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Hamada et al.

[11] **3,900,807**

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[54] **MAGNETICALLY CONTROLLED SWITCHING DEVICE**

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[21] Appl. No.: **408,816**

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Oct. 30, 1972 Japan 47-109074
Oct. 31, 1972 Japan ..... 47-125985[U]

[52] **U.S. Cl.** **335/152**; 335/112; 335/153
[51] **Int. Cl.²** **H01H 67/30**
[58] **Field of Search** 335/152, 112, 153

[56] **References Cited**

UNITED STATES PATENTS

3,431,520	3/1969	Lindenberger	335/152 X
3,760,311	9/1973	Zimet et al.	335/152
3,805,378	4/1974	Archer et al.	335/153 X

FOREIGN PATENTS OR APPLICATIONS

1,005,975	9/1965	United Kingdom	335/152

Primary Examiner—R. N. Envall, Jr.
Attorney, Agent, or Firm—Nelson E. Kimmelman; Allan Ratner; Paul Maleson

[57] **ABSTRACT**

A magnetically controlled switching device in which a plurality of reed relays are arranged in matrix array, each relay being composed of a plurality of reed switches, and which has the following characteristic features. Firstly, a coil form where the reed switches are positioned provides guides which introduce leads of the reed switches toward the edge portion of the coil form. The end of the leads are bent so as to easily introduced the leads along the guides of the coil form. Secondly, for the purpose of connecting the leads to a plurality of vertical and horizontal multiple connecting wires, projected portions are provided in the multiple connecting wires, and the reed relays are disposed so that the lead terminals are not arranged in the direction of the multiple connecting wires and the leads and the projected portions are respectively connected. Thirdly, the coil forms where said reed switches are positioned and a group of terminals for the exciting coils are fixed to a magnetic shunt plate. Said magnetic shunt plate, said coil forms, said group of terminals, terminal flanges which insulate said terminals and supporting members which support the base plate on which the multiple connecting wires are arranged are formed simultaneously as one body with synthetic resin.

