Sept. 1, 1959 H. G. FLECK 2,902,564

ROTARY SWITCH

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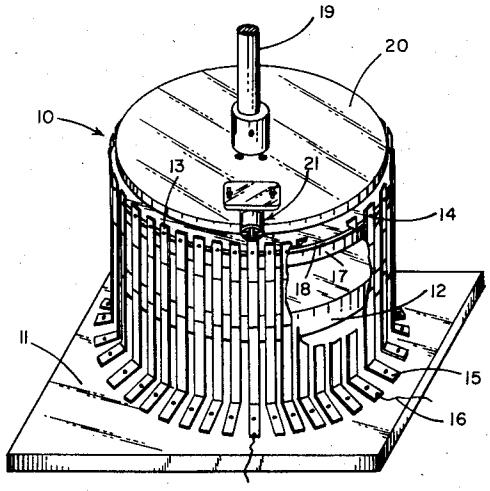


FIG. 1

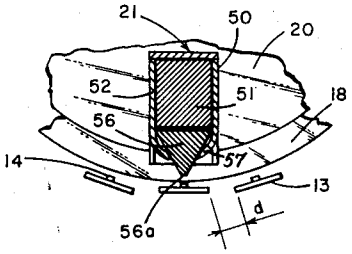
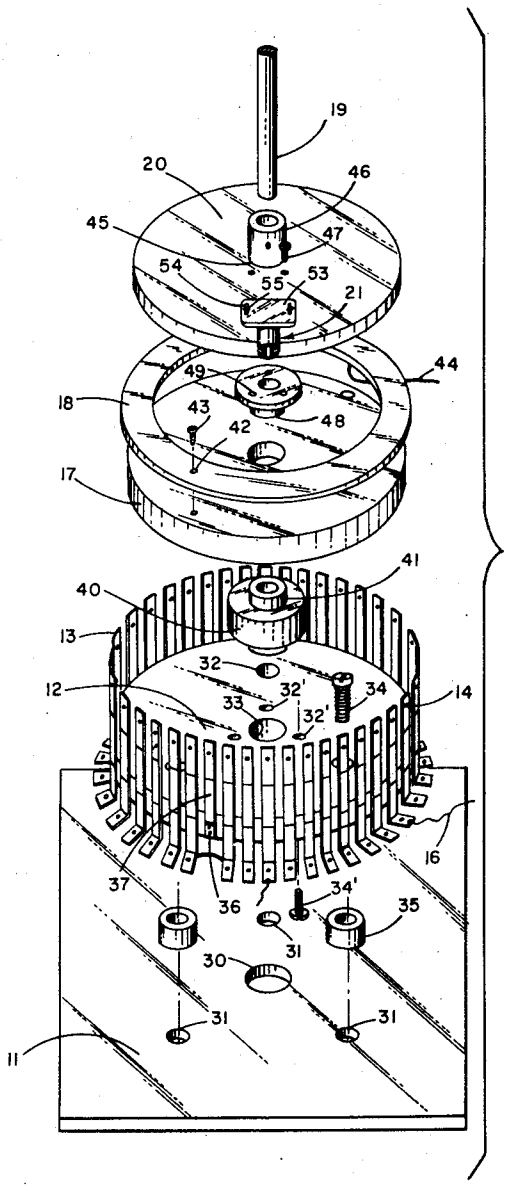


FIG. 3

FIG. 2



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ROTARY SWITCH

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3 Claims. (Cl. 200—104)

The present invention relates to rotary switches and, more particularly, to a magnetically operated rotary switch to make and break a plurality of circuits in a continuous predetermined pattern.

On certain operations a make and break of a plurality of circuits at frequent predetermined intervals is required, as, for instance, when checking stations in the course of a manufacturing process. In the past it has been common to use mechanically operated step switches. However, where the interval for the successive completion of circuits is short, such as about once every second, and the operation is continuous over long periods of time, mechanical switches wear rapidly. Furthermore, mechanical switches have the disadvantage of requiring power to overcome contact friction. While other rotary magnetic switches are known, many such switches are complicated and costly.

It is therefore an object of this invention to provide a new and improved rotary switch to make and break a plurality of circuits which is simple, inexpensive and long-lived.

It is a further object to provide a new and improved rotary switch having a small power requirement.

It is a still further object to provide a new and improved rotary switch designed to make and break a plurality of circuits in a continuous predetermined cycle.

