

[54] **KEY APPARATUS AND
ARRANGEMENT THEREOF**

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[58] **Field of Search**.....335/205, 207, 206

[56] **References Cited**

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[57] **ABSTRACT**

A key apparatus includes a magnetic reed switch and at least one magnet forming a magnetic portions for energizing the reed switch, the magnetic portion having a plurality of magnetic poles disposed to produce substantially parallel magnetic fluxes opposite in sense so that the reed switch is maintained open under the influence of both of said substantially parallel magnetic fluxes opposite in sense when the key is in normal position and that the reed switch is closed under the influence of one of said magnetic fluxes. A plurality of such key apparatuses are arranged so as to form columns and rows and in such a manner that all the magnetic portions in any common column or row faces in the same direction but that the adjacent magnetic portions in any common row or column face in opposite directions, whereby the key board can be compact.

6 Claims, 9 Drawing Figures

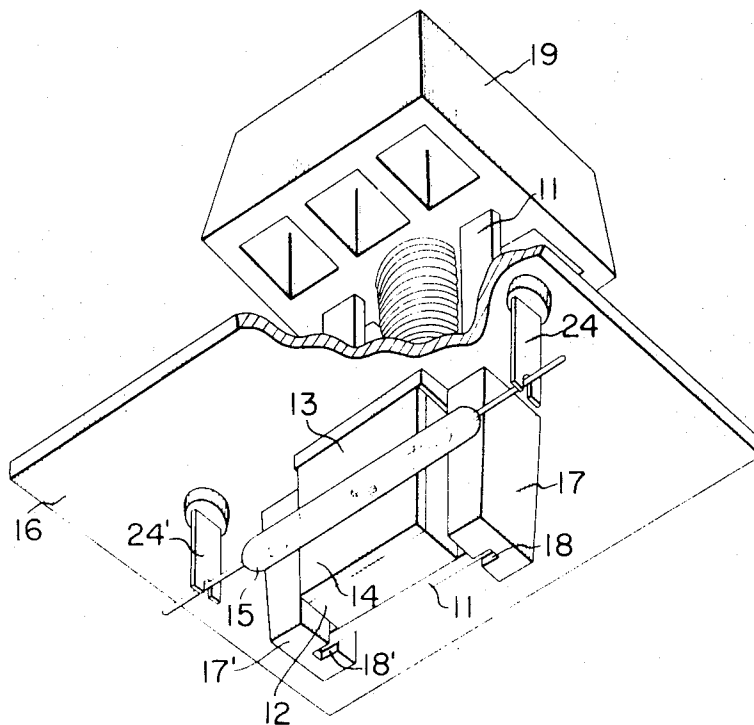


FIG. 1

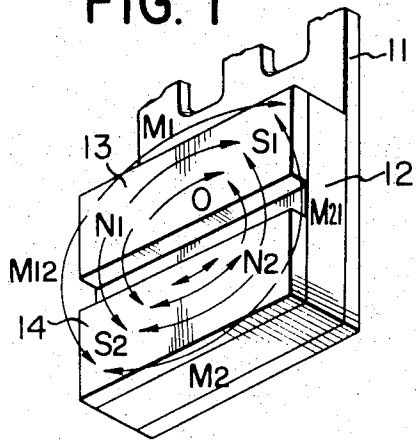


FIG. 2

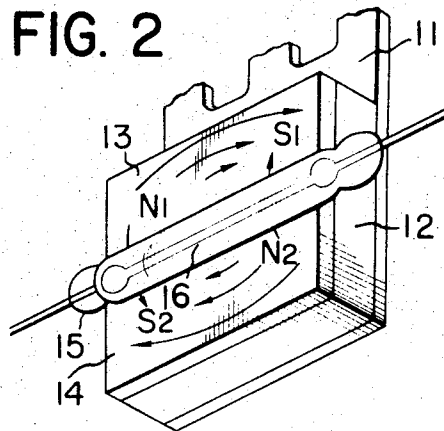


FIG. 3A

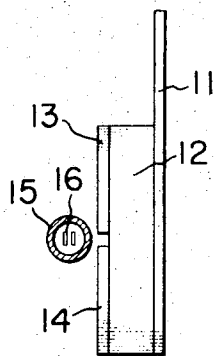


FIG. 6A

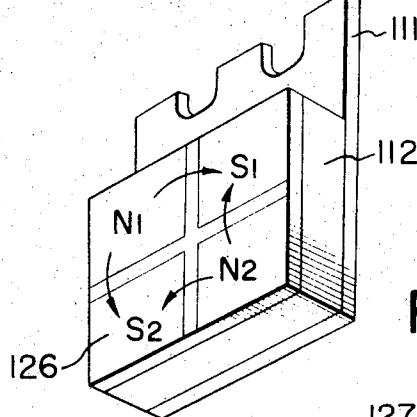


FIG. 6B

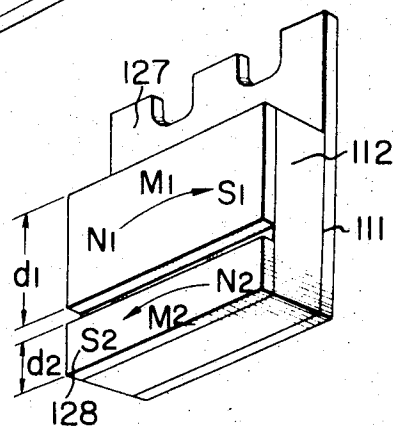


FIG. 3B

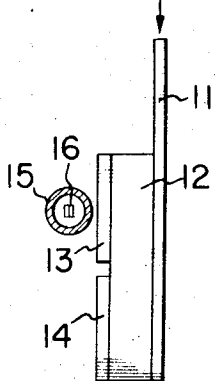


FIG. 4

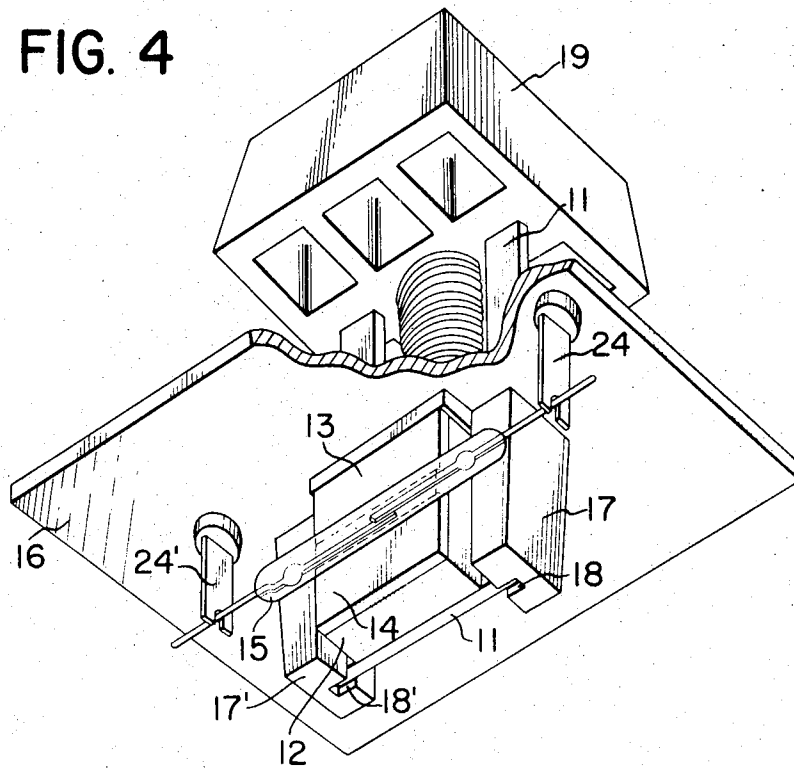


FIG. 5

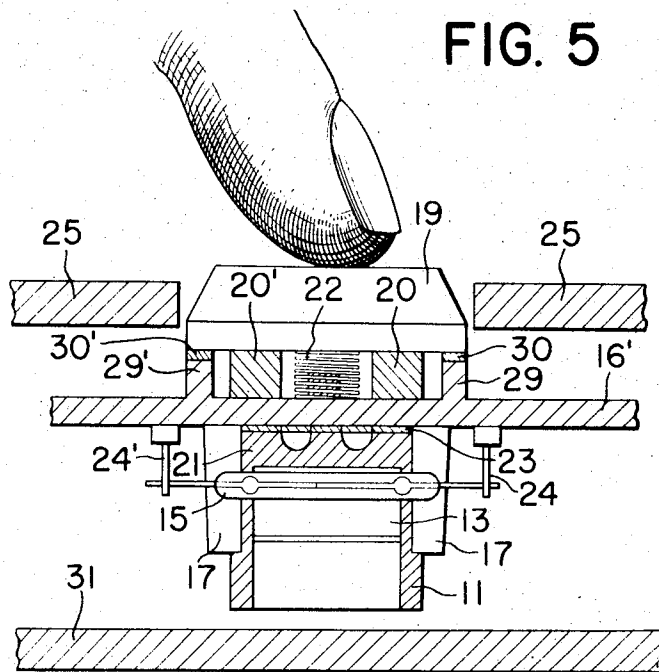
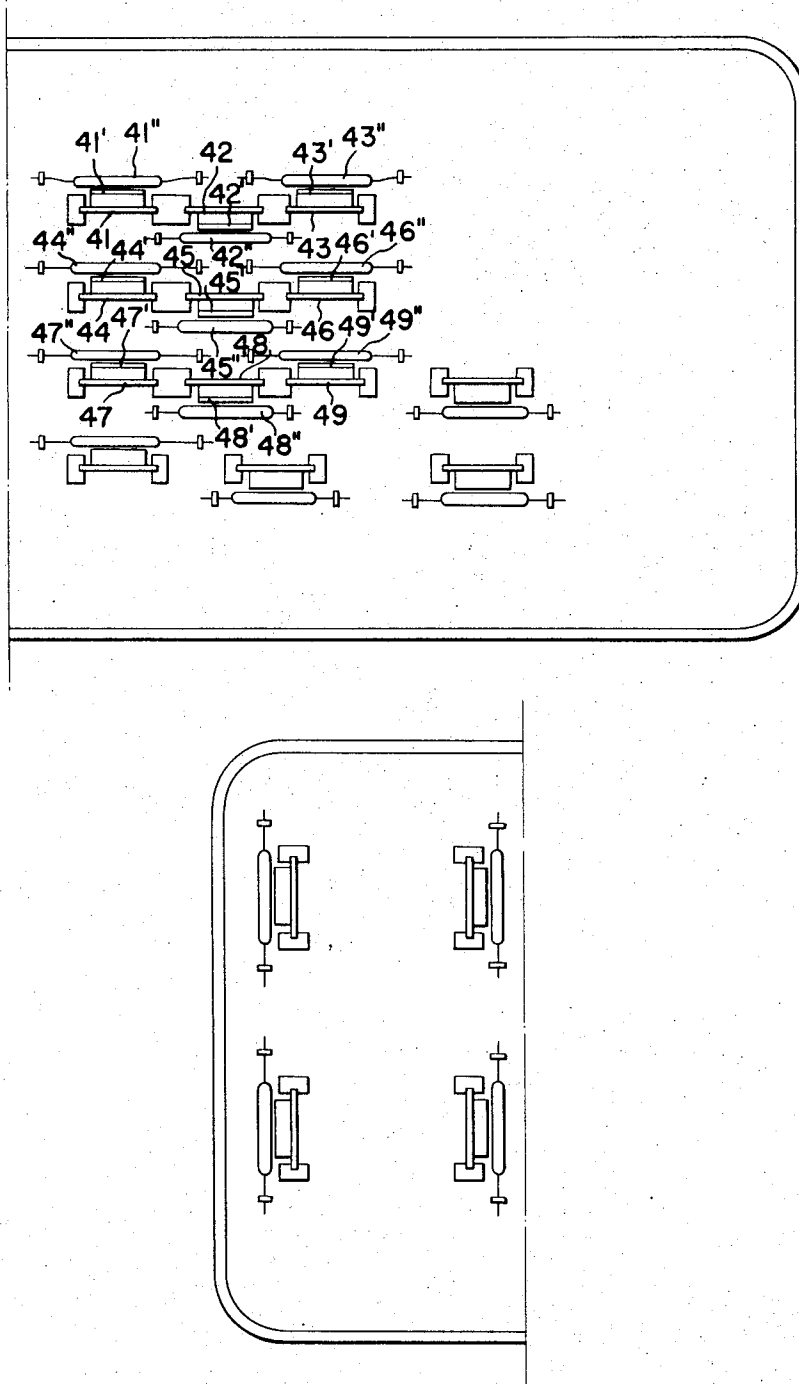