3 Claims, 15 Drawing Figures

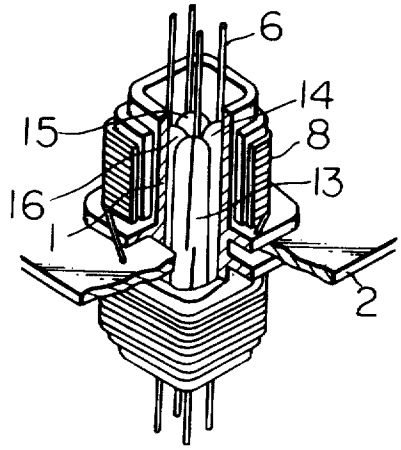


Fig. 1

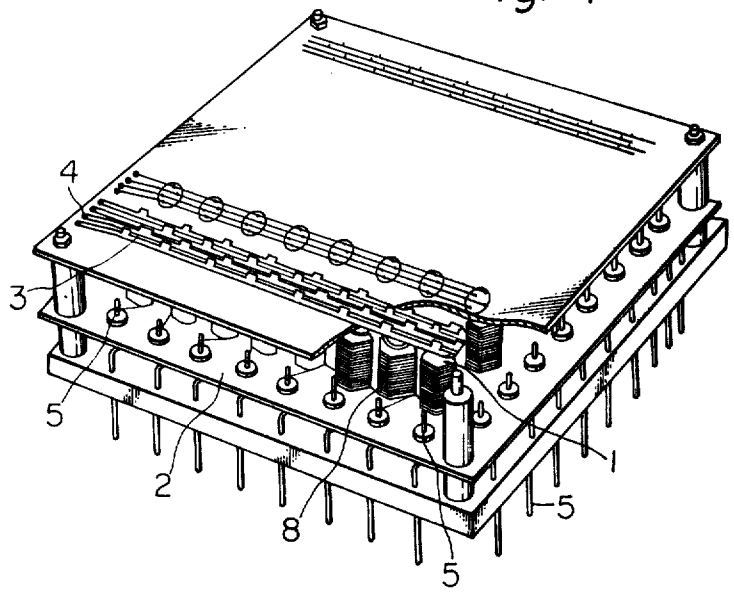


Fig. 2

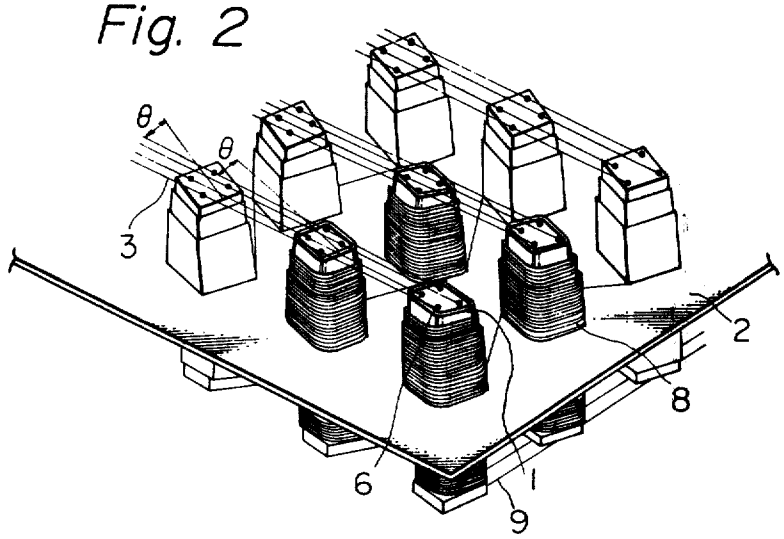


Fig. 3A

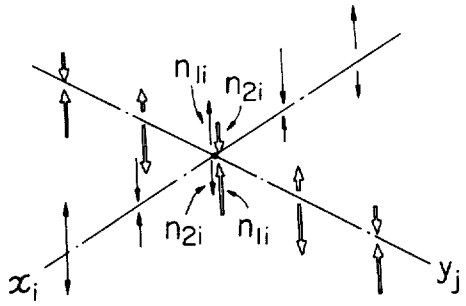
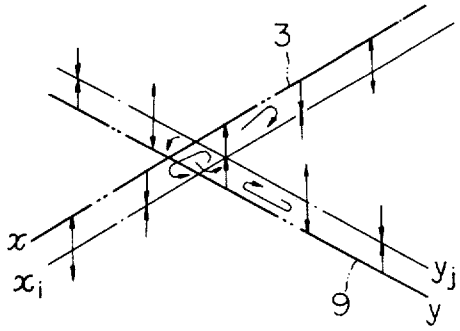


