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Parmenter

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[54] **SCANNER WITH REED RELAYS**

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[52] **U.S. Cl.** **335/151,** 335/152
[51] **Int. Cl.** **H01h 1/66,** H01h 51/00
[58] **Field of Search** 335/112, 151, 152, 153, 335/154

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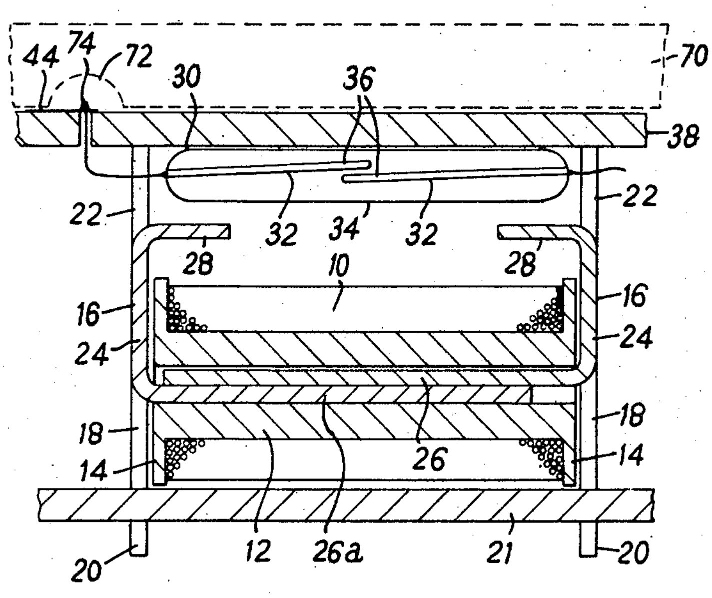
[57] **ABSTRACT**

Electrical switching apparatus such as a scanner comprises a plurality of reed relays, each of which has an operating coil, and at least one reed contact unit which is mounted outside the coil, to reduce thermal E.M.F. generation. The reed contact units are mounted on a first printed circuit board, and control respective analogue signals passing through the printed circuit tracks of this first board, while the coils are mounted on, and respectively energised via the printed circuit tracks of, a second printed circuit board parallel to the first board. In this way, interference between the scanned analogue signals and the relay energising signals is reduced.

7 Claims, 4 Drawing Figures



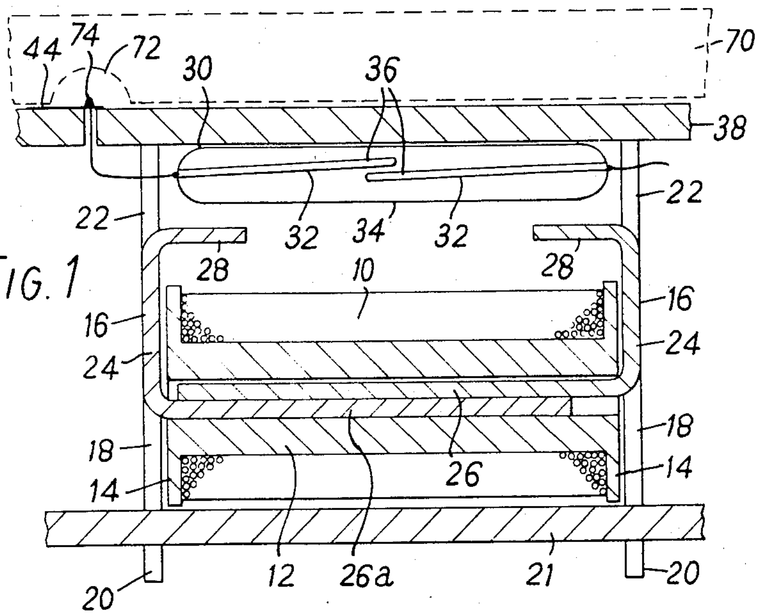

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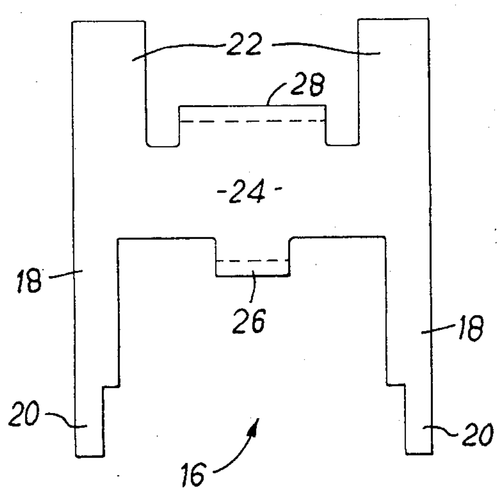
FIG. 1