These and other objects are accomplished in accordance with the present invention by a device including a rotatable shaft supported by a base and to which is secured a permanent magnet having a pole face directed radially outwardly from the shaft. A plurality of thin elongated spring arms made of a magnetically attractable and electrically conductive material are supported at their lower ends by the base, and the spacing and number of spring arms may be chosen according to the switching pattern desired. The free ends of the spring arms are spaced a relatively short distance from the rotary path of the pole face of the magnet and flex inwardly from an unbiased position to a biased position as the magnet rotates and each free end successively comes within the magnetic field. An electrical contact which takes the form of an annular ring is supported in fixed relation to the base. The magnet is adjustably mounted and is focused so that as the shaft is rotated, it successively and sequentially attracts only one of the spring arms to make and break electrical contact with the annular ring.

These and other features of my invention will be apparent from the following detailed description of a preferred form of my invention taken in conjunction with the accompanying drawing wherein:

Fig. 1 is a perspective view of the switch of the present invention with portions cut away to show more clearly interior details;

Fig. 2 is an exploded view of the switch showing the various elements; and

Fig. 3 is a top sectional view of a portion of the apparatus of Fig. 1 taken on the midplane of disk **20**.

In Fig. 1 of the drawing is shown a rotary switch **10**, constructed in accordance with the present invention, mounted on a baseboard **11**. Rotary switch **10** comprises, broadly, a first mounting disk **12** made of insulating material fixed parallel to and in spaced relationship to baseboard **11**. Secured to the edge of disk **12** perpendicular to its plane are a plurality of spaced spring arms **13** made of magnetic material, each of which carries at its upper end a movable contact **14**. Fastened to the lower end of each spring arm **13** is a conducting strip **15**. The free end of each conducting strip **15** serves as a terminal for a lead **16**, each of which may be connected to an electrical device. A second insulating disk **17** is fixed parallel to and in spaced relationship to first disk **12** and carries on its upper face a ring **18** of conducting material which serves as a fixed contact and is placed so as to be opposite movable contacts **14**. Shaft **19** carries a support arm or disk **20** at the outer perimeter of which is fixed a permanent magnet means **21** placed so as to be opposite the upper ends of spring arms **13**. As magnet means **21** is rotated, each of successive spring arms **13** is selectively attracted inwardly, thereby engaging movable contacts **14** sequentially with ring **18**. The circuit is completed by the connection of a lead between the ring and an electrical device or devices.

More particularly, referring to the exploded view of Fig. 2, baseboard **11** has a central aperture **30** to permit passage of shaft **19**, which, in the preferred embodiment illustrated, extends all the way through the switch. Baseboard **11**, which is made of insulating material, is also provided with three smaller apertures **31** equally spaced from aperture **30** and from each other. First disk **12** is likewise made of insulating material and has three apertures **32** aligned with apertures **31** and also has a central aperture **33** to permit passage of shaft **19**. Each of screws **34** passes through an aperture **32**, then through a bushing **35** which serves to space first disk **12** from baseboard **11**, and thence is screwed into an aperture **31**. The first disk **12** is thus fixed parallel to and spaced from baseboard **11**.

Secured to the edge of disk **12** by screws **36** or the like are the plurality of reed-like arms **13** made of some resilient conductive magnetic material such as strip spring steel. Spring arms **13** are preferably mounted parallel to shaft **19** and are equally spaced. A movable contact **14** of any conventional form is carried by the upper end of each spring arm **13**.

Each spring arm has a vibration dampening member **37** in contact with its outer face, each spring arm **13** and its vibration damping member **37** being fastened to disk **12** by drive screws **36**. More specifically, vibration dampeners **37** are made of the same material as spring arms **13**, are mounted against the outer surface of spring arm **13** and are coextensive therewith except that they terminate at their upper ends a short distance below movable contacts **14**. Members **37** serve to dampen vibrations of spring arms **13**, particularly when magnet means **21** is rotated at higher speeds. Each spring arm **13** also has associated with it at its lower fixed end a conducting strip **15** fastened thereto by drive screws **36**. The free ends of strips **15** are connected to baseboard **11** and are provided with terminals for leads **16**, it being understood that each strip **15** has a lead associated with it and that the terminals may be of any conventional form.

