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(54) **Title**: AN ELECTRO PERMANENT MAGNETIC WORK HOLDING SYSTEM INVOLVING CONVERSION OF MAGNETIC POLE FROM SQUARE POLE TO LONG POLE OR A CROSS POLE CONFIGURATION OR VICE VERSA

(57) **Abstract**: An electro permanent magnetic work holding system with variable magnetic pole configuration (5), comprising a work holding face(l) located on a base plate (2) carrying electrical winding (3) with magnetic poles (4), below which are placed permanent magnets (5), the said system being characterized in that the said magnetic poles are deployed in square pole, long pole or cross pole configuration or arrangement, there allowing handling of work pieces varying dimensions with a greater degree of attachment with the said work holding face (1).

An Electro Permanent Magnetic work holding system involving conversion of magnetic pole from Square pole to Long pole or a Cross pole configuration or vice versa.

The subject invention relates to an Electro Permanent Magnetic work holding system (herein after referred to as EPM) involving conversion of magnetic pole from Square pole to Long pole or a Cross pole configuration or vice versa. The change of configuration of the poles is accomplished by changing the polarity of the permanent magnets positioned below the magnetic poles. This can be achieved by altering the direction of flow of current in the electrical solenoids surrounding the permanent magnets.

Conventional EPM have a particular pole configuration, namely square, long or transverse etc. Different pole configurations are best suitable for different applications. The new invention provides an apparatus which can be converted from one pole configuration to another, the selection of which can be done depending upon the type of application.

In metal working machines such as CNC machining center, milling machines, electrical discharge machines (EDM), grinding machine, etc., a magnetic work holding apparatus is often used as a worktable, whereby a work piece to be machined can be held securely on the worktable by magnetic force, and then machining operation may be performed on the work piece.

In the prior art, Electro permanent magnetic (EPM) work holding apparatuses of flux reversal type are known in which a magnetic circuit is activated or deactivated by magnetising or demagnetising the permanent magnets inside the apparatus. This is a combination of permanent magnetic and electro magnetic devices: it presents the advantages of the latter without the disadvantages of the former. These devices use intrinsic energy of the permanent magnetic device but instead of being switched "ON" or "OFF" mechanically, it requires electrical pulses similar to electro magnetic devices but only momentarily delivered by an electrical winding.

Once switched "ON", these devices provide magnetic force for infinite duration of time independent of any external energy source. For instance, US Patent No. 4507635 granted to Michele Cardone of Milan, Italy, pertains to a magnetic anchoring apparatus, comprising in combination: an external ferromagnetic crown provided with a base plate and lateral walls; at least one group of four pole pieces defining pairs of corresponding poles of an anchoring surface, said pole pieces presenting their longitudinal axes at right angles to the base plate and in correspondence with the apices of a square. Moreover, the apparatus comprises a plurality of permanent magnets for feeding the aforesaid poles, interposed between the pole pieces, and between the latter and said ferromagnetic crown.

The principal property of a magnet is its capability to attract ferromagnetic materials resulting from flow of magnetic energy called "flux" between magnetic north and south poles. When a ferromagnetic work piece is placed across the poles of a magnet, the "flux" passes through it and the work piece gets attracted.

The strength of attraction of a magnet is the function of the quantum of induction of magnetic flux into the work piece and this depends on the pole configuration of the work holding apparatus.

The arrangements of magnetic poles are shown in the accompanying drawings which are given by way of illustration and not by way of limitation, wherein

Fig.1 shows the square poles which were hitherto being used;

Fig.2 shows the arrangement for long pole configuration;

Fig.3 depicts the arrangement involving cross pole configuration.

Fig 4 and Fig 5 illustrates the use of ferromagnetic strips as additional pole pieces to enhance the performance of the work holding assembly for long pole and cross pole configurations.

In the aforementioned Figures 1-5, the principal components are described with suitable numerals. The work holding face of the apparatus is (1), the base plate is (2), (3) shows the electrical windings, Magnetic poles are shown as (4), permanent magnets are denoted by (5) and the additional pole pieces as 6.

