# United States Patent

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[72] Inventors: Mitsunori Yamane; Masayuki Hayashi, both of Fukuyama, Japan



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[73] Assignee Mitsubishi Denki Kabushiki Kaisha Toyko, Japan
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[31] 43/55956


[54] CONTROL DEVICE FOR REED SWITCH

3 Claims, 4 Drawing Figs.


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[51] Int. Cl. H01h 41/00
[50] Field of Search 335/205-207



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*Primary Examiner*—G. Harris
*Assistant Examiner*—R. N. Envall, Jr.
*Attorneys*—Robert E. Burns and Emmanuel J. Lobato



**ABSTRACT:** Four permanent magnets are disposed at predetermined angular intervals equal to an angle of 36° on a circular magnetic substrate by having the S pole faces of the first and fourth magnets and the N pole faces of the second and third magnets fixed to the substrate on a circle concentric to it. With the substrate rotated, a reed switch above it faces successively the first and second magnets to close the switch, the second and third magnets to open the switch, and the third and fourth magnets to again close the switch to permit pulses to be generated.

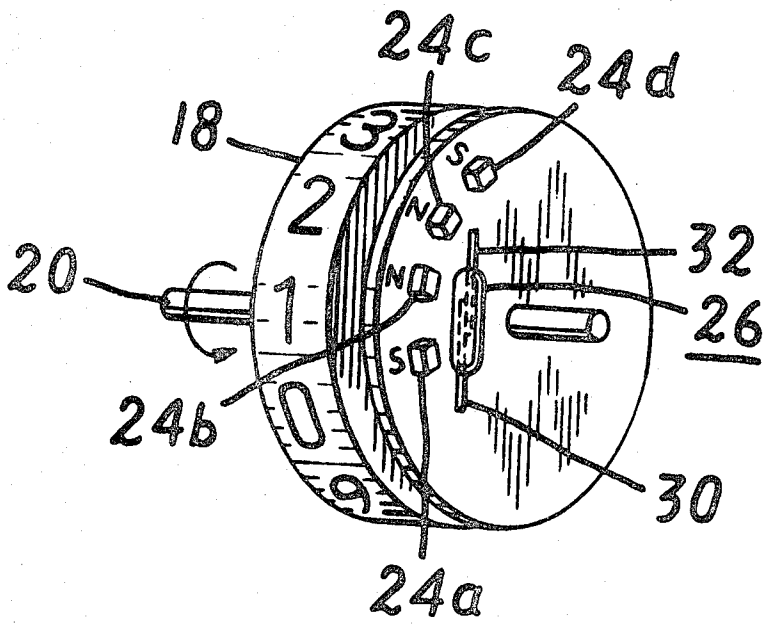



FIG. 1

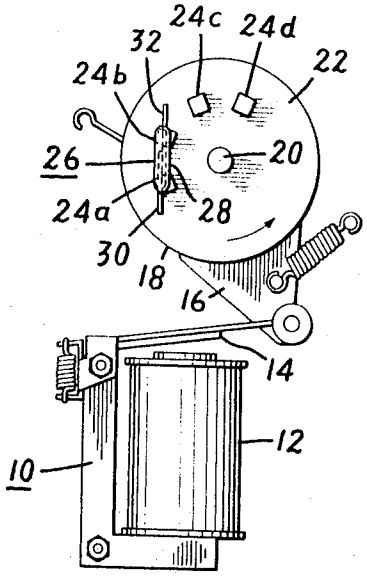



FIG. 2

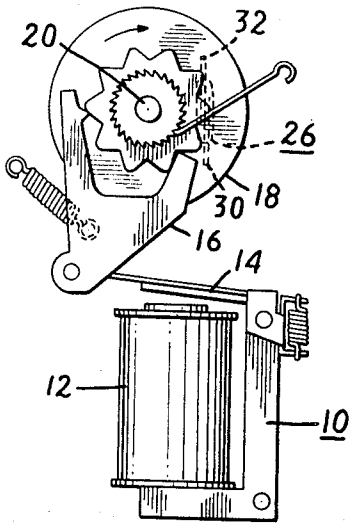



FIG. 3

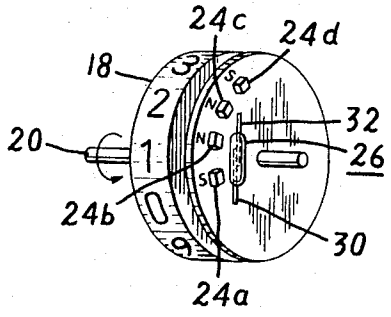
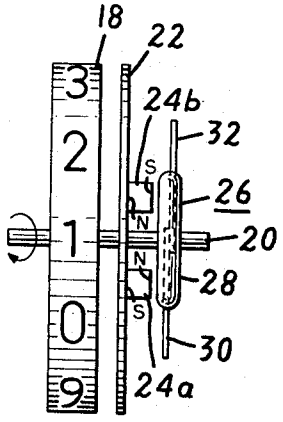



FIG. 4



# CONTROL DEVICE FOR REED SWITCH

## BACKGROUND OF THE INVENTION

This invention relates in general to a pulse-generating device, and more particularly to improvements in a pulse-generating device suitable for use with a read out counter system.

In order to obtain a small-sized pulse-generating device of the type referred to, the device could previously include a magnetic reed switch comprising a pair of reed-shaped contact strips, one of which has a stationary permanent magnet disposed in the proximity thereto and the other of which has a movable iron piece movable toward and away from the same. The movement of the movable iron piece toward and away from the other iron contact strip causes the closing and opening of a magnetic circuit composed of the permanent magnet, the contact strips and a magnetic support for the switch thereby to control the operation of the switch to produce pulses. In those switches, the repeated opening and closing of the magnetic circuit has been controlled only by the movable iron piece, movable toward and away from the other contact strip, so that a remanence may remain