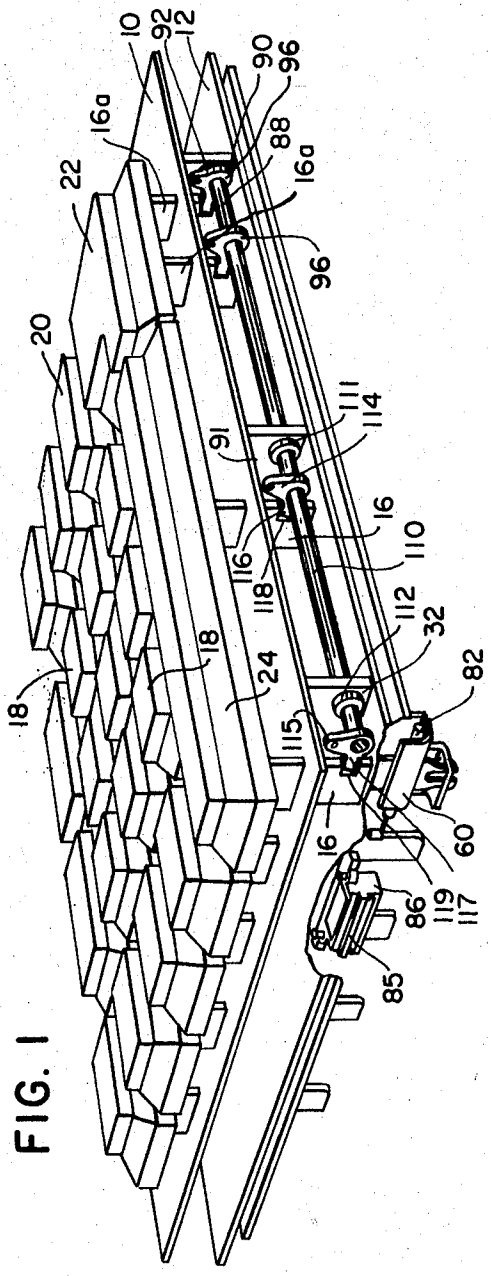

FIG. 1

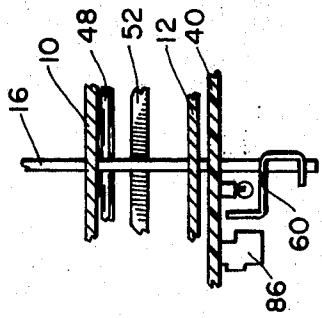

FIG. 5

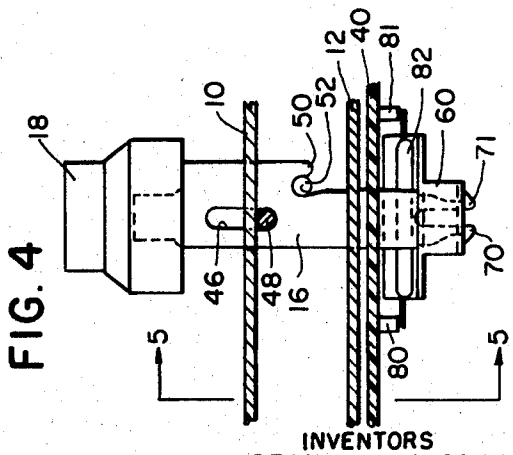

FIG. 4

INVENTORS
DEAN B. JACKSON
EDWARD S. STORK &
DARRELL L. FLORY

BY Louis A. Kline
Wilbert Hawk, Jr.
Geo. J. Muckenthaler