A second insulating disk **17** is fixed in parallel spaced relationship with first disk **12** by means of a ring-shaped spacer **40** through which extends an elongated bearing **41**. Bearing **41** receives shaft **19** and is of sufficient length to extend through disks **12** and **17** to permit smoother operation of the shaft. Spacer **40** is maintained in place by means of screws **34'** which are inserted up through apertures **32'** in disk **12** into the spacer.

Second disk 17 has secured to its upper face an annular ring 18 larger in outside diameter than disk 17 and made of a conducting material. Ring 18 serves as a second contact, and is so placed as to be radially inwardly of contacts 14. Ring 18 is provided with a plurality of apertures 42 to permit passage of screws 43 which fasten ring 18 to disk 17. A lead 44 is connected to ring 18 in any desired manner to complete the conducting path through the switch. While this second contact has been shown as a single common contact for all of movable contacts 14, an individual contact may be provided for each movable contact 14, in which case, of course, a plurality of leads would be provided.

As has been heretofore briefly explained, magnet means 21 is connected to shaft 19 by a sweep arm so as to rotate therewith. The sweep arm in the preferred embodiment disclosed takes the form of an insulating support disk 20 having a central aperture 45 into which is pressed a sleeve bearing 46 that receives shaft 19 and is fixed thereto by a set screw (not shown). Secured to the bottom of disk 20 by screws 47 which pass down through the disk is flanged bearing member 48 having threaded apertures 49 for the passage of screws 47. If desired, sleeve 46 and flanged bearing member 48 may be made as one piece.

The outer periphery of disk 20 has a radially extending slot 50 cut therein in which permanent magnet means 21 is mounted. Magnet means 21 takes the form of cylindrically shaped permanent magnet 51 of Alnico or similar material. Magnet 51 (see Fig. 3) is encased by a cylindrical housing 52 which is fastened at its upper side as by welding or soldering or the like to a flat plate 53 (see Fig. 2). Plate 53 is provided with slots 54 at either side through which extend screws 55 to permit fastening plate 53 to sweep arm 20. Slots 54 allow adjusting of magnet means 21 inwardly and outwardly. Of course, plate 53 and housing 52 are constructed of non-magnetic material so as not to distribute the flux.

To facilitate focusing of the magnetic field produced by permanent magnet 51, a soft iron, substantially triangular piece 56 having a flattened outer face 56*a* is butted against the outer pole of magnet 51. Prongs 57 may be struck out of housing 52 and bent inwardly against focusing piece 56 to hold it in place. The outermost flat face 56*a* of focusing piece 56 is so placed as to be radially inwardly of the upper ends of spring arms 13, as shown in Fig. 1.

In operation, shaft 19 is rotated, thus sweeping magnet means 21 past the upper ends of spring arms 13. As the magnet passes each spring arm 13, the arm is drawn inwardly as shown in Fig. 3, thereby closing movable contact 14 against ring 18. Each spring arm 13 thus moves from an unbiased position in which movable contact 14 is spaced from ring 18 to a biased position in which contact 14 engages ring 18. Obviously, the circuit is then completed through leads 16 and 44 to the electrical device connected thereto. Of course, as the magnet passes on, spring arm 13 returns to its unbiased position when the spring force is greater than the force of the magnetic field. It is to be noted in Fig. 3 that outer flat face 56*a* of magnet means 21 does not engage spring arm 13 when the circuit is completed and therefore contact friction and noise are eliminated.

The width of spring arms 13, the spacing *d* between adjacent arms and the force of the magnetic field created by magnet means 21 are so adjusted that only one movable contact 14 engages ring 18 at any particular time. The force of the magnetic field may be varied by moving the entire magnet means inwardly and outwardly within the limits of slots 54 and by varying the shape of focusing piece 56. Thus, flat face 56*a* may be made more or less wide as desired.

Because there is no friction or mechanical abrasion involved in closing the contacts, but rather only magnetic force, the power required to rotate shaft 19 is small.

If a motor is used, it may therefore be of smaller capacity than for a mechanical switch. The small power requirement adapts the switch disclosed for us as an explosion proof switch, for example, since the switch may be enclosed in a non-magnetic housing and power supplied by a small bar magnet mounted on top of shaft 19 and driven by a similar magnet outside the enclosure and opposite the first magnet.