on the movable iron piece, and on the contact strips etc. Alternatively, a leakage flux due to the permanent magnet close to the one contact strip may form a magnetic circuit extending through components (for example, the support for the contact strip) other than the movable iron piece. Therefore it has been disadvantageous in that the separation of the movable iron piece from the other contact strip may not lead to a fool-proof opening of the read switch.

## SUMMARY OF THE INVENTION

Accordingly, it is an object of the invention to provide a pulse-generating device including a new and improved magnetic read switch including a pair of reed-shaped contact strips which provide a highly reliable device.

It is another object of the invention to provide a pulse-generating device including a new and improved means for ensuring that a pair of reed-shaped contact strips are separated from each other by the action of an inherent resilience of the strips.

The invention accomplishes the above-cited objects by the provision of a pulse-generating device comprising a rotary substrate, permanent magnet means disposed on the substrate, and a magnetic reed switch fixedly disposed above the substrate and including a pair of resilient reed-shaped contact strips, characterized in that the permanent magnet means include a plurality of permanent magnets disposed at predetermined angular intervals on the substrate and substantially on a circle having the center lying on the axis of rotation of the latter, and that the magnetic reed switch lies opposed to a path along which the pole face of each of the permanent magnets is moved as the substrate is rotated, the pair of resilient reed-shaped contact strips being contacted by each other through magnetic attraction when the strips face a pair of pole faces dissimilar in polarity and separated away from each other through magnetic repulsion when the strips face a pair of pole faces similar in polarity.

Preferably, each permanent magnet may have one pole face fixedly secured to the substrate and its other pole face capable of facing the magnetic reed switch, said magnets having a predetermined pattern of polarity distribution.

Conveniently, the permanent magnet means may include at least three permanent magnets, a first one of the magnets having the pole face fixed to one substrate and of opposite polarity the corresponding pole faces of the second and third magnets fixed to the substrate wherein a first pair of adjacent pole faces with similar polarity are disposed between a second pair of pole faces having polarities opposite to those of said first pair.



