Oct. 23, 1962 W. H. A. BOYD 3,059,498

NON-DEAD-CENTERING MECHANISM

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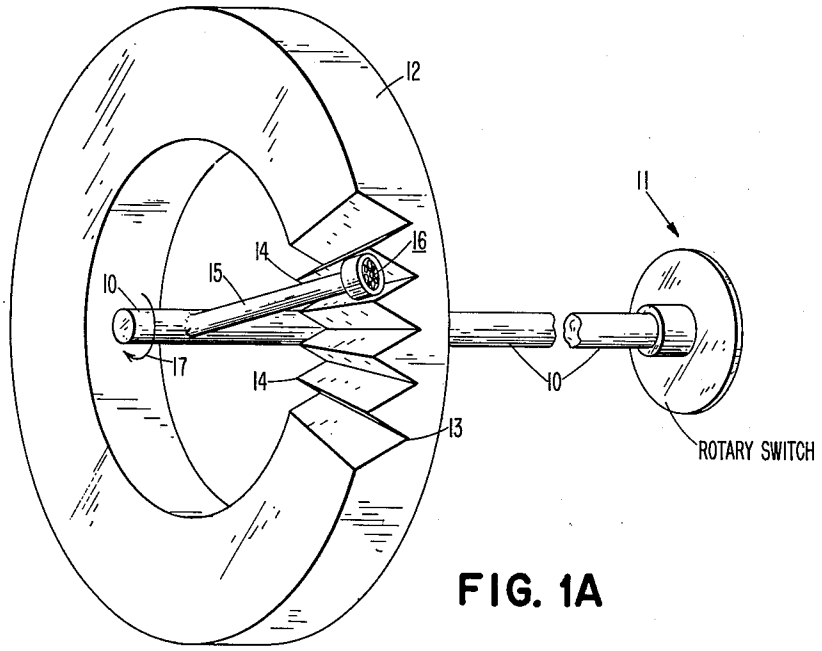


FIG. 1A

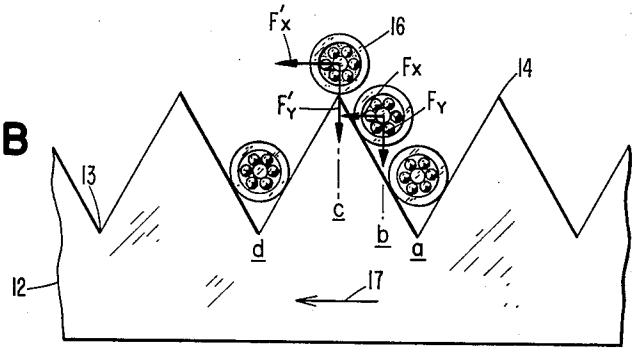
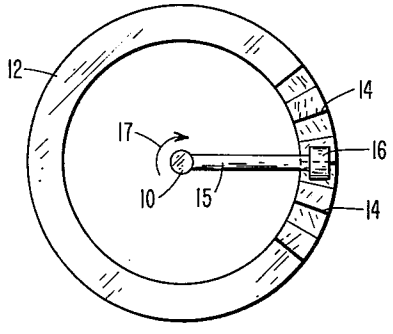


FIG. 1B

FIG. 1C



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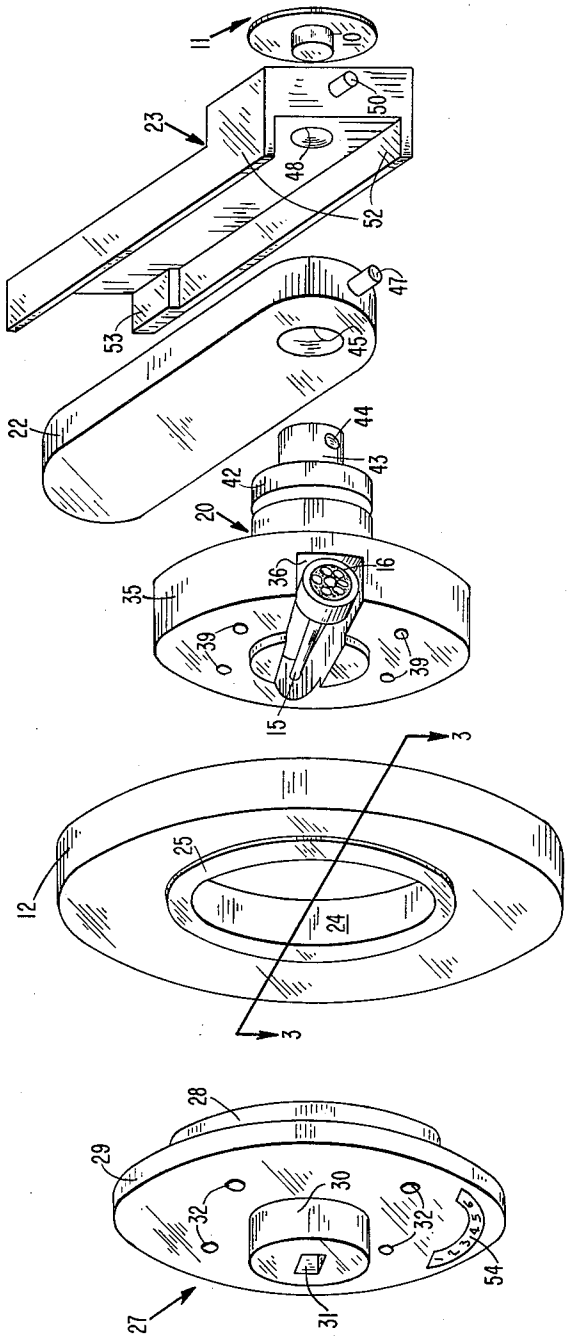
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FIG. 2