Fig. 3B



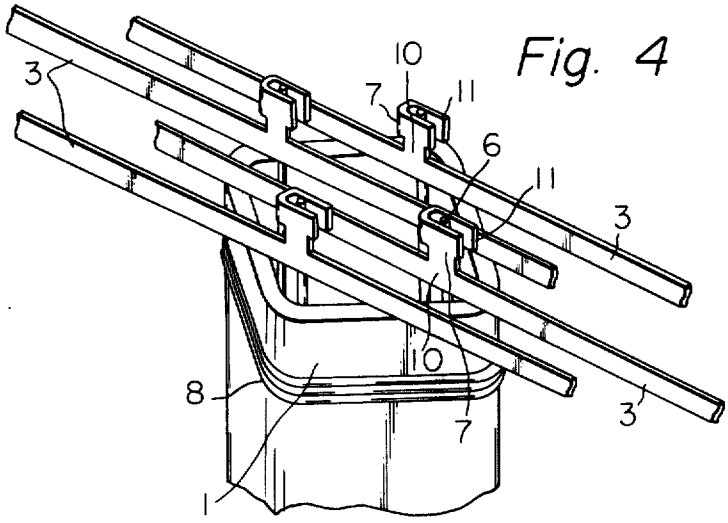


Fig. 4

Fig. 5

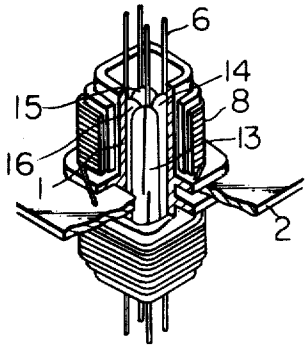


Fig. 6A

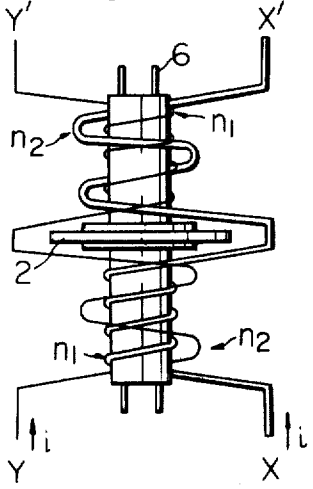


Fig. 6B

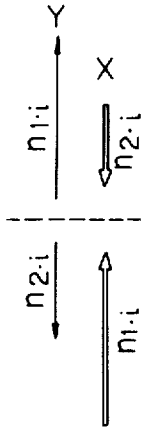


Fig. 7A

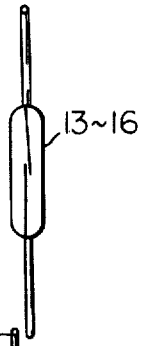
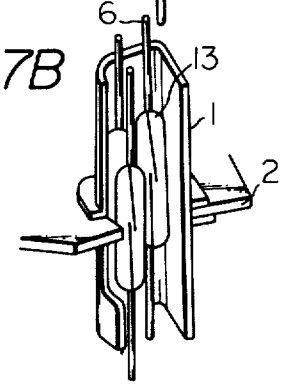


Fig. 7B



PRIOR ART

Fig. 8A

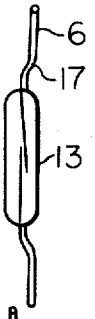


Fig. 8B

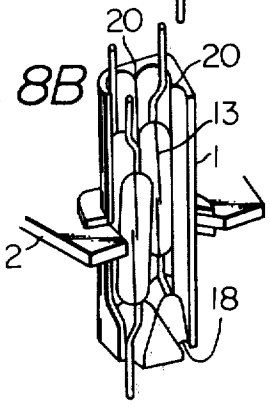


Fig. 9

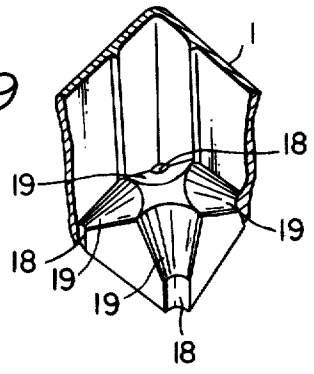


Fig. 10

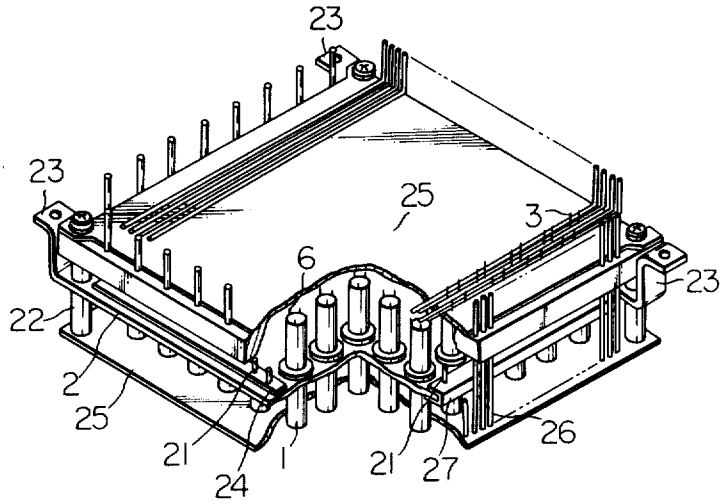
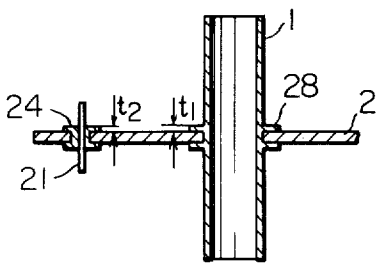