## BRIEF DESCRIPTION OF THE DRAWING

The invention will become more readily apparent from the following detailed description taken in conjunction with the accompanying drawing in which:

FIG. 1 is a schematic front view of a pulse-generating device constructed in accordance with the principles of the invention and incorporated into a read out counter;

FIG. 2 is a schematic rear view of the device illustrated in FIG. 1;

FIG. 3 is a schematic perspective view of the pulse-generating unit shown in FIGS. 1 and 2; and

FIG. 4 is an elevational view of the unit shown in FIG. 3.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawing and FIGS. 1 and 2 in particular, it is seen that an arrangement disclosed herein comprises an electromagnet generally designated by the reference numeral 10 including an electromagnetic coil 12 and a movable iron piece or armature 14. The coil 12 is adapted to be intermittently energized with input pulses dependent upon an electric quantity measured for example by a wattmeter (not shown). The armature 14 is operatively connected to a spring-loaded feed claw 16 which is, in turn, operatively coupled to a digit dial 18 in the conventional manner. The digit dial 18 has disposed on the outer periphery the digits of 0, 1, 2, ..... 9 at substantially equal angular intervals in the named order. Each time the coil 12 is energized the armature 14 is attracted by the electromagnet 10 to step the digit dial 18 in the direction of the arrow shown in FIG. 1 through the feed claw 16.

The digit dial 18 has fixedly extending through the center thereof a rotary shaft 20 which is, in turn, provided with a circular substrate 22 on that portion of the shaft thereof remote from the feed claw, said substrate being formed of any suitable magnetic material such as iron for rotation with the digit dial 18. The circular substrate 22 is provided on its exposed surface with a plurality of permanent magnets 24 disposed at substantially predetermined angular intervals on a circle having its center lying on the axis of rotation of the substrate with one pole of each magnet fixedly secured to the exposed substrate surface. The permanent magnets 24 are positioned between the associated digits on the dial 18 and have substantially the same angular intervals as the digits. As clearly shown in FIGS. 1 and 3, the embodiment illustrated includes four permanent magnets 24*a*, *b*, *c* and *d* the outermost two 24*a* and *d* of which have their respective S pole faces fixedly secured to the substrate 18, the remaining or intermediate magnets 24*b* and *c* having their respective N pole faces fixedly secured to the substrate for the purpose as will be made apparent hereinafter. That is, the first magnet has one pole face fixed to the substrate, which one pole face is opposite in polarity to those pole faces of the second and third magnets fixed to the substrate while the fourth magnet is oriented similar to the first magnet.

As shown in FIGS. 1, 3 and 4, a magnetic reed switch generally designated by the reference numeral 26 is suitably disposed above the exposed surface of the substrate 18, and in slightly spaced relationship with respect to the permanent magnets 24, at its position where it opposes a path along which the free pole face of each magnet is moved during the rotational movement of the substrate 18. The switch 26 includes an enclosed elongated envelope 28 having a length sufficient to bridge any pair of adjacent permanent magnets 24, a pair of reed-shaped contact strips 30 and 32 of any suitable resilient and magnetic material such as iron sealed through the opposite ends of the envelope 28, with the inner end portions within the envelope overlapping each other to form a narrow gap therebetween. Preferably, the contact strips may have their surfaces plated with any suitable conductive material and may have their outer ends disposed outside the envelope 28, so that they are adapted to be electrically connected to any suitable external circuit (not shown).

The arrangement thus far described is operated as follows: It is assumed that during the rotational movement of the substrate **22** in the direction of the arrow shown in FIG. **1** or **3** the permanent magnets **24***a* and *b* of opposite polarity face the reed-shaped contact strips **30** and **32** respectively. Under the assumed condition, there is formed a closed magnetic circuit traced from the permanent magnet **24***a* through the N pole face of the magnet **24***a*, the contact strip **30**, the contact strip **32**, the S and N pole

faces of the permanent magnet **24***b* and the substrate **22** and thence back to the permanent magnet **24***a* through the S pole face thereof. Therefore the inner end portions of the strip are magnetically attracted by each other. That is, the reed switch **26** is put in its closed position.