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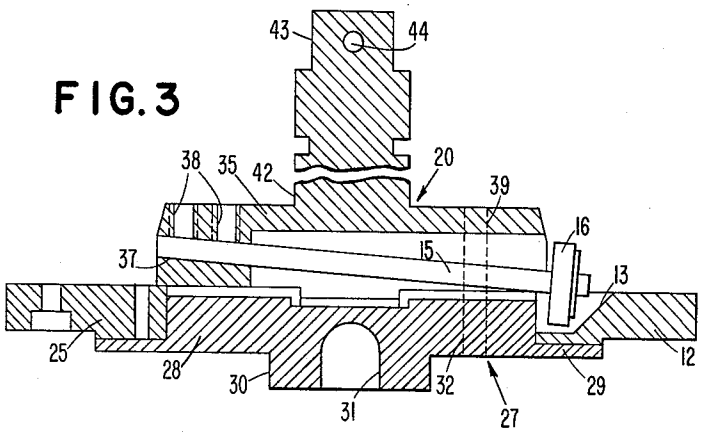
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NON-DEAD-CENTERING MECHANISM

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FIG. 3



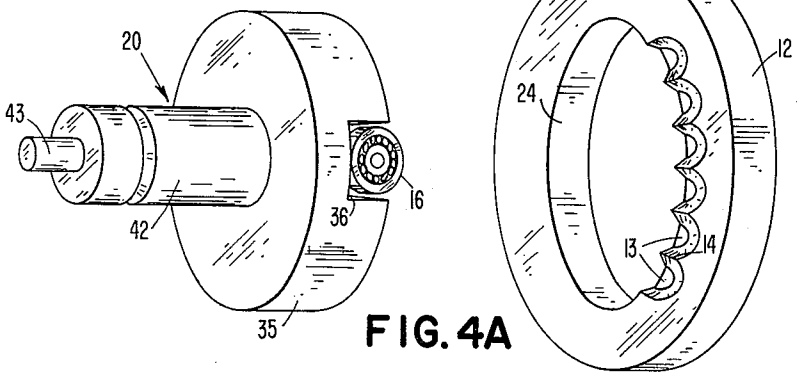


FIG. 4A

FIG. 5A

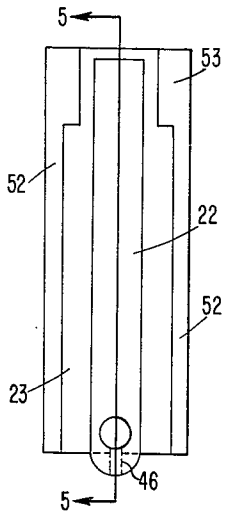
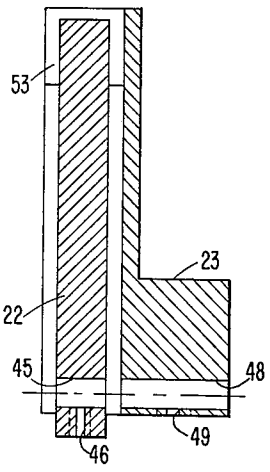


FIG. 5B



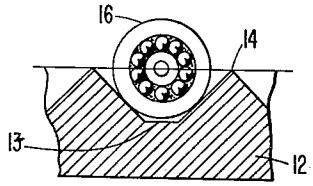


FIG. 4B

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3,059,498

NON-DEAD-CENTERING MECHANISM

William Hunter A. Boyd, Kensington, Md., assignor to the United States of America as represented by the Secretary of the Army

Filed Oct. 5, 1961, Ser. No. 143,257
2 Claims. (Cl. 74—527)
(Granted under Title 35, U.S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government for governmental purposes without the payment to me of any royalty thereon.

The present invention relates to a non-dead centering mechanism. More especially, the invention is directed to a mechanical device with which a rotatable shaft may be set to any selected one of a number of predetermined positions. This device simultaneously prevents any dead-centering of the shaft between successive angular positions. The shaft in question may be, for example, the control shaft of a multiple-throw rotary electric switch.

When using an electric switch to select the operating parameters of various electrical circuits, it is often necessary to assure unambiguous setting of the switch to the desired position. In connection with several types of electronic fuze for ordnance missiles, the final adjustments of the fuze circuits before launching are accomplished by manually presetting the control shaft of a rotary electric switch. This final setting of the fuze is of utmost importance in tactical use of the missile, since it determines the intensity of the burst as well as the altitude at which the burst occurs. It is imperative, therefore, that these switches be extremely reliable and accurate in their operation. The non-dead centering mechanism of this invention achieves the desired reliability and accuracy by eliminating the possibility of the control shaft's stopping between switch positions.