Fig. 11



MAGNETICALLY CONTROLLED SWITCHING DEVICE

The present invention relates to a magnetically controlled switching device, which is composed of reed switches and is principally used for speech path switches and for electronic switching system.

Recently, a great many reed switches are used as crosspoint switches of speech path circuits in electronic switching systems. In such a switching system, reed relays are arranged in matrix form and a speech path circuit is selected by exciting reed relays which are positioned at the crosspoints. The magnetically controlled switching device using reed switches which have a function of selecting such speech path circuit is widely used. The construction of such magnetically controlled switching device is disclosed, for example, in THE BELL SYSTEM TECHNICAL JOURNAL, VOL. 43, PART I, January, 1964, pp 25–30 (FIGS. 7–10 and the corresponding explanation).

Recently, the size of such reed switches has been considerably reduced as the technique of fabricating reed switches has progressed. Such reduced size switches are now being utilized in the large scale magnetically controlled switching devices.

Based on the means for holding the reed switches, magnetically controlled switching devices are divided into two types, that is, electrically holding type and magnetically latching type. In the magnetically latching type, there is no current and no electrical loss during the hold condition and, consequently, many advantages can be expected from this type. The present invention relates to a magnetically latching type magnetically controlled switching device.

A conventional type of magnetically controlled switching device requires a magnetic core plate for latching composed of semi-hard magnetic material, at every crosspoint because the reed switch used in said device has no holding function of its own. The type FDR-8 reed switch, which has now been developed by Fujitsu Limited, utilizes semi-hard magnetic material in the reed member of said reed switch and has a magnetic latching function due to the residual magnetism of the reed members. Therefore, said FDR-8 reed switch is an epoch making switch due to the fact that the magnetic core plate for latching which is conventionally required can be removed, and the magnetic interference between crosspoints is small because the residual magnetism of the reed members can be directly utilized to close the contacts. The magnetic latching type magnetically controlled switching device F-1L, which utilizes this type FDR-8 reed switch and which was developed by Fujitsu Limited, has a simpler and smaller construction and stabler action than the conventional speech path switch which requires a magnetic core plate for latching at every crosspoint. Further, the magnetic latching type magnetically controlled switching device F-1L is considerably smaller and lighter than the conventional speech path switch. Further because the number of its components is less its construction is simple. Consequently, the F-1L device is increasingly used as the speech path switch in electronic switching systems.

When such miniaturized reed switch is used in a coil form the distances between the lead terminals are so small that connection of the multiple connecting wires to the lead terminals is difficult and short circuit between said lead terminals are easily caused. Further, when a large scale electronic switching system is assembled by using such miniaturized reed switches, a large number of components and a great amount of labor are required. Consequently, low cost due to mass production cannot be expected.

The object of the present invention is to provide a magnetically controlled switching device which overcomes the above-mentioned problems.

According to the first characteristic feature of the present invention, the magnetically controlled switching device has a plurality of reed switches having a magnetically latching function, and a plurality of coil forms containing said reed switches and around which the driving coils of said reed switches are wound, and which connects the lead terminals of the reed switches with the vertical and horizontal multiple connecting wires, and the device provides: (a) holding portions for holding said lead terminals in edge portions of the coil forms, and; (b) holes for obliquely passing through the lead terminals in said holding portions so that the lead terminals which are bent are easily passed through said holes.