THEIR ATTORNEYS

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FIG. 2

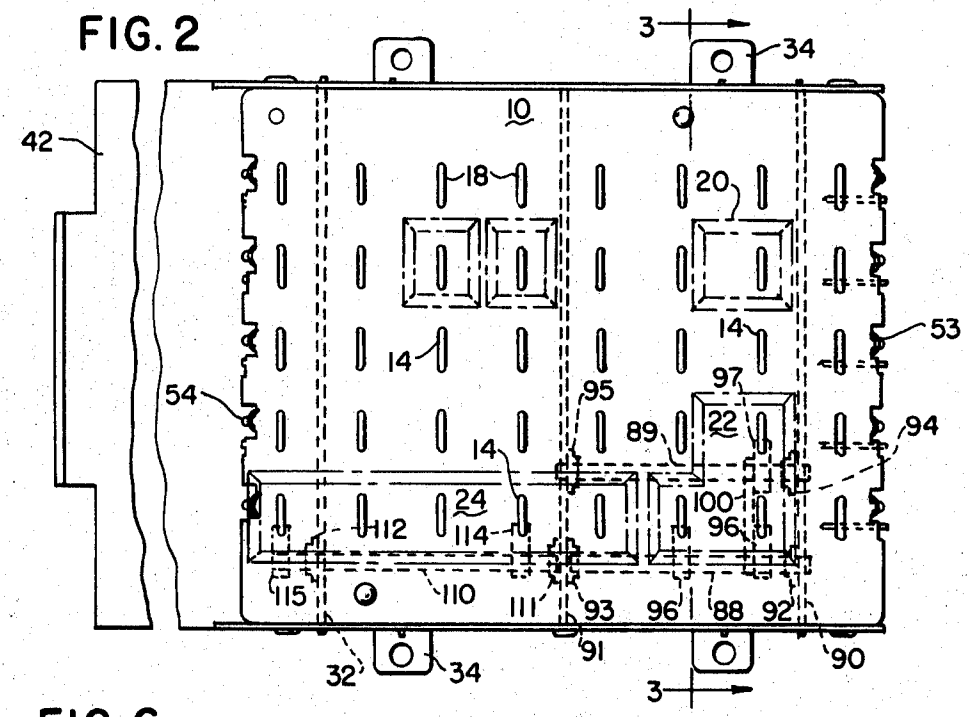


FIG. 6

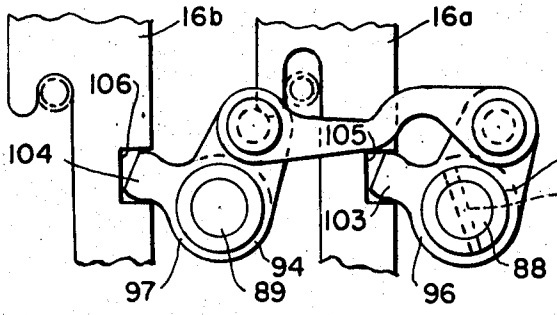


FIG. 7

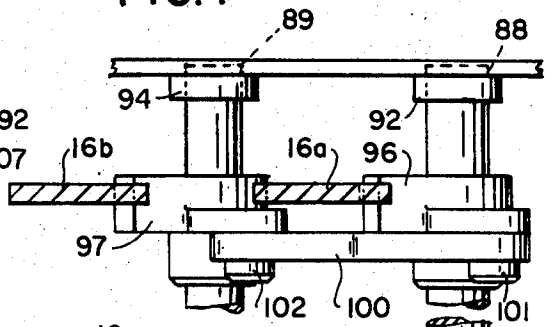
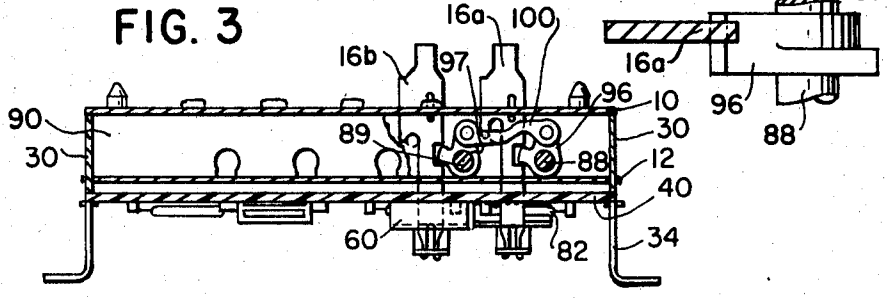