FIG. 2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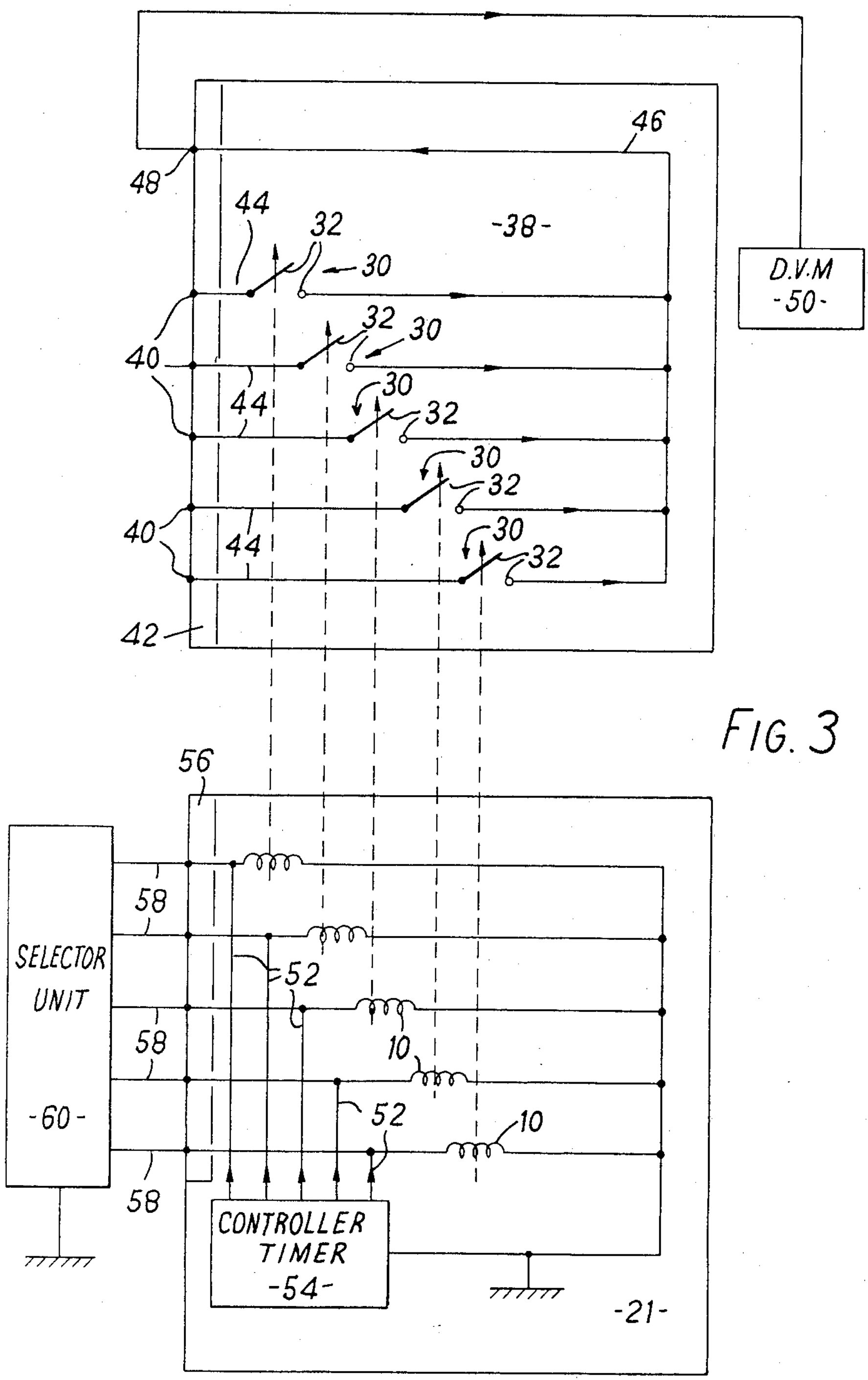
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SELECTOR UNIT
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10
CONTROLLER TIMER
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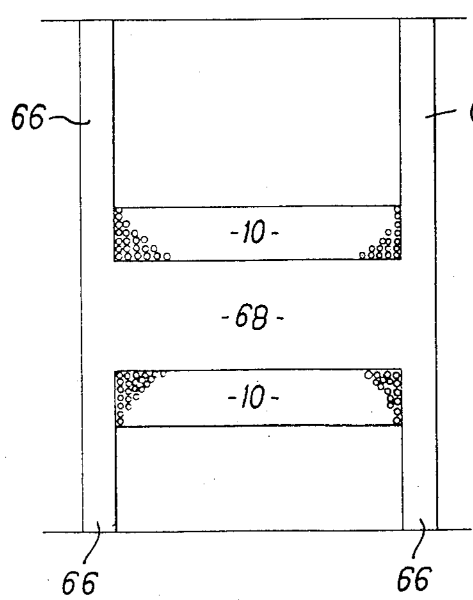
FIG. 3