FIG. 7



KEY APPARATUS AND ARRANGEMENT THEREOF

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

This invention relates to a key apparatus, and more particularly to a key apparatus having a reed switch (hereinafter referred to as "reed switch") and magnets for energizing the reed switch and to an novel arrangement of such key apparatus.

2. DESCRIPTION OF THE PRIOR ART

A reed switch has been widely in use as the input device for an electronic computer or the like. Such a reed switch comprises a glass tube hermetically enclosing therein inert gas and a pair of magnetically and electrically conductive reeds (hereinafter referred to as "reeds") disposed partly in overlapping relationship so as to serve as contact means. The reeds are also flexible.

Such reeds are normally open, but when a magnetic field is applied thereto by bringing a magnet close thereto, the pair of electrically conductive reeds are intensively subjected to the magnetic flux from the magnet so that the contact portions of the reeds are caused to attract each other into contact and establish electrical connection therebetween. When the extraneous magnetic field is decreased, that is, when the magnet is moved away from the reeds so as to reduce the density of the magnetic flux affecting the contact means, these contact portions are opened and electrically disconnected from each other.

It has been widely in practice to use a permanent magnet as the source of such magnetic field. One of the known arrangements of the magnet with respect to the reed switch of the described type is such that the magnet is disposed in a direction parallel to an axis of the reed switch or to the direction of extension of the reeds (the direction of the magnet is that determined by the opposite poles thereof). In such an arrangement, the magnet is moved axially of the reed switch to control the latter so that the contact portions of the reed switch are closed by a greater density of magnetic flux from the magnet when the magnet is centered with respect to the reed switch and that the contact are opened when the magnet is deviated from the contact portions.

Another known arrangement of the magnet is such that the magnet is disposed in a direction normal to the major axis of the reed switch or to the direction of extension of the reeds of the reed switch. With this arrangement, the magnet is also moved axially of the reed switch to control the latter so that the contacts of the reed switch are caused to attract each other and closed by a greater density of magnetic flux when the magnet has come closer to one of the pair of reeds (or when the magnet is deviated from the contacts) and that the contacts are opened when the magnet is centered with respect to the contact means.

As has been described above, the magnet for controlling the reed switch of this type is moved along the major axis of the reed switch and usually the magnet is directly coupled and fixed to the key. For this reason, the reed switch must be fixed to the key board in perpendicular relationship therewith and this has led to a greater height of the key board.

Consequently, the key apparatus of the above-described construction has been incompatible with the

increasing requirement for the compactness of electronic computer, especially of the desk type.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a key apparatus and arrangement thereof which can reduce the size or height of the key board.

It is another object of the present invention to provide a key apparatus which can reduce the distance of travel of the magnet for controlling the reed switch, namely, reduce the key stroke.

It is still another object of the present invention to provide a key apparatus having a plurality of magnets for controlling the reed switch.

It is yet another object of the present invention to provide a key apparatus in which magnets are moved perpendicularly to the major axis of the reed switch to control the operation of the latter.

It is still another object of the present invention to provide an effective arrangement of such key apparatus.

These and other objects and advantages of the present invention will become readily apparent from the following illustrative description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view showing an example of the magnetic portion constituting the key apparatus according to the present invention;

FIG. 2 is a perspective view showing the positional relationship between the magnetic portion of FIG. 1 and the reed switch as the latter is in open position.