FIG. 3



INVENTORS
DEAN B. JACKSON
EDWARD S. STORK &
DARRELL L. FLORY

BY Louis A. Kline
Wilbert Hawk, Jr.
Geo. J. Muckenthaler

THEIR ATTORNEYS

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3,715,023

CAM-AND-LINKAGE ARRANGEMENT FOR SIMULTANEOUS MOVEMENT OF MULTIPLE KEYSTEMS CONNECTED TO A COMMON KEY

Dean B. Jackson, Kettering, Edward S. Stork, Dayton, and Darrell L. Flory, Brookville, Ohio, assignors to The National Cash Register Company, Dayton, Ohio

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U.S. Cl. 197—98 1 Claim

ABSTRACT OF THE DISCLOSURE

A modularly-constructed matrix-arranged keyboard having a printed circuit board and means associated therewith for opening and closing circuits for the purpose of relaying input information to a separate encoding system. The keyboard includes a plurality of keys with keystems, each stem capable of carrying a shunt member on its lower end for movement in a path between a switch and a magnet as the key is depressed and then released. A cam-and-linkage arrangement is provided for maintaining even distribution of the movement of multiple keystems connected to a common key.

BACKGROUND OF THE INVENTION

In the field of key-operated input and recording devices or machines, the ten-keyboard machines and the full-keyboard machines have enjoyed success with utilization of mechanically-connected components in the line-up between the keys and the recorded information. Typical of such machines are the typewriter, the adding machine, and the cash register, where depression of selected keys actuates mechanical linkages, levers, racks, bars, rods, and the like to displace or move these components or elements for the recording of information corresponding to that on the keys. However, with the advent of higher-speed machines, it has been found that electrical and electronic components and circuits are required to handle the increased amount of information being gathered and processed for further use or for storage in a total system. Therefore, it is a tried and tested observation that certain mechanical arrangements have been too slow, complex, and expensive to compete with electrical systems for efficient high-speed operations.

In later years, such ten-key keyboards and full keyboards have been redesigned to work with electrical and electronic circuits by the use of circuit making and breaking devices in a manner whereby actuation of a key provides for making and breaking an electrical circuit. Such redesigned keyboards have generally featured a circuit making and breaking device associated with each amount key and function key, each of the amount keys occupying a central position over its respective keystem, and the function keys occupying a larger area and supported on two or more keystems. One type of electrical keyboard utilizing such making and breaking devices is shown in British Pat. No. 1,127,840, which discloses a keyboard with a plurality of switches each having a switch tube containing a contact bridge which is displaceable in the switch tube by movement of a permanent ring magnet, the magnet being movable, upon depression of a key, along the switch tube to attract the contact bridge from one set of contacts to another set of contacts. The function keys are carried on a plurality of keystems.

Additional prior art relating to the circuit making and breaking device is taught in German Gebrauchsmuster

Pat. No. 1,957,375, granted on the application of S. Geiger, wherein a shielding or screening member (in the several forms of a slotted rotatable disc, a slidable plate, or a pivotable plate) is moved into position either to permit or to interrupt flux between a flux generator and a reed contact unit.

Additionally, U.S. Pat. No. 2,720,961, issued Oct. 18, 1955, on the application of William Richard Smith, discloses key latching and release mechanism which relates to a cam pivotally positioned on a keystem whereby, when the stem is moved in one direction, the cam wedges a latching bail to a unlatching position, and, when the key stem moves in the opposite direction, the cam is pivoted out of the way by the latching bail.