FIG. 4



SCANNER WITH REED RELAYS

This invention relates to reed relays, and to electrical switching apparatus, such as scanners, employing reed relays.

In a known form of reed relay, the reeds comprise two elongated flexible electrical contacts of magnetic material, which are sealed within a glass capsule and are so secured at the opposite ends of the capsule that respective free end portions of the reeds lie alongside one another in spaced-apart relationship: the assembly of the reeds and the capsule will hereinafter be referred to as a reed contact unit. The reed contact unit is mounted within an electrical coil, with the reeds substantially parallel to the axis of the coil, so that the passage of an electric current through the coil causes the reeds to attract one another, thereby establishing electrical contact between them.

The passage of an electric current through the coil also generates heat which, in this known form of reed relay, is transmitted to the reeds. It has been found that, in operation, differences between the respective temperatures of the reeds arise, particularly where there is asymmetry in the arrangement of the reeds within the coil: typically, where the coil is dissipating three quarters of a watt, a temperature difference between the reeds of about one Centigrade degree may arise. This temperature difference may be transferred to the respective junctions between the reeds and the circuitry of which they form part, which can, in turn, lead to the production of a thermal E.M.F. of up to 40 microvolts between the reeds. This is particularly disadvantageous, for example, when the reed relay forms part of a scanner, and is being used to switch low voltages which are to be measured in an electrical measuring instrument such as a digital voltmeter.

Moreover, in electrical switching apparatus such as scanners, employing reed relays for selectably or sequentially connecting each one of a plurality of analogue input signals to an output, e.g. for measurement purposes, it is desirable that the analogue input signals be isolated from the signals used to energise the relays, so as to reduce the possibility of interference between the relay energising signals and the analogue signals. At the same time, it is desirable to use a printed circuit type of construction, for ease and economy of manufacture and for good accessibility and replaceability.

It is an object of the present invention to provide a reed relay in which differential heating of the reeds by the coil is substantially reduced, and which is relatively simple and economical to manufacture. It is a further object of the present invention to provide electrical switching apparatus, such as a scanner, employing reed relays, in which interference between the relay energising signals and the signals being switched by the relays is substantially reduced.

According to one aspect of the present invention, therefore, a reed relay comprises a coil, two plate-like pole pieces which are respectively positioned at opposite ends of the coil and which are substantially perpendicular to the axis thereof, each pole piece having a respective first bent-over portion which extends axially into the coil and a respective second bent-over portion which extends substantially parallel to the axis of the coil and towards the second bent-over portion of the other pole piece, and at least one reed contact unit which is positioned outside the coil and is adapted to be mounted parallel to and adjacent a line joining the second bent-over portions, the first bent-over portions being arranged to overlap each other within the coil, and together be a push fit therein.

In a preferred embodiment of this aspect of the invention, the pole pieces are substantially H-shaped in plan view, the first and second bent-over portions extending substantially perpendicularly to the plane of the H-shape, both in the same direction, from the opposite sides of the cross-piece of the H-shape.