According to the second characteristic feature of the present invention, the horizontal and vertical multiple connecting wires to which the above-mentioned lead terminals are connected provide projections having a U-shaped bent part in every matrix crosspoint.

A line drawn between adjacent lead terminals in a coil form is at an angle to the direction of the multiple connecting wires, and the connections between the lead terminals and the multiple connecting wires are effected in the above-mentioned U-shaped bent part.

According to the third characteristic feature of the present invention, the magnetically controlled switching device provides, on a magnetic shunt plate, coil forms and insulating plates which provide a plurality of terminals for driving wires of the reed switches, and supports the magnetic shunt plate with supporters, said coil forms, said insulating plates and said supporters for supporting said magnetic shunt plate are formed simultaneously as one body by molding with synthetic resin.

Further features and advantages of the present invention will be apparent from ensuing description, with reference to the accompanying drawings, to which, however, the scope of the invention is in no way limited.

FIG. 1 is a general view of a four wire magnetically controlled switching device;

FIG. 2 is a partially enlarged view of the device shown in FIG. 1;

FIGS. 3A and 3B are diagrams explaining the connection of the multiple connecting wires shown in FIG. 2;

FIG. 4 is a further partially enlarged view of the device shown in FIGS. 1 and 2;

FIG. 5 is a crosspoint used in the present invention;

FIGS. 6A and 6B are diagrams explaining a function of reed switch shown in FIG. 5;

FIGS. 7A and 7B are diagrams showing the construction of the conventional coil form for a reed switch;

FIGS. 8A and 8B are diagrams showing the construction of the coil form for the reed switch according to one embodiment of the present invention;

FIG. 9 is an enlarged view of the holding part of the coil form shown in FIG. 8;

FIG. 10 is a diagram explaining the construction of the magnetic shunt plate of the magnetically controlled switching device of one embodiment of the present invention;

FIG. 11 is a section of an enlarged portion of the coil form and the control terminal shown in FIG. 10.

Referring to FIG. 1, a coil form 1 contains a plurality of reed switches which are used as crosspoint switches, as mentioned hereinafter, and outside of each 1, a driving coil 8 which drives the above-mentioned reed switch 1 is wound. A magnetic shunt plate 2 is composed of magnetic material and provides a plurality of holes for arranging the above-mentioned coil forms 1 in matrix array. Horizontal and vertical multiple connecting wires 3 and 9 shown in FIG. 2, connect the lead terminals 6 of the reed switches held in the coil forms 1 with the output terminals (hereinafter described) of the circuits of the speech path. Said multiple connecting wires 3 and 9 are composed of high permeability magnetic material and are capable of relieving and demagnetizing effect between reed switches. Such phenomenon is frequently produced when the reed switch is miniaturized.

The exciting condition of each reed switch which is positioned at each crosspoint is shown in FIG. 3A. FIG. 3A shows a case where exciting coils XX′ and YY′ (hereinafter described) corresponding to the reed switches positioned at special crosspoints are selectively excited and the other reed switches positioned in the same rows and columns are restored. Referring to FIG. 3A, a surface determined by the one dot chain lines x_i and y_i represents the magnetic shunt plate surface, and the length of the arrows and the arrow heads, shown along the one point chain lines, respectively represent the magnitude and the direction of the magnetic field applied to the reed member of each reed switch.