Another example of the prior art is disclosed in U.S. Pat. No. 2,997,703, issued Aug. 22, 1961, on the application of Ralph R. Powell, which shows keyboard-controlled circuitry for coding information for use in computers or the like, the keyboard having a function key, a circuit control unit or device associated with each amount key, and respective key stems, wherein the unit or device includes a permanent magnet secured to one leg of a U-shaped bracket, and the other leg carries transformer cores. Depression of a key in a downward path positions the lower end of the keystem between the magnet and the cores to exert sufficient shielding effect on the flux produced by the magnet to prevent the cores from becoming saturated, so that pulses may be generated in the core windings.

U.S. Pat. No. 3,296,369, issued Jan. 3, 1967, on the application of Clayton H. Clark and Donald J. Stefanik, shows a keyboard having typing keys and a space bar, with key-operated, magnetically-actuated, permutatable groups of glass-enclosed reed contact switches, wherein the magnets are swingably positionable in one of two positions and retainable thereat upon depression of the keys.

And finally, the U.S. Pat. No. 3,363,737, issued Jan. 16, 1968, on the application of Tasaku Wada and Kahei Furusawa, shows a keyboard with a function key and a plurality of amount keys, in which a signal is generated through a coil wound on a fixed core when a plate of magnetic material in contact with an end of the core is separated from the core in accordance with keying of a non-magnetic key bar.

SUMMARY OF THE INVENTION

The present invention relates to a keyboard and, more particularly, to a modular-type keyboard utilized as an input device for manual entry of variable data, and also as a control unit for a terminal portion of a program or system which may require alteration, definition, and/or other general control operations. The keyboard is matrix-arranged as to location of the keystems and modularly constructed as to physical configuration for flexibility and for adaptability to numerous applications. The keyboard includes spaced support plates, spring-loaded keystems protruding through the plates, and a circuit board carrying a plurality of reed-type switches and their associated actuating magnets. The lower end of each keystem carries a shunt member which is normally positioned in a plane between the switch and its magnet, but which is displaced or moved, upon depression of a key, in a path to permit opening and closing of the switch by the magnetic forces.

In the up, or undepressed, position of the key, the switch is open by reason of the keystem-carried shunt being positioned between the switch and the magnet, thereby cutting off the lines of magnetic force of the magnet from acting on the switch. When the key is depressed, the shunt is moved downwardly in linear manner,

thus allowing the magnetic lines of force from the magnet to close the switch and operate the encoding circuit.

The point of effective operation, or the point at which voltage is applied to the encoding circuit for the closing of the reed switch, takes place at an operate point approximately one third of the distance from the bottom of key travel whenever a key is depressed. The reset point, defined as that point in key travel wherein the key is in a restored condition and thus capable of another activation, is approximately one third of the distance from the top of key travel. In this respect, the keyboard is designed for optimum linear key travel between the operate point and the reset point for any given key. It is very important, therefore, that the key operate in a plane which is parallel or level with respect to the switching mechanism.

Along with the minimum key travel, an additional feature of the present keyboard is the "ride or slur" characteristic, which permits partial depression or application of force above the point of effective operation of one or more keys. This feature permits the operator to "ride" a key with one finger providing a "home" reference for the hand during touch operation, while at the same time preventing unwanted code output from partially-depressed keys. The keyboard design also includes interlocking of the keys when two or more keys are depressed within a predetermined time interval and, in the instant invention, applies to keys that are actively being depressed as opposed to keys that are depressed and held down. As soon as the operate point during depression of the key is reached, the circuit is completed and the input information is encoded, so that additional keys may be depressed without restoration of the previously depressed keys.

Along with the design of the keyboard utilizing the modular construction, an additional feature is provided for those keys which are carried on more than one keystem. In the case of keys which occupy greater space and are carried by a row of keystems, or keys which are carried by two or more rows and levels of keystems, it is necessary that the several keystems be depressed and moved together, so as not to cause binding between the stems and the supporting plates whenever a key is struck off center or is struck at one edge portion thereof. A cam-and-linkage arrangement is provided to connect the several keystems together to maintain even distribution of keystem movement.

Since the magnets and the switches are individually secured to the circuit board and the shunt member is supported from the keystem, the design of the keyboard features a simplified, low-cost, and easily-maintained assembly.