The pole pieces may conveniently be made by suitably bending a blank stamped from a mild steel sheet.

According to another aspect of the present invention, a reed relay comprises a core member, a coil wound upon the core member two pole pieces which are respectively positioned at opposite ends of the coil and which are substantially perpendicular to the axis thereof, the pole-pieces and the core member being integrally formed from a plastics material loaded or filled with a ferromagnetic material, and at least one reed contact unit which is positioned outside the coil and is adapted to be mounted parallel to the axis of the coil and adjacent a line extending perpendicularly between the pole pieces.

The ferromagnetic material may be iron powder, and the pole pieces and the core member may be formed by moulding.

The invention also includes electrical switching apparatus such as a scanner, or a digital voltmeter or other electrical measuring instrument, incorporating at least one reed relay in accordance with any of the preceding statements of invention.

According to a further aspect of the present invention, electrical switching apparatus such as a scanner includes:

a plurality of reed relays each comprising a coil, at least one reed contact unit positioned outside the coil, and magnetic circuit means for transmitting magnetic flux produced by the coil to the reed contact unit to as to cause, in use, electrical contact between the reeds thereof;

at least one first printed circuit board having a plurality of first electrically conductive tracks thereon for the passage of respective analogue electrical signals, each reed contact unit being mounted on the first board and connected in series with a respective one of the first tracks; and

at least one second printed circuit board which is substantially parallel to the first board and has a plurality of second electrically conductive tracks thereon for the passage of respective relay energising signals, each of the coils being connected in series with a respective one of the second tracks;

the reed relays being positioned between the first and second boards.

Each coil may conveniently be mounted on the second board.

Preferably, the first and second boards are secured to each other in spaced-apart relationship.

For each reed relay, magnetic circuit means may comprise two pole-pieces respectively positioned at opposite ends of the coil, and the pole pieces may conveniently also serve to space-apart the first and second boards.

In a preferred embodiment of this aspect of the invention, for each reed relay, the axis of the coil is parallel to the plane of the second board, and the pole pieces comprise respective plate-like each having a respective first bent-over portion which extends axially into and is secured within the coil and a respective second bent-over portion which extends substantially parallel to the axis of the coil and towards the second bent-over portion of the other pole piece, the reed contact unit being positioned parallel to and adjacent a line joining the second bent-over portions.

The invention will now be further described, by way of non-limitative example only, with reference to the accompanying drawings, of which:

FIG. **1** is a cross-sectional view of part of a scanner in accordance with the present invention, incorporating a reed relay also in accordance with the present invention;

FIG. **2** is a plan view of a pole piece for use in the reed relay of FIG. **1**;

FIG. **3** is a greatly simplified schematic circuit diagram of the scanner of FIG. **1**;

and FIG. **4** is an alternative construction for the pole-piece of FIG. **2**.

Referring first to FIG. **1**, the reed relay comprises an electrical coil **10** wound on a hollow plastics bobbin **12**. The hollow interior of the bobbin **12** is substantially rectangular in cross-section and the bobbin is provided with an outwardly extending, approximately rectangular flange **14** at each end.

At each end of the bobbin **12** there is positioned a respective approximately H-shaped plate-like pole piece **16**, made from mild steel sheet: the H-shape of each pole piece **16** is shown more clearly in FIG. **2**. Each of the pole pieces **16** is disposed in a plane substantially perpendicular to the common axis of the coil **10** and bobbin **12**, and they are arranged so that their H-shapes are in substantial alignment.

The lower ends of the lower limbs **18** of each of the pole pieces **16**, as viewed in FIG. **2**, are provided with respective reduced-width portions **20**, which may conveniently project through holes in a printed circuit board **21** of the scanner, so as to facilitate mounting the pole pieces **16** on the board. The upper limbs **22** of each of the pole pieces **16** are substantially uniform in width, and are shorter than the lower limbs **18**.