The long pole and/or cross pole arrangements of the magnetic poles in accordance with the invention has offered a number of advantages, the most prominent of which is the possibility of using work pieces of varying dimensions , apart from cost considerations.

Conventional EPM apparatus usually has a square pole configuration which somewhat restrict the adaptability of the apparatus to a particular nature of work piece.

The present invention substantially improves the performance by changing the pole configurations from square to long pole or cross pole configurations.

It is an object of the present invention to improve the performance of the EPM apparatus by alternating the configuration of the magnetic poles.

A further object of this invention is to improve upon the performance of the EPM apparatus by providing ferromagnetic strips to act as additional pole pieces by interconnecting individual magnetic poles.

A still further object of this invention is to provide means for effecting alteration in the configuration of the magnetic poles of the EPM apparatus, as and when needed or desired.

Another object of this invention is to provide means for enhancing the quantum of induction of magnetic flux into the work piece for better attraction thereof to the work holding surface.

The foregoing objects are achieved by the present invention which related to an electro permanent work holding system with desired variable magnetic pole configuration(s), comprising a work holding face located on a base plate, carrying electrical winding with magnetic poles, below which are placed permanent magnets, the said system being characterized in that the said magnetic poles are deployed in long pole and/or cross pole configurations or arrangement,

thereby allowing handling of work pieces of varying dimensions with a grater degree of attachment with the said work holding face.

From the foregoing it has been observed that the pattern of flux to a large extant depends on the configuration of magnetic poles. Thus the pattern of flux in a square pole configuration varies from the one in long pole or cross pole configuration. Proper selection of the configuration in accordance with the present invention yields desirable result.

In a further embodiment of the present invention, change of configuration of the poles accomplished by changing the polarity of the permanent magnets located beneath in magnetic poles.

In the subject system solenoids are provided around the said permanent magnets for altering or changing the direction of current flow to effect the desired change of polarity resulting the change of configuration.

As the present invention may be embodied in several forms with out departing from the sprit or essential characteristics thereof, it should be understood that the above-described features are not limited by any of the foregoing description, unless otherwise specified, but rather should be construed broadly within its sprit and scope as defined in the appended claims, and therefore all changes and modifications that fall within the meets and bounds of the claims, or equivalences of such meets and bounds are intended to embraced by the appended claims.

I claim:

An electro permanent magnetic work holding system with variable magnetic pole configuration(5), comprising a work holding face(1) located on a base plate(2) carrying electrical winding (3) with magnetic poles(4), below which are placed permanent magnets (5), the said system being characterized in that the said magnetic poles are deployed in square pole, long pole or cross pole configuration or arrangement, there allowing handling of work pieces varying dimensions with a greater degree of attachment with the said work holding face(1).

A system as claimed in claim 1, characterized in that ferromagnetic strips(6) are provided therein which act as additional pole pieces by interconnecting individual magnetic poles whereby enhancing the performance of the work holding assembly, simultaneously protecting the work face(1) from were and tear.