In accordance with the above discussion, the principal object of the present invention is to provide a keyboard of simple modular design adaptable for several applications.

Another object of the present invention is to provide a matrix-arranged keyboard wherein the keystems are on common centers for flexibility in broad terminal usage.

A further object of the present invention is to provide a keyboard which will operate in accordance with human factor requirements that have been established for efficient operation.

An additional object of the present invention is to provide means on each of the keystems movable in a path between a switch and a magnet for permitting opening and closing of the switch during operation of the key.

Still another object of the present invention is to provide a keyboard with multiple-stem-carrying keys wherein a cam-and-linkage arrangement maintains even distribution of keystem movement as the key is depressed.

Additional advantages and features will become apparent and fully understood from a reading of the following description, taken together with the annexed drawings, in which:

FIG. 1, on the sheet with FIGS. 4 and 5, is a perspective view showing the keyboard of the present invention;

FIG. 2, on the sheet with FIGS. 3, 6, and 7, is a top plan view of the keyboard construction;

FIG. 3, on the sheet with FIGS. 2, 6, and 7, is a view taken on the line 3—3 of FIG. 2;

FIG. 4, on the sheet with FIGS. 1 and 5, is an enlarged view of a keystem and its associated parts;

FIG. 5, on the sheet with FIGS. 1 and 4, is a view taken on the line 5—5 of FIG. 4;

FIG. 6, on the sheet with FIGS. 2, 3, and 7, is an enlarged view of the keystem linkage shown in FIG. 3; and

FIG. 7, on the sheet with FIGS. 2, 3, and 6, is a plan view of the keystem linkage.

Referring to the drawings, there is shown in FIG. 1 a perspective view of a keyboard including an upper support plate **10** and a lower support plate **12** spaced from the upper plate, the plates having apertures **14** (FIG. 2) equally spaced therein for reception of keystems **16** capped by amount keys **18**, function and/or control keys **20**, and certain other special keys **22**, **24**. The apertures **14** are spaced on three-quarter-inch centers each way, so as to provide a matrix-arranged board wherein the several keys are adaptable and suitable for being placed at different locations depending upon the desired arrangement of the amount, function, and/or special keys. A framework of plate members (see also FIG. 3) has front and rear plates **30** and a supporting plate **32** suitably joined together between the upper plate **10** and the lower plate **12** to form a box-like construction for enclosing certain of the working parts of the keyboard. While FIG. 2 shows a 5" by 8" fashioned board, there being five levels and eight rows of keys, additional rows could be added when a lengthened keyboard is required. In the types of business machines utilizing the instant keyboard, the five levels and eight rows are generally considered adequate, realizing that space is an important design factor in present machines, and that the trend is toward smaller, more compact systems.

Keyboard support legs **34** are provided to secure the board to a suitable base (not shown), the legs each being an extension of the front and rear plates **30**. A plug-in type of printed circuit board **40** (FIG. 3) is attached to the framework and secured between the support legs **34**, the board having an extension **42** beyond one end of the keyboard for connection with suitable terminals (not shown) of the electrical part of the equipment or system.

The keys, such as the amount keys **18** (FIG. 4), are secured to the tops of the stems **16** in a suitable manner, so as to provide removability of the associated parts during maintenance. Each of the keystems has an elongated slot **46** adjacent the upper support plate **10** for receiving a retainer rod **48** (see also FIG. 5), there being a rod extending across each of the rows of keystems for the purpose of limiting upward travel of the keys upon depression thereof. Additionally, each of the keystems **16** has a notch, or kerf, **50** in one side for receiving and retaining an elongated tension spring **52**, which spring also extends across each of the rows of keystems and is connected to tabs **53** and **54** (FIG. 2) for providing a bias or restraining force to downward movement of the keys. This spring, of course, acts to counteract the depression of the keys and is the restoring force for the keys after operation thereof.