Since there is no sliding on the contact area, contact noise is eliminated. To prevent oxidation on the contacts the surface of the contacts may be gold plated and the switch mounted in a dust proof enclosure.

While the spring arms 13 and movable contacts 14 carried thereby are disclosed as being equally spaced, the spring arms could be spaced so as to produce any desired switching pattern. The spacing may be as wide as desired, of course, and the limit on how close the spacing may be depends on the speed of rotation, among other factors. This design of switch operates very satisfactorily at slow and moderately high speeds.

While a preferred embodiment has been disclosed, it is understood that one skilled in the art may make modifications without departing from the principles of the present invention, and said invention is to be limited only by the claims appended hereto.

For example, various types of spring arms may be utilized, it being possible to resiliently mount the movable contacts in various ways. Further, the converse mode of operation may be adopted, i.e., have the permanent magnet attract a movable contact away from a fixed contact so as to open each circuit successively and selectively as the magnet sweeps by. Still further, ring 18 may be made to rotate with shaft 19 so as to maintain the contact surfaces clean and counteract any arcing effects at the contact faces.

I claim:

1. In a rotary switch, the combination comprising: a base; a shaft supported by the base; a permanent magnet adjustable means for securing the permanent magnet to the shaft with a magnet pole face directed radially outward from the shaft for rotation relative to the base, said means permitting radial adjustment of the permanent magnet; a soft iron focusing piece mounted against the permanent magnet pole face and having an outer face narrower than the permanent magnet pole face for focusing the magnetic flux into a narrow radially-directed bundle at such outer face of the focusing piece; a plurality of elongated magnetically-attractable spring arms individually having one end secured in fixed relation to the base for supporting the other end a relatively short distance outwardly from the rotary path of the outer face of the focusing piece, these other ends being spaced around such rotary path so as to be sequentially attracted by the focused flux of the permanent magnet when such magnet is rotated; and an electrical contact member mounted adjacent each of the spring arms and supported in fixed relation to the base so that as the spring arms are sequentially flexed by the magnetic attraction of the focused flux the state of electrical contact between the spring arms and the contact members is altered.

2. In a rotary switch, the combination comprising: a base; a shaft supported by the base; a sweep arm secured to the shaft for rotation relative to the base; a permanent bar magnet attached to the sweep arm and having a pole face directed radially outward from the shaft; a soft iron focusing piece mounted against the permanent magnet pole face and having a cross section which decreases as the radial distance from the shaft increases to provide for the focusing piece an outer face of smaller area than the permanent magnet pole face thereby to focus the magnetic flux into a narrow radially-directed bundle at such outer face of the focusing piece; a housing member for securing the focusing piece to the permanent magnet; means for securing the housing member to the sweep arm permitting radial adjustment of such housing member; a plurality of

elongated magnetically-attractable spring arms individually having one end secured in fixed relation to the base for supporting the other end a relatively short distance outwardly from the rotary path of the outer face of the focusing piece, these other ends being spaced around such rotary path so as to be sequentially attracted by the focused flux of the permanent magnet when such magnet is rotated; and an electrical contact member mounted adjacent each of the spring arms and supported in fixed relation to the base so that as the spring arms are sequentially flexed by the magnetic attraction of the focused flux the state of electrical contact between the spring arms and the contact members is altered.

3. In a rotary switch, the combination comprising: a base; a shaft supported by the base; a sweep arm secured to the shaft for rotation relative to the base; a permanent bar magnet attached to the sweep arm and having a pole face directed radially outward from the shaft; a soft iron focusing piece mounted against the permanent magnet pole face and having an outer face narrower than the permanent magnet pole face for focusing the magnetic flux into a narrow radially-directed bundle at such outer face of the focusing piece; a tubular housing encasing the permanent magnet and having prongs formed therein engaging the focusing piece; means for securing the tubular housing to the sweep arm permitting radial adjustment of such housing; a plurality of elongated magnetically-

attractable spring arms individually having one end secured in fixed relation to the base for supporting the other end a relatively short distance outwardly from the rotary path of the outer face of the focusing piece, these other ends being spaced around such rotary path so as to be sequentially attracted by the focused flux of the permanet magnet when such magnet is rotated; and an electrical contact member mounted adjacent each of the spring arms and supported in fixed relation to the base so that as the spring arms are sequentially flexed by the magnetic attraction of the focused flux the state of electrical contact between the spring arms and the contact members is altered.

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