FIGS. 3A and 3B are side views showing the relationship between a pair of magnets forming the magnetic portion of FIG. 1 and the reed switch when the latter is opened and closed by the magnets.

FIG. 4 is a perspective view partially broken of the key apparatus incorporating the magnetic portion and reed switch.

FIG. 5 is a side view showing the key apparatus when the key is depressed or the reed switch is closed.

FIGS. 6A and 6B are perspective views showing further examples of the magnetic portion according to the present invention.

FIG. 7 is a bottom plan view showing the input key board of a desk type electronic computing machine incorporating a number of such key apparatuses as shown in FIGS. 4 and 5.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, there is shown an arrangement of magnets for controlling the reed switch. A metallic base plate 11 carries thereon a bed 12 formed of non-magnetic material, and a pair of magnets 13 and 14 are securely mounted on the bed 12. The pair of magnets, which have their magnetic poles at the opposite ends thereof, are arranged in such a manner that their adjacent poles are opposite in polarity, thereby constituting a magnetic portion having four magnetic poles. As shown in FIG. 1, there is produced a magnetic flux M_1 between poles N_1 and S_1 , a magnetic flux M_2 between poles N_2 and S_2 , a magnetic flux M_{12} between poles N_1

and S_2 , and a magnetic flux M_{21} between poles N_2 and S_1 . However, the magnets 13 and 14 are opposite in magnetic sense and accordingly the magnetic fluxes M_1 and M_2 are also opposite in magnetic sense, whereby these two magnetic fluxes act to negate each other in the adjacent portions of the magnets. As a result, the magnetic fluxes M_1 and M_2 are least intense at the center O between the two magnets and more intense in the portions farther from that center. This also holds true with the magnetic fluxes M_{12} and M_{21} . In other words, the magnetic fluxes M_1 , M_2 , M_{12} and M_{21} gradually increase their densities in proportion to the distance from the center O.

Therefore, if a reed switch 15 is disposed in such a manner that the contact means 16 thereof is positioned at the center O as shown in FIG. 2, then the contact means 16 will be least subjected to the negative fluxes, thereby to maintain open. The magnetic fluxes M_{12} and M_{21} which are present at the opposite ends of the reed switch 15 cannot affect the contact means 16 significantly.

FIG. 3A shows the reed switch 15 in open position. By depressing the base plate 11, the bed 12 and the magnets 13 and 14 are moved down together so that the magnet 13 is just opposed to the reed switch 15, as shown in FIG. 3B. When the contact means 16 of the reed switch 15 is thus moved away from the center O, the reed switch 15 is brought within the influence of the magnetic flux M_1 from the magnet 13. This means that the magnetic flux M_1 passes through the reed switch 15 and causes the contact means 16 thereof to be closed and establish electrical connection.

While the base plate 11 has been shown and described to be depressed, the same result may be attained by arranging the base plate 11 so as to be raised thereby to bring the reed switch 15 within the influence of the magnetic flux M_2 from the lower magnet 14.

Referring to FIGS. 4 and 5, there is shown the entire key apparatus whose essential portion has been shown in FIGS. 1 to 3. A holder plate 16' securely holds a pair of downwardly extended portions 17 and 17', which have aligned grooves 18 and 18' formed in their respective inner side walls for slidably receiving the above-described base plate 11.

The base plate 11 extends upwardly through a slot (not shown) formed in the holder plate 16' so as to provide three divided extensions 20, 20' and 21. The extension 21 is shorter than the other extensions 20 and 20', on which a key 19 is fixedly mounted. A coil spring 22 is mounted around the extension 21 and between the key 19 and the holder plate 16' so that the coil spring 22 acts to raise the key 19. The base plate 11 in the lower portion thereof has secured thereto the bed 12 carrying the magnetic portion comprising two magnets 13 and 14, as described previously, and the bed 12 is engaged with the underside of the holder plate 16', thereby to serve as stopper means for preventing the base plate 11 from being forced out through the holder plate 16' by the force of the coil spring 22. In the portion of the underside of the holder plate 16' which corresponds to the bed 12, there may be provided a layer of elastic material 23 such as felt, rubber or the like so as to prevent any noise from being produced by the stopper means when the key 19 is returned by the spring 22.