Continuing on down the keystem **16**, which projects, in turn, through the lower support plate **12** and through the printed circuit board **40**, the keystem has secured on its lower end portion a pre-formed shield element or shunt **60** having spaced apertures therein slidingly receiving the lower portion of the keystem. As illustrated in FIG. 4, the lower end of the keystem **16** is bifurcated to form fingers **70** and **71** for the purpose of capturing the shunt **60**. The slot formed by the bifurcated lower portion of the

stem permits springing of the fingers **70** and **71** for easy insertion of the shunt on the keystem.

Connected to the printed circuits and supported from the circuit board **40** are terminals or posts **80** and **81** (FIG. 4), to which are solidly connected the terminals of a glass-enclosed reed switch **82** (see also FIG. 3). Also supported from the circuit board **40**, but separated from any printed circuitry thereon, is a small permanent magnet **85** contained in a non-metallic holder **86** (FIG. 1), the magnet being face oriented and positioned in spaced relationship and on a plane approximately level with the reed switch **82**, as seen in FIG. 5.

It should be noted from FIGS. 1 and 2 that the keys **22**, **24** occupy a much greater portion of the keyboard than do the individual amount keys **18** or function keys **20**, the key **22** extending across the space of five keystem apertures, and the key **24** covering a corner of the board and extending over three keystems. Because of the expanse of these keys, it is necessary to provide means for obtaining even distribution of movement across the key, so as to prevent binding of the keystems in the apertures when the keys are depressed. Taking the key **22** first, and referring to FIGS. 1 and 2, bails or shafts **88** and **89** (see also FIGS. 6 and 7) are journaled in support plates **90** and **91**, which plates extend between the front and rear plates **30**, the shafts being carried in bearing-type hubs **92**, **93**, **94**, and **95** secured to the support plates. As also seen in FIGS. 3 and 6, the shafts **88** and **89** run parallel adjacent keystems **16***a* and **16***b* and carry cam arms **96** and **97** pivotally connected together by means of a link **100** and stud-type pins **101** and **102** to form a yoke arrangement, the arms **96** and **97** having respective fingers **103** and **104** extending into and engaging with notches or recesses **105** and **106** in the keystems **16***a* and **16***b*. Referring to FIGS. 3 and 6, when the keystem **16***a* is depressed, the notch **105** carries the finger **103** down also by reason of the finger being secured to the shaft **88** on a pin **107**, thus rotating the arm **96** counter-clockwise and moving the link **100** to the left, in turn rotating the arm **97** and the finger **104**, which moves the keystem **16***b* downwardly a similar distance. Likewise, when the keystem **16***b* is moved downwardly, the yoke arrangement effects like movement of the keystem **16***a*. This construction is used for the control key **22** to insure that the stems **16***a* and the stem **16***b* move the same distance upon depression of the key **22**, even though pressure is exerted off center across the top of the key by reason of pressing the key toward an edge thereof.

Now again referring to FIGS. 1 and 2, it is seen that the key **24** extends substantially across the lower portion of the keyboard, and a shaft assembly is provided to insure even downward displacement of the key, so as to prevent binding of the keystems in the apertures. A shaft **110** is journaled in hubs **111** and **112**, the hub **111** being secured to the central support plate **91**, and the hub **112** being secured to the support plate **32**. Cam arms **114** and **115**, similar to the arms **96** and **97**, are secured to the shaft **110**, the arms having respective fingers **116** and **117** extending into and engaging with notches or recesses **118** and **119** in the two keystems as shown. When the key **24** is depressed near one end thereof, the shaft **110** is rotated, and the force is carried along the shaft to the other keystem through the action of the cam arms **114** and **115**.