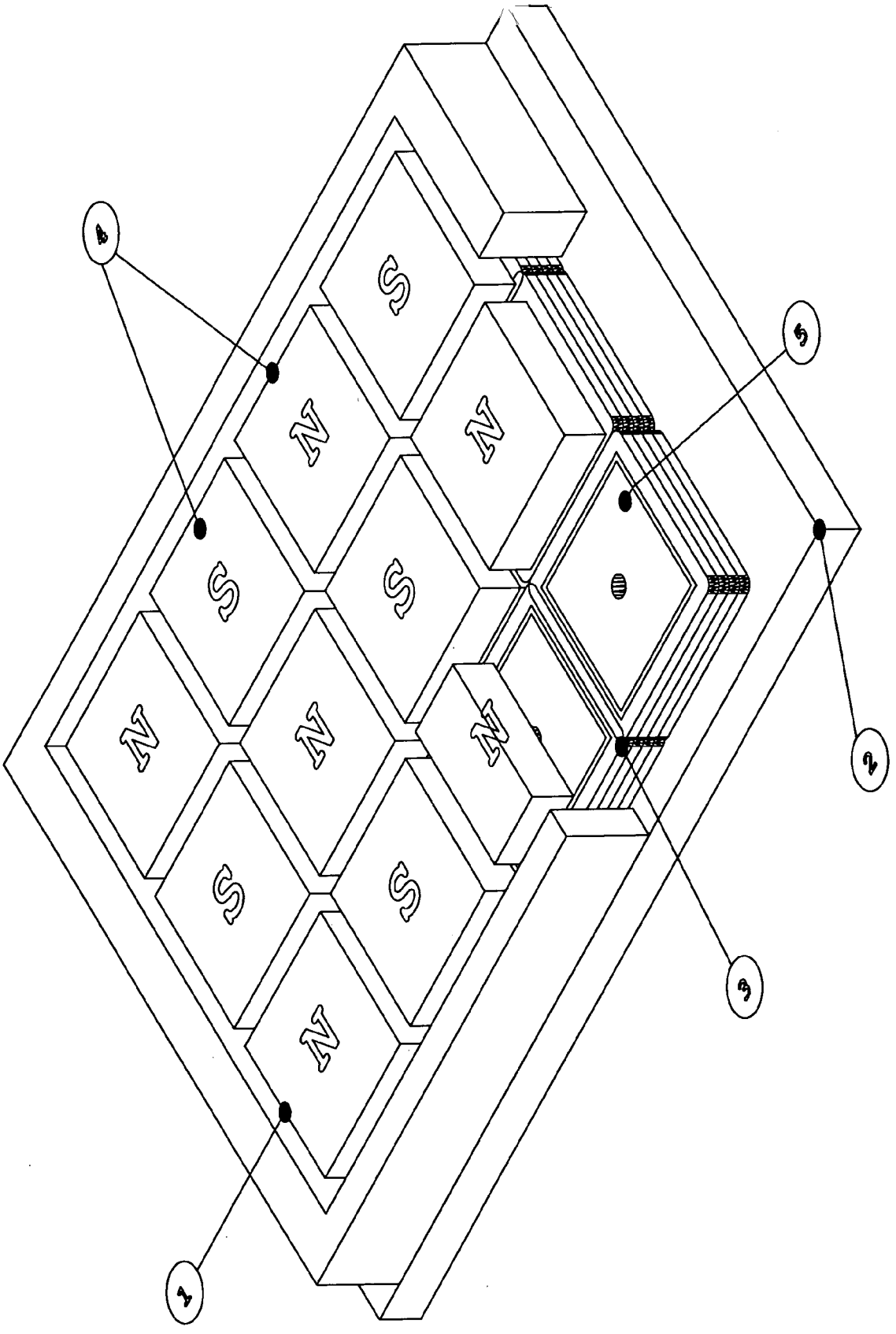
A system as claimed as claim 1, characterized in that the change in poles is accomplished by changing the polarity of the permanent magnets(5) located below the magnetic poles(4).

A system as claimed as claim 3, characterized that solenoids are provided around the said permanent magnets(5) for altering or changing the direction of current to effect the desired change of polarity resulting in change of configuration.

A system as claimed as claim 2, characterized in that the said ferromagnetic metal strips(6) acting as additional pole pieces are arranged either in longitudinal or transverse configuration with reference to the main magnetic pole pieces(4).

A system as claimed as claim 5, characterized in that the said ferromagnetic strips are made of soft iron.