Referring to FIG. 3B, a surface determined by the two dot chain lines x, y represents multiple connecting wires 3 and 9. This is, multiple connecting wire 3 connects, on the upper part of the magnetic shunt plate, the reed switches which are arranged in the row direction (x_i axis direction) and the multiple connecting wire 9 connects, on the lower part of the magnetic shunt plate, the reed switches which are arranged in the column direction (y_i axis direction). According to the above-mentioned connections, the reed member of the reed switch which is positioned at the crosspoint (x_i, y_i), multiple connecting wires 3, 9, the reed members of the reed switches which are positioned in the identical row or column adjacent to said reed switch and the magnetic shunt plate constitute a closed magnetic path. Therefore, when the excitation as shown in FIG. 3A is carried out, the reed member positioned at the crosspoint receives the additional magnetic flux from the adjacent reed switches. Then, even if the required magnetomotive force is small, the function of the reed member can be effected. When the excitation for restoration of reed switch is carried out, an additional amount of magnetomotive force equal to the amount of the leakage flux from adjacent reed switches is required and, consequently, the required magnetomotive force for the restoration becomes large. Therefore, the reed switch positioned at the excited crosspoint is not restored with noise.

The present invention will now be explained with reference to FIGS. 2 and 4. As shown in FIG. 2, four reed switches are inserted in the respective coil forms 1 so as not to lie on the same line with respect to the longitudinal directions of the respective multiple connecting wires 3 and 9, and connected to said respective multiple connecting wires 3 and 9. Thus, the multiple connecting wires 3 and 9 are respectively arranged on the same plane in parallel, with a substantially equal distance between adjacent connecting lines.

FIG. 4 is an enlarged perspective view illustrating a method of connecting the vertical multiple connecting wires 3 and the upper lead ends 6 of the four reed switches inserted in the coil form 1 and arranged at the four corners thereof. The horizontal multiple connecting wires 9 and the lead ends 6 are connected in the same manner as the wires 3 and the lead ends 6. Referring to FIG. 4, a projection 7, for engagement with each reed end 6, is formed on each multiple connecting wire 3 at the connecting portion of 3 and 6. This projection 7 is composed of a U-shaped bent portion 11 the inside of which contacts the lead end 6, and a supporting portion 10 supporting the bent portion 11 so as to prevent the bent portion from contacting the adjacent multiple connecting wire 3. The multiple connecting wires 3 and the reed switches contained in the respective coil forms 1 are arranged in the same manner as explained in FIG. 2, and the bent portion 11 of the projection 7 is engaged with and then soldered to the lead end 6. As a result of this arrangement the work of the assembly becomes very easy.

FIG. 5 shows the relation between the coil form 1 and the reed switches 13–15 which are contained in the bobbin 1. Referring to FIG. 5, four remanent reed switches 13, 14, 15 and 16 are contained in the wire coil form 1, and the lead ends 6 of these reed switches are arranged in row and column direction as shown in FIG. 2 and FIG. 4 as mentioned above, and connected with the multiple connection wires. FIG. 6A shows the function of the exciting coil, 6 represents one lead end of a reed switch and 2 represents the magnetic shunt plate. The exciting coils XX′ and YY′ are wound in opposite direction to each other, and the number of turns of the exciting coils XX′ and YY′ under the magnetic shunt plate 2 are repsectively n_1 and n_2 ($n_1 > n_2$). On the other hand, number of turns of the exciting coils XX′ and YY′ above the magnetic shunt plate 2 are respectively n_2 and n_1 ($n_1 > n_2$). And the portion of each exciting coil XX′ and YY′ above the magnetic shunt plate is wound in a direction opposite to that which is wound on the lower side of the magnetic shunt plate. Accordingly, when the exciting current i is applied only to the exciting coil YY′, the magnetic field Y shown in FIG. 6B is applied to the reed member of the reed switch, and when the exciting current i is applied only to the exciting coil XX′, the magnetic field X shown in FIG. 6B is applied to the reed member of the reed switch. In these cases, the upper reed member and lower reed member respectively receive the magnetic fields with opposite direction, then this reed switch is opened. When the exciting current i is supplied simultaneously to the exciting coils XX′ and YY′, the resultant of the magnetic fields X and Y are supplied to the reed members of the reed switch, and the upper reed member and lower reed member receive the magnetic fields with a same direction, and the reed switch is closed. When the exciting current i is cut off, the remanent reed switch is held in its closed condition by the residual flux of each reed member.