The H-shape of each of the pole pieces **16** has a respective cross-piece **24**. A bent-over portion **26** extends perpendicularly to the plane of the H-shape of one of the pole pieces **16**, from the side of the cross-piece **24** adjacent the lower limbs **18**, into the hollow interior of the bobbin **12**, and is almost equal in length to the axial length of the bobbin. A corrsponding bent-over portion of the other pole piece **16** is indicated at **26*a*** and is similar to the portion **26** but slightly displaced with respect thereto, so that the portions **26, 26*a*** overlap each other within the hollow interior of the bobbin **12** and together are a push-fit therein. A respective further bent-over portion **28** also extends perpendicularly from the plane of the H-shape of each of the pole pieces **16**, in the same respective directions as the portions **26, 26*a***, but from the side of the cross-piece **24** adjacent the upper limbs **22**. The portions **28** are substantially aligned with each other in a common plane parallel to but displaced from the common axis of the coil **10** and bobbin **12**, and are shorter than the portions **26, 26*a***, so that their adjacent ends are spaced apart.

Each of a plurality of reed contact units **30** comprises two elongated reeds **32** sealed in a substantially cylindrical glass capsule **34** and is mounted as will hereinafter be described outside the coil **10**. The reeds **32** are so secured at opposite ends of the capsule **34** that they are substantially parallel, with their free end portions **36** overlapping and slightly spaced apart. They are made from a nickel alloy, and the portions **36** preferably have a diffused gold coating to provide good electrical contact properties.

Typically there may be four reed contact units **30**, and they are arranged substantially parallel to each other and to the common axis of the coil **10** and bobbin **12**, and slightly displaced from the common plane containing the bent-over portions **28** on the side of this common plane remote from the coil **10** and bobbin **12**. The reed contact units **30** thus extend from the region between the upper limbs **22** and one of the pole pieces **16** to the region between the upper limbs **22** of the other pole piece **16**.

As already mentioned, the pole pieces **16** are mounted on the printed circuit board **21**, and it will be appreciated that the coil **10** and bobbin **12** are secured to the board **21** by means of the bent-over portions, **26, 26*a*** of the pole pieces. In this case, the reed contact units **30** can conveniently be mounted on a further printed circuit board **38** of the scanner, which further board is parallel to, and fixedly mounted on, the board **21**. As can be seen in FIG. **1**, the pole pieces **16** also serve as spacers to space-apart the boards **21, 38**.

In operation, when an electric current is passed through the coil **10** a magnetic field is produced along the axis of the coil, which magnetic field is entrained by the pole pieces **16** to produce a magnetic field extending between the bent-over portions **28**. This field is parallel to the reeds **32** and causes them to attract one another, thereby establishing electrical contact between their end portions **36**. The upper limbs **22** of the pole pieces **16** serve to reduce magnetic flux leakage and concentrate the magnetic flux in the region between the bent-over portions **28**. Since the reed contact units **30** are mounted outside the coil **10**, heating of the reeds **32** by the coil **10** in operation is substantially reduced. The reed relay hereinbefore described is thus particularly suitable for use in switching apparatus such as scanners, or in other applications where it is desired to switch a low voltage which is to be measured in an electrical measuring instrument such as a digital voltmeter.

Each of the pole pieces **16** is produced by stamping a suitably shaped blank from a mild steel sheet, and then appropriately bending or folding the blank to produce the bent-over portions **26, 26*a*** and **28**. It will be appreciated that this is a relatively simple and economical process.

The circuit of the scanner is shown in FIG. **3**, and comprises a plurality of analogue inputs **40** forming part of an edge connector **42** of the printed circuit board **38**. Each of the inputs **40** may be connected to receive an analogue signal from a respective one of a plurality of separate, remotely positioned transducers (not shown), and is connected, via a respective printed circuit track **44** provided on the board **38**, to one of the reeds **32** of a respective reed contact unit **30**. The other reed **32** of each of the reed contact units **30** is connected to a common printed circuit track **46**, which is in turn connected to an output **48** in the edge connected **42**. The output **48**, which constitutes the analogue output of the scanner, is shown connected to the input of a digital voltmeter **50**, which may for example form part of a data logger and be provided with print-out facilities.