The holder plate 16' further has a pair of holder terminals 24 and 24' downwardly extending therefrom so that in the normal or depressed position the reed switch 15 may be substantially in alignment with the clearance between the magnets 13 and 14 or that the contact means 16 of the reed switch 15 is positioned at the center O, i.e. the reed switch is subjected to the influence of the magnetic fluxes M_1 and M_2 . Also, the stroke of the key 19 is such that when depressed the magnet 13 travels down until the reed switch 15 is brought within the influence of the magnetic flux M_1 from that magnet.

Such position setting may be achieved by selecting the height of restraining means 29 and 29' extended upwardly from the holder plate 16'. The restraining means 29 and 29' may have the top ends thereof covered with layers of elastic material 30 and 30' such as felt, rubber or the like to prevent any noise which would otherwise occur when the restraining means strike the underside of the key 19.

The key apparatus is also provided with top and bottom plates 25 and 31 constituting the key board.

FIGS. 6A and 6B show further examples of the magnetic portion on the bed 12 fixed to the base plate 11. In FIG. 6A, use is made of a single magnet 126 of rectangular cross section having therein a pair of electrodes. This magnet 126 has four magnetic poles disposed at the four corners thereof in such a manner that adjacent poles are opposite in polarity. The effect of such magnet upon the reed switch is entirely the same as that described with respect to the embodiment of FIGS. 1 and 2, and therefore the detailed description thereof is omitted herein. However, it should be noted that the use of such a single magnet reeds to a greater ease with which the magnet portion is manufactured.

In FIG. 6B, use is made of two magnets 127 and 128 secured to the bed 112 in such a manner that adjacent poles are opposite in polarity. As seen, however, these two magnets have different widths, i.e. a greater width d_1 for magnet 127 and a smaller width d_2 for magnet 128. The greater dimensions of the magnet 127 provide a greater density and intensity of the magnetic flux M_1 than the magnetic flux M_2 provided by the smaller magnet 128. Therefore, the magnetic flux at the midpoint between both magnets does not become zero in spite of the cancelling effect of both of the magnetic fluxes, and the magnetic flux from the magnet 127 dominates that of the magnet 128 at the midpoint between the magnets. However, the strength of the magnetic field in this area between the magnets is insufficient to bring the contact elements in the reed switch into contact with each other to close the reed switch. In other words, the reed switch, in a normal state, is subjected to reduced magnetic field caused by the cancelling effect of both of the magnetic fluxes M_1 and M_2 .

When the key associated with the supporting plate 111 is depressed, the reed switch is offered to the dominant magnetic flux M_1 from the magnet 127, and then the reed switch is closed. As is apparent from FIG. 6B, the reed switch encounters an abrupt change in strength of magnetic field from an interacting region between both of the magnets M_1 and M_2 to an operating region governed by the magnet M_1 exclusively, with the result that the reed switch can be closed and opened by moving the magnet structure over a short

distance. In other words, the reed switch may be operated with a smaller stroke of the key and without being affected by noise.

As will be appreciated from the foregoing description, the key apparatus of the present invention enables the reed switch to be fixed perpendicularly to the direction of movement of the key, whereby the height of the key apparatus may be greatly reduced.

FIG. 7 shows, in bottom plan view, an example of the input key board of a desk type electronic computer in which a number of such key apparatuses are disposed closely adjacent to one another.