An electro permanent magnetic work holding system with desired variable magnetic pole configuration(5), substantially as hereinbefore described with particular reference to the accompanying drawings.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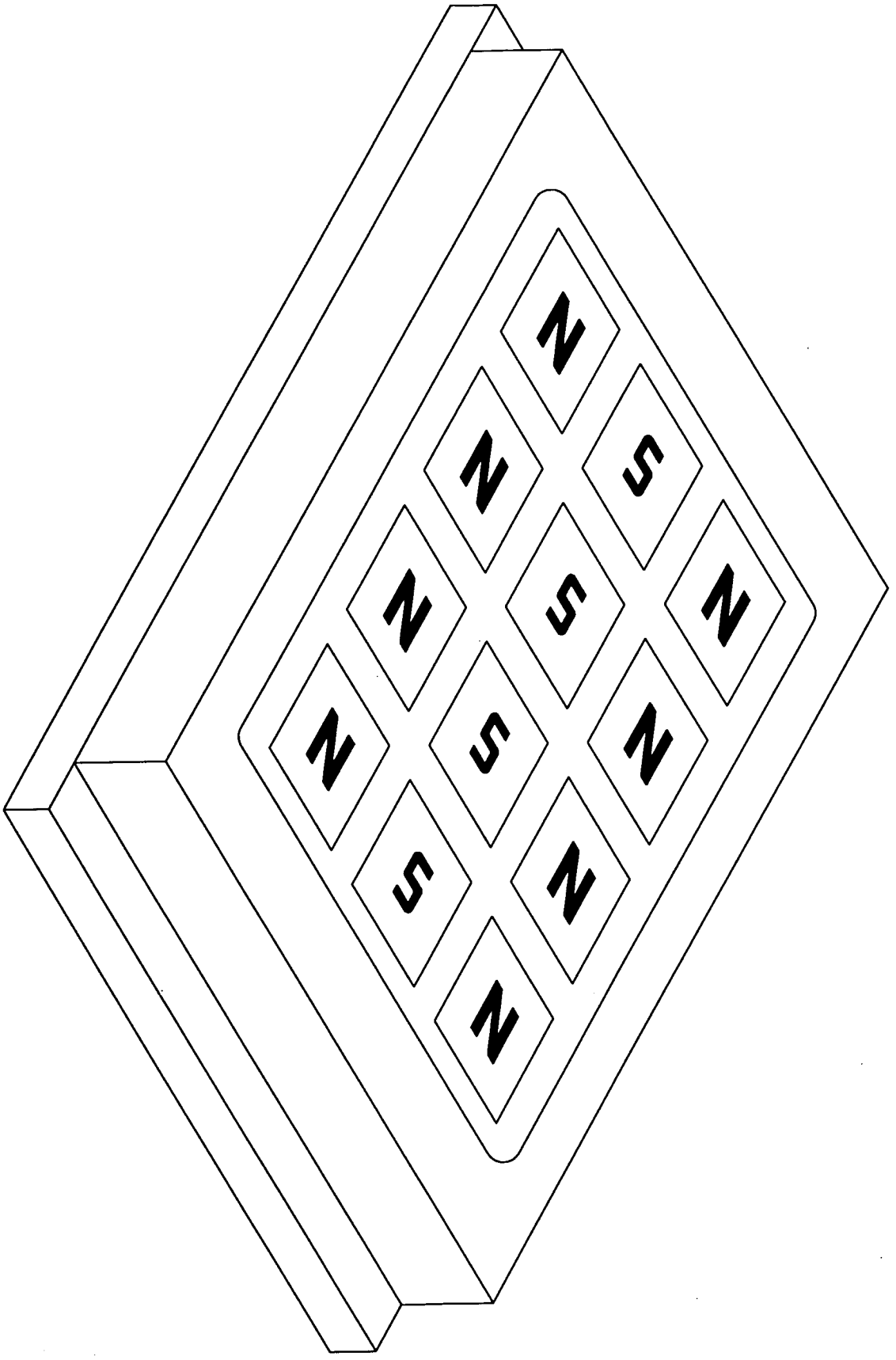