A further rotation of the substrate **18** will cause the permanent magnets **24***b* and *c* of the same polarity to be put directly below the reed switch **26**. At that time the N pole faces of the magnets **24***b* and *c* face the contact reads **30** and **32** to exert a magnetic repulsion upon both strips thereby to forcedly separate them from each other even though the remanence due to the previous contacting thereof still retains. Thus the reed switch **28** is put in its open position.

Then the permanent magnets **24***c* and *d* face the reed switch **26**, whereupon the contact strips **30** and **32** again engage each other as will be readily understood from the previous description made in conjunction with the permanent magnets **24***a* and *b*. In this case, it is noted that the magnetic flux flows in the direction reversed from the previous case. Thus it will be appreciated that the closing and opening of the reed switch results in the generation of pulses.

When the substrate **18** is further rotated the reed switch **28** leaves the last or fourth magnet **24***d* and is reopened. Thereafter the reed switch **26** reaches the first and second permanent magnets **24***a* and *b* whereupon the process as above described is repeated to provide pulses in succession. In the embodiment illustrated a circuit (not shown) connected to the reed switch **28** provides one pulse each time the digit dial **18** reaches its position corresponding to each of the digits **1** and **3**.

In summary, the invention provides a pulse-generating device in which a pair of permanent magnets, dissimilar in polarity, are caused to move toward and face the associated reed switch to close the switch through magnetic attraction, and then another pair of permanent magnets similar in polarity, are caused to move toward and face the same switch to open it through magnetic repulsion, whereby the switch is repeatedly closed and opened. This measure ensures that the device can produce pulses without any malfunction often performed by the conventional devices.

While the invention has been described in conjunction with a reed switch successively put in its closed, opened and closed positions, it is to be understood that the invention is not to be restricted thereto or thereby and is equally applicable to reed switches performing different modes of operation. For example, the arrangement of FIGS. **1** and **2** or **3** and **4** may include three permanent magnets **24***a*, *b* and *c* whereby the reed switch **26** can be repeatedly and successively put in its closed and open positions. With more than four of the permanent magnets used, pairs of adjacent magnets having their pole faces fixed to the substrate in a polarity orientation opposite to the first-described pairs. Alternatively the reed switch **26** may have operatively associated therewith two sets of three permanent magnets similar to the set of permanent magnets **24***a*, *b* and *c* and spaced away from each other, whereby the reed switch is successively put in its closed, open, closed and open modes of operation, with the first open mode and second closed mode of operation having a pulse pause interval for which the digit dial is successively stepped. Further, if desired, a plurality of reed switches may be disposed at different radial distances from the center of the substrate, with each switch operatively associated one or more sets of permanent magnets such as previously described.



While the invention has been illustrated and described in terms of a readout counter system it is to be noted that the invention is equally applicable to a variety of systems other than readout counter system.

What we claim is:

**1.** A reed switch control device comprising a rotatable disc, at least three permanent magnets disposed on said disc along a circle concentric with an axis of rotation of said disc, wherein each of said magnets has one pole directed outwardly of said disc, and a reed switch mounted adjacent said disc and having a pair of resilient reed-shaped contact strips of magnetic material engageable by and disengageable from each other in response to positioning of said permanent magnets, wherein said magnets include a first said magnet having a second and a third said magnet disposed on opposing sides thereof and spaced equally therefrom so that when said first magnet is disposed adjacent one of said contact strips, one of said second and third magnets is disposed adjacent the other said contact strips, and wherein said outwardly directed poles of said first and second magnets are of opposing polarities and said outwardly directed poles of said first and third magnets have the same polarity, whereby rotation of said disc causes said first and second magnets to attract and close said contact strips, and further rotation of said disc causes said first and third magnets to repel and open said contacts.

**2.** A reed switch control device as set forth in claim **1**, comprising a fourth permanent magnet disposed on said concentric circle and spaced from said third magnet a distance equal to the distance between said first and third magnets, said outwardly directed pole of said fourth magnet having a polarity opposing that of said third magnet pole, whereby further rotation of said disc causes said third and fourth magnets to attract and close said contact strips.

**3.** A reed switch control device as set forth in claim **1**, in which said disc comprises a magnetic material.