By uniformly winding the number of turns n_2 of the exciting coil with equal pitch over the width of the number of turns n_1, non uniformity of the magnetic field near gap of contact of the reed switch can be prevented, a uniform characteristic of the function of the reed switch can be obtained, and the required driving current can be decreased.

We will next explain in detail the construction of the coil form of the reed switch with respect to FIGS. 7A, 7B, 8A, 8B and 9.

FIG. 7A is a reed switch, FIG. 7B is a perspective view partly in broken section, showing a construction of the conventional coil form. Reference numerals which are the same in FIGS. 7A or 7B and in FIG. 5, represent the same meanings. As shown in FIG. 7B, a plurality of remanent reed switches 13 are contained in the coil form 1 which is inserted in the each hole of the magnetic shunt plate 2. The insertion of the reed switches 13 etc. into the coil form 1, is carried out as follows. Firstly, the lower side leads of said reed switches 13 etc. are held by respective jigs (not shown) and the upper side leads thereof are connected to respective horizontal multiple connecting wires. Next, said jigs are released and the lower side leads of the reed switches 13 etc. are connected to vertical multiple connecting wires. Thus, the reed switches 13 etc. are held in the coil form 1 by means of the said vertical and horizontal multiple connecting wires, positioned at the both sides of the selector switches 13–16.

As mentioned above, the construction of the bobbin for the reed switches according to the conventional art has several drawbacks in that the space between the two lead ends of the reed switch becomes small due to the miniaturization of the selector switch, so that it is very difficult to carry out the connecting operation between lead ends of the selector switches and the vertical and horizontal multiple connecting wires respectively, and there is a possibility of producing a dangerous short-circuit phenomenon. Moreover, a large amount of time and a human labor are required for the insertion of the selector switches into the bobbin. Further, it is very difficult to insert the reed switches in so that they are correctly disposed.

FIGS. 8A and 8B are perspective views, partly in broken section, of a reed switch and a construction of a coil form according to the present invention. FIG. 9 is an enlarged perspective view, partly in broken section, of a holding member of the coil form shown in FIG. 8B. As shown in FIG. 8A, both lead ends of the reed switches 13, etc., are bent at point 17. A holding member 19 provided with a plurality of guide holes 18 for guiding said bent lead ends of the reed switches 13, etc., are disposed at the upper and lower end portions of a coil form as shown in FIG. 9. Further, a plurality of guide projections 20 for guiding all the reed switches 13, etc., are provided on the inside wall of the coil form 1 as shown in FIG. 8B. In this embodiment, the reed switches 13, etc., are inserted into the coil form 1 and the bent lead ends of the reed switches 13, etc., are inserted into the guide holes 18.

The construction of the magnetic shunt plate 2 will next be explained with reference to FIG. 10 which shows the magnetic shunt plate 2, and FIG. 11, which shows the portion where the coil form 1 and control terminals 21 are fixed on the magnetic shunt plate 2.

Referring to FIG. 10, 6 are lead ends of corresponding reed switches, 2 is a magnetic shunt plate made of a magnetic material and provided with a plurality of through holes for securely holding therein the coil form 1 control (or junction, repeating) terminals 21 and supporting poles or pillars 22. L-shaped fixtures 23 are mounted on the extended four corners of the magnetic shunt plate 2. These fixtures 23 are used for attaching and earthing the entire device. The magnetic shunt plate 2 is provided with (a) the coil form 1, each containing the reed switches; (b) end flanges 24 for insulating and securing the control terminals 21 connected to corresponding exciting coils, each exciting the reed switches contained in the each coil form 1; (c) the supporting pillars 22 for supporting insulated substrates 25 and 25*a*, multiple connecting wires 3 connected to the corresponding lead ends 6 of the reed switches disposed above the insulated substrate, and; (d) insulating members 27 for preventing a short-circuit phenomenon between signal terminals 26 and the side surface of the magnetic short-circuit plate 2. The magnetic shunt plate 2, the coil form 1, the end flanges 24, the insulating member 27 and the supporting pillars 22 are formed simultaneously as one body by molding with synthetic resin. As shown in FIG. 11, after heating the control terminal 21, the heated control terminal 21 is pressed into the end flange 24 secured through the through hole formed in the magnetic shunt plate 2.