Fig. 2

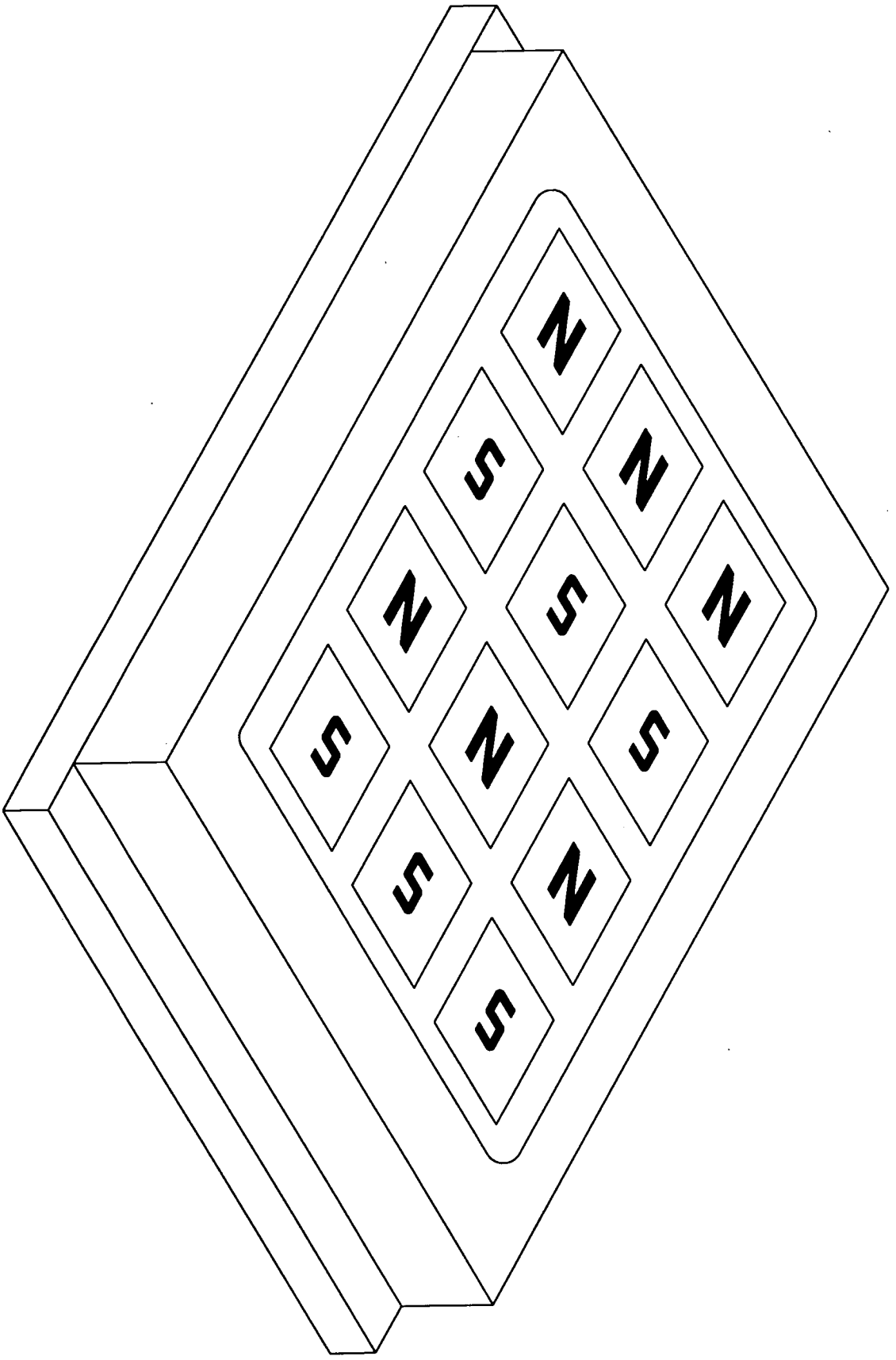