The respective coils **10** associated with the reed contact units **30** are shown mounted on the printed circuit board **21**, and are connected to be sequentially energised, via respective printed circuit tracks **52** provided on the board **21**, by a controller/timer circuit **54** also mounted on the board **21**. The circuit **54** may typically sequentially energise the coils **10** for one second each at one second intervals, and repeat the sequence every hour: the timing will be determined in each instance by the measuring and print-out time required by the digital voltmeter **50**, and the frequency with which it is desired to take measurements with the transducers.

The printed circuit tracks **52** are also connected, via an edge connector **56**, to the outputs **58** of a selector unit **60**. The selector unit **60** is manually operable, e.g. by means of numbered push-buttons (not shown), to permit any one of the coils **10** to be energised, so that measurements can be taken at times other than those determined by the controller/timer circuit **54** if desired.

It will be appreciated that the tracks **44, 46** are isolated from the tracks **52** by virtue of being on separate printed circuit boards, **38** and **21** respectively. This substantially reduces the possibility of interference between the relay energising signals from the controller/timer circuit **54** (or selector unit **60**) and the analogue signals from the transducers.

Several modifications may be made to the described embodiments of the invention. For example, the pole pieces **16** need not be H-shaped: in particular, the upper limbs **22** may be omitted. Additionally, the pole-pieces **16** could be replaced by the pole-pieces **66** shown in FIG. **4**. The pole-pieces **66** are substantially parallel, and are joined together by a core member **68** which is formed integrally, e.g. by moulding, with the pole-pieces **66** from a plastics material filled or loaded with a ferromagnetic material such as iron powder. The coil **10** is simply wound upon the core-member **68**. Moreover differential heating of the respective junctions between the reeds **32** and the tracks **44** and **46** can be still further reduced by shielding these junctions from air currents by means of moulded shielding members secured to the board **38**. These shielding members may be made, for example, from expanded polystyrene, and be provided with cavities which locate over and isolate the junction: such a shielding member is shown dotted at **70** in FIG. **1**, the cavities being indicated at **72** and the junctions at **74**. Finally many other applications of reed relays in accordance with the present invention are possible.

What is claimed is:

1. A scanner unit for selectively connecting one of a plurality of analog electrical signals to be measured to the input of an electrical measuring instrument, the scanner unit comprising a first printed circuit board having a plurality of first electrical conductive tracks thereon for the passage of the analog electrical signals; a second printed circuit board mounted in substantially parallel relationship to said first board and having a plurality of second electrically conductive tracks thereon for the passage of relay energizing signals; a plurality of reed relays each comprising a coiled conductor connected directly in series with one of said second tracks and responsive to a relay energizing signal thereon to produce magnetic flux, and at least one reed contact unit positioned outside of the coiled conductor and responsive to the magnetic flux produced by said coiled conductor to close normally open contacts therein, each of said reed contact units being mounted directly on said first board, the contacts within each said reed contact unit being connected directly in series with one of said first tracks whereby selective energization of one of said second tracks causes completion of a circuit through at least one of said first tracks to the measuring instrument.

2. A scanner unit according to claim **1** and further comprising means for mounting each coiled conductor on the second board.

3. A scanner unit according to claim **1** and further comprising means for securing the first and second boards to one another in spaced apart relationship.

4. A scanner unit according to claim **1** wherein each reed relay further includes magnetic circuit means for transmitting the flux produced by the coiled conductor to the reed contact unit, said magnetic circuit means comprising two pole pieces respectively positioned at opposite axial ends of the coiled conductor.

5. A scanner unit according to claim **4**, wherein said pole pieces include spacer means for spacing apart said first and second boards.

6. A scanner unit according to claim **4**, wherein, for each reed relay, the axis of said coiled conductor is parallel to the plane of said second board, and said pole pieces comprise respective plate-like members each having a respective first bent-over portion which extends axially into and is secured within the coiled conductor and towards the second bent-over portion which extends substantially parallel to the axis of the coiled conductor and towards the second bent-over portion of the other pole piece, said reed contact unit being positioned parallel to and adjacent a line joining the second bent-over portions.

7. A scanner unit as claimed in claim **4**, wherein, for each reed relay, there is provided a core member upon which the coiled conductor is wound with its axis parallel to the plane of the second board, and wherein pole pieces and the core member are integrally formed from a plastics material loaded or filled with a ferromagnetic material.

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