The key apparatuses are designated by numerals 41 to 49, of which 41-42-43, 44-45-46 and 47-48-49 form "rows" and 41-44-47, 42-45-48 and 43-46-49 form "columns". Those of such key apparatuses 41 to 49 which form any common column are arrayed in such a manner that the magnetic portions thereof face in the same direction. More specifically, the magnetic portions 41', 44' and 47' of the key apparatuses 41, 44 and 47 face upward as viewed in FIG. 7, while the magnetic portions 42', 45' and 48' of the key apparatuses 42, 45 and 48 face downward, and the magnetic portions 43', 46' and 49' of the key apparatuses 43, 46 and 49 face upward. On the other hand, those of the key apparatuses 41 to 49 which form any common row are arrayed in such a manner that adjacent magnetic portions face in opposite directions to each other. Thus, as shown, the magnetic portions 41 and 43' face upward while the magnetic portion 42' faces downward, the magnetic portions 44' and 46' upward while the magnetic portion 45' downward, and the magnetic portions 47' and 49' upward while the magnetic portion 48' downward.

The described arrangement of the magnets of the key apparatuses forming columns and rows enables reed switches 41'' to 49'' to be effectively arranged so as to form a compact key board.

The same result as described above can also be attained by arranging the key apparatuses 90° out of phase with respect to the arrangement of FIG. 7 and interchanging the columns and rows with each other so that the magnetic portions in a certain column face in the same direction while adjacent magnetic portions in a certain row face opposite to each other.

What is claimed is:

1. A key apparatus comprising a key movable into an operative position by an external force applied thereto and returnable to a normal position upon release of said external force, a member movable in response to movement of said key, a magnetic unit secured to said member for generating substantially parallel magnetic fluxes at fixed spaced intervals and having opposite polarity, comprising a first magnetic portion having opposite poles and a second magnetic portion having opposite poles, the polarity of the poles of said second magnetic portion being oppositely disposed with respect to the polarity of the poles of said first magnetic portion, the first magnetic portion being magnetically separated from the second magnetic portion by a non-magnetized region, and a reed switch disposed adjacent to and spaced from said magnetic unit and having two contact elements enveloped therein, said reed switch

keeping said contact elements opened when said key is in the normal position, and said reed switch being operated to close said contact elements under the influence of a substantial flux component generated by one of said first and second magnetic portions of said magnetic unit when said key is in the operative position.

2. A key apparatus as defined in claim 1, wherein said first and second magnetic portions comprise magnets respectively, and said magnets are disposed spaced from each other to form a magnetic gap therebetween.

3. A key apparatus as defined in claim 1, wherein said reed switch is disposed closely spaced from and in substantially parallel relationship with respect to said first and second magnetic portions.

4. A key apparatus comprising a key movable into an operative position by an external force applied thereto and returnable to a normal position upon release of said external force, a member movable in response to the movement of said key, a magnetic unit comprising two magnet means each having different magnetic flux density and disposed in parallel with each other for generating substantially parallel magnetic fluxes at fixed spaced intervals and having opposite polarity and a reed switch, having two contact elements enveloped, disposed at an area where said magnetic fluxes generated by said two magnet means interact with each other and closely spaced from said magnet means, said reed switch keeping said contact elements opened when said key is in the normal position, and said reed switch being operated to close said contact elements under the influence of one magnet means having higher magnetic flux density than the other magnet means when said key is in the operative position.

5. A key apparatus as defined in claim 4, wherein said reed switch is normally located adjacent the spaced area between said two magnet means disposed in parallel, and one magnet means is brought into an opposed position upon depression of said key.

6. A key arrangement comprising a plurality of key apparatus arranged in a matrix array each comprising a key movable into an operative position by an external force applied thereto and returnable to a normal position upon release of said external force, a supporting member movable in response to movement of said key, a magnetic unit comprising a first magnetic portion having opposite poles and a second magnetic portion having opposite poles, the polarity of the poles of said second magnetic portion being oppositely disposed with respect to the polarity of the poles of said first magnetic portion, the first magnetic portion being magnetically separated from the second magnetic portion by a non-magnetized region, and a reed switch disposed spaced from and in parallel relationship with said first and second magnetic portions and perpendicular to the moving direction of said supporting member, wherein each reed switch opposed to its respective magnetic unit on one column in said matrix array is arranged on one side with respect to each supporting member, and each reed switch opposed to its respective magnetic unit on the adjacent column is arranged on the opposite side with respect to each supporting member.

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