Fig. 3

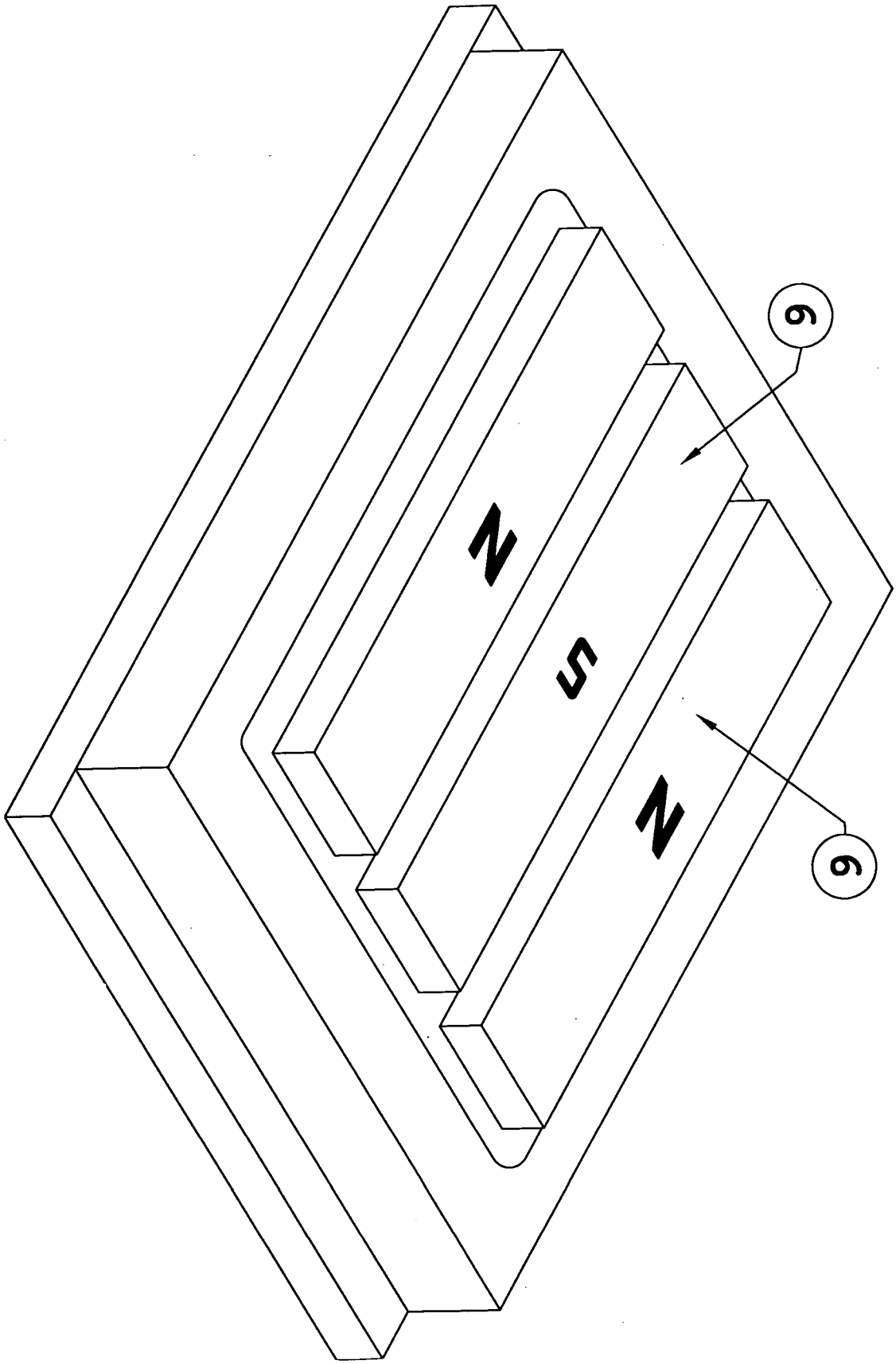