In the operation of the keyboard, depression of any key downwardly to the operate point, which, as mentioned earlier, is approximately one-third the distance from the bottom of key travel, also carries the shunt **60** downwardly and allows generation of an electrical current through closing of the switch **82**. This is accomplished by reason of the shunt **60** being moved out of the path of the magnetic lines of force between the magnet **85** and the switch **82**. As the key is returned upwardly to the undepressed, or key-restored, position, the reset point is passed during this travel, and, by reason of the shunt interrupting the magnetic lines of force, the switch contacts open, and the circuit is broken. Again, as mentioned earlier, this reset point is approximately one-third of the distance from the top of the key travel. The spring **52** applies that bias necessary to hold the key in the "up" position when no force is applied to the key, in which position the switch **82** is open, since the shunt **60** attached to the keystem is positioned between the switch and the magnet **85**. On depression of the key, the shunt is removed from between the magnet and the switch, permitting the magnetic force to be applied to the switch and thus cause the switch to close and apply current to the particular encoding circuit. When key force is removed, the spring **52** forces the key and stem to the "up" position, and the shunt is therefore repositioned between the magnet and the switch to interrupt the magnetic lines of force, and the switch opens.

In the even distribution of forces across the large keys, such as the key **22**, depression force on a portion thereof, or toward an edge of the key, is carried to other keystems through the shafts **88** and **89** carrying the cam arms **96** and **97** engageable in the recesses **105** and **106** in the stems, and, where the key turns the corner (as does the key **22**), the link **100**, connecting the cam arms, insures that the keystems are evenly moved during depression. The link **100** may be extended or lengthened in the case when a key may occupy the space taken by the key **22** and additionally space taken by one or more function keys **20**. Therefore, special keys may occupy greater portions of the keyboard and include the even distribution of depression force feature to insure reliable and efficient operation.

Likewise, when the key **24** is struck near one end thereof, the force is carried along the shaft **100** through the cam fingers **116** and **117** working in the recesses **118** and **119** to provide even distribution of downward movement of the keystems, so as to prevent binding thereof with the support plates and to insure precise operation of the switch at the "operate" and "reset" points.

It is thus seen that herein shown and described is a keyboard-circuit-closing and -opening means directly connected to the keystem and positioned to move between the magnet and the reed switch for operating the encoding circuits. The keyboard also features the shaft-and-cam arrangement for use in depression of large keys, so as to have the advantage of adaptability to numerous keyboard designs. While only one embodiment has been disclosed for the construction and operation of the keyboard, certain variations on the above may occur to those skilled in the art, so it is contemplated that all such variations having these features are within the scope of the invention.

What is claimed is:

1. A keyboard comprising a pair of spaced support plates, the plates having apertures therein arranged in matrix fashion,

frame members connecting the plates,

a plurality of keystems positioned in the apertures and slidable therein and certain of the keystems having a recess along one side thereof,

switch means positioned to be operable upon depression of the keystems,

keys secured to the keystems, certain of the keys being of a size and shape to extend across a plurality of the keystems, at least one of said certain keystems being positioned in offset manner from the others,

a pair of bails tandemly positioned and parallelly supported from the spaced plates and extending in proximal position with said certain keystems,

a linking member pivotally connecting the bails in a yoke arrangement, and

a plurality of cam members fixed to the bails and including pin means for carrying said linking member, and cooperating with the keystem recesses for rotating the bails when at least one of the certain keys is depressed, the cam members on the bails operating within the recesses to evenly carry said certain key-

stems downwardly through their associated apertures for operating said switch means.

References Cited

UNITED STATES PATENTS

1,357,423	11/1920	Robb	235—145 R
1,999,727	4/1935	Gubelmann	235—145 R
2,964,740	12/1960	Hense	340—174
2,997,703	8/1961	Powell	340—347
3,169,701	2/1965	Dombrowski	197—98
3,292,761	12/1966	Erpel	197—98
3,327,829	6/1967	Hermann	197—98

OTHER REFERENCES

J. N. Cassell, Space Bar Mounting, May 1967, vol. 9, No. 12, from p. 1773, IBM technical disclosure bulletin.

EDGAR S. BURR, Primary Examiner

C. W. HANOR, Assistant Examiner

U.S. Cl. X.R.

235—145 R