Further, in carrying out a winding operation of the driving coil, it is preferable that the end portion of the winding wire is firstly wound about the control terminal 21, and after completion of the winding operation a soldering treatment is carried out. In this case, if the thickness t_1 of a collar 28 of the coil form 1 is equal to the thickness t_2 of the end flange 24, the end portion of the winding wire can be wound about the control terminal 21 by horizontally displacing and turning the winding bit after the winding wire has been wound around the coil form 1. This is a necessary condition for automating the winding operation.

In the case of the conventional art where the control terminal 21 and the end flange 24 are separately formed and then are assembled together, it is necessary that the end flange 24 should have a sufficient thickness t_2 from the point of view of the strength and handling thereof. However, in the case of the present device, where the end flange 24 made of a resinous material is firstly formed to the magnetic shunt plate 2 and then the control terminal 21 is pressed into the end flange 24, the thickness t_2 of the end flange 24 can be reduced.

As mentioned above, the construction of the magnetically controlled switching apparatus according to the present invention results in the following three characteristic features.

a. By utilizing the coil form 1 shown in FIG. 8B and FIG. 9 the directions and positions of the respective reed switches can be correctly set by only inserting the lead ends of the reed switches into the guide holes. Further, the connection treatment between the two lead ends of the reed switches contained in the coil form and the multiple connecting wires can be carried out very simply because the space between the lead ends of the reed switches can be increased to approximately twice the length of that of the conventional art.

b. By arranging the reed switches contained in the respective coil forms and the vertical and horizontal connecting wires in the manner as shown in FIGS. 2 and 4 the above-mentioned reed switches and multiple con-

necting wires can be connected on the same plane. Further, the distance between facing connecting portions becomes large, so that operations such as assembling and soldering become very easy. Moreover, even though the distance between two lead ends is reduced due to the miniaturization of the reed switches, the connecting portions can be upwardly projected by providing the projections on the multiple connecting wires, and the possibility of producing a dangerous short-circuit phenomenon between the adjacent multiple connecting wires can be extremely reduced.

c. The composition of the magnetic shunt plate can be remarkably simplified. Further, since the magnetic shunt plate acts as an attaching member concurrently with an earth treatment member, the number of circuit components can be decreased. Moreover, the winding operation becomes very easy. Thus the present device displays a great many enhanced effects.

What is claimed is:

1. A magnetically controlled switching assembly comprising:

a. a plurality of reed switches having lead terminals which are bent;

b. a plurality of coil forms for containing said reed switches about which the driving coils of said reed switches are wound, said forms having unfilled apertures in the end portions thereof through which said bent lead terminals are passed; and

c. multiple vertical and horizontal conductors which are composed of magnetic material for connecting said leads at crosspoints of a matrix in row and column directions.

2. The magnetically controlled switching assembly according to claim **1**, wherein said multiple vertical and horizontal conductors provide projections at every matrix crosspoint, adjacent lead terminals in one coil form are shifted with respect to the direction of said multiple connecting conductors, and the connections between said lead terminals and said multiple connecting conductors are effected at said projections.

3. A magnetically controlled switching assembly according to claim **1**, further comprising a magnetic shunt plate on which said coil forms are mounted, a plurality of insulating plates on which are mounted a plurality of terminals for said driving coils, and supporting pillars which support said magnetic shunt plate, said coil forms, said insulating plates, said supporting pillars and said magnetic shunt plate constituting an integral structure.

* * * * *