Fig. 4

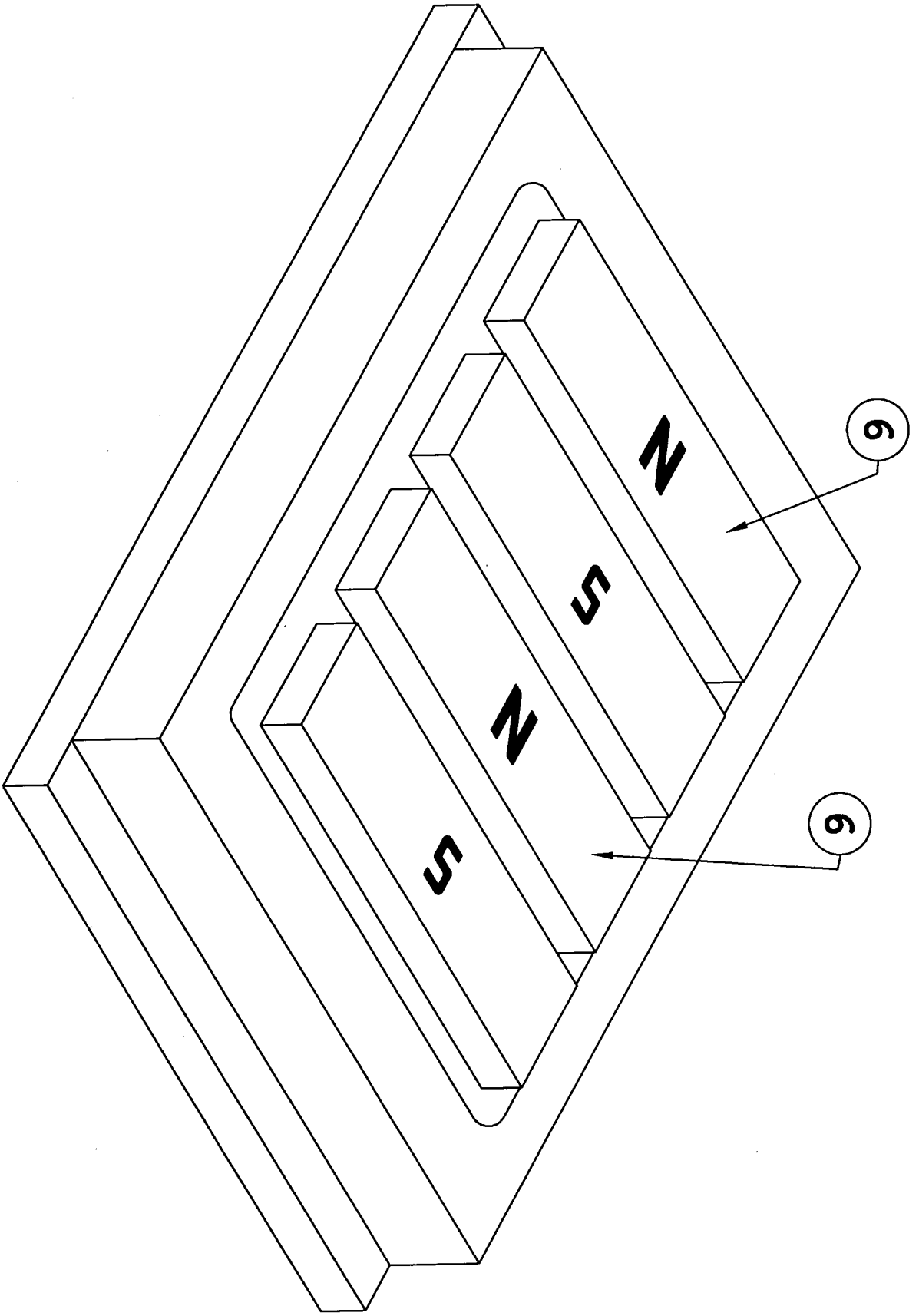

Fig. 5