An object of the present invention is to improve reliability in the setting of a rotary or translational switch position selector.

Another object is to prevent inadvertent stopping of a rotary setting device between angular positions thereof.

A further object is to provide an improved non-dead centering device of compact design having a simple and rugged construction, long life, and ease of manufacture.

An additional object is to furnish a non-dead centering mechanism which has a detent "feel" in connection with manual operation.

The specific nature of the invention, as well as other objects, uses and advantages thereof, will clearly appear from the following description and from the accompanying drawing, in which:

FIG. 1A is a schematic representation of the principal elements forming the non-dead centering mechanism of this invention.

FIG. 1B is a diagram showing a portion of the stator element together with the rotor spring arm in several different positions.

FIG. 1C is a left end view of the elements in FIG. 1A.

FIG. 2 is an exploded perspective view of a preferred embodiment of the invention. The non-dead centering mechanism is illustrated together with its shaft coupling members and the electric switch assembly.

FIG. 3 is a sectional view taken on line 3—3 of FIG. 2 showing the dial plate, the stator and the rotor assembled.

FIG. 4A is a further perspective view of the rotor and the stator from the side opposite to that shown in FIG. 2.

FIG. 4B is a partial section view taken along line 4—4 in FIG. 4A.

FIG. 5A is an end elevation of the shaft coupling members used in this invention.

FIG. 5B is a sectional view on line 5—5 of FIG. 5A.

Referring now to the drawing, wherein like reference numerals designate like parts, FIG. 1A shows diagrammatically the main components of the non-dead centering mechanism in conjunction with an electric switch **11**. The central control shaft **10** of switch **11** is rotated to some predetermined angular position to select a desired condition of the switch contacts. Switch **11** may be any suitable multiple-throw rotary switch of known construction. The non-dead centering device comprises generally a stator plate **12** mounted coaxially with control shaft **10** and an indexing arm **15** rigidly connected at one end thereof to the shaft **10**. The stator plate **12** serves as a stationary registering member, and for this purpose contains a plurality of V-shaped notches **13** cut across a portion of one face. A rack section with teeth **14** is formed thereby. Both FIGS. 1A and 1B illustrate this arrangement. The notches **13** must be located so that the base or bottom of each corresponds to a respective one of the predetermined positions of shaft **10**.

The indexing arm **15** carries a ball bearing roller **16** which is mounted at the outer end of arm **15**, as seen in FIGS. 1A and 1C. The roller **16** initially registers in one of the V-notches **13** and moves successively into the other notches when shaft **10** turns. The arm **15** is a slender cylindrical rod which acts as a cantilever spring as it positions shaft **10** with respect to the stator plate **12**. It is particularly emphasized that indexing spring arm **15** is free to deflect circumferentially within the plane of its rotation about shaft **10**, as well as normal to that plane. The cross-section of spring arm **15** is, preferably, either circular or square.

In operation, the selector shaft **10** is rotated, either manually or with any suitable automatic driving means, to some particular angular position corresponding to the desired setting of the various electrical contacts of switch **11**. In conjunction with the afore-mentioned electronic fuzes, actuation of shaft **10** is preferably manual. FIGS. 1B and 1C are now referred to in describing the operation when control shaft **10** is rotated. The movement of shaft **10** causes roller **16** to travel from any given position *a* in a first notch **13** to position *d* in an adjacent notch **13**. As shaft **10** turns in the direction of arrow **17**, indexing spring arm **15** deflects appreciably, and then causes ball bearing roller **16** to move, first to *b* and then to the apex of tooth **14** at *c*. Because of the slope of the walls of notches **13**, roller **16** and the outer end of arm **15** both rise vertically, in FIG. 1B. Indexing spring arm **15** is deflected both parallel and normal to its plane of rotation about shaft **10**. When arm **15** deflects in the manner described, energy is stored in it. Consequently, spring arm **15** applies a force to the wall of the notch **13**. This force is represented for point *b* by vector F_x, parallel to the plane of rotation, and vector F_y, normal to the aforementioned plane. At the apex of the notch at *c*, the corresponding components are F_x' and F_y', of larger magnitude. When position *c* is reached, the portion of the total energy stored in spring arm **15** due to its deflection in the plane of rotation is released, causing bearing roller **16** to snap over into the bottom of the next notch at *d*. At point *c* the force component F_x' is no longer opposed by the side wall of the first notch **13**. Therefore, the outer end of arm **15** can travel freely from point *c* in the direction of arrow **17** under the influence of force F_x, the stored energy being thus released. It is seen that, with this arrangement, there is no position between *a* and *d* where the spring arm could be dead-centered. Even when roller bearing **16** is on the tip of a tooth **14**, as at *c*, there is no possibility of dead-centering, because the forces on member **16** are unbalanced. Should shaft **10** not be rotated far enough to bring roller **16** to *c*, then when the torque applied to shaft **10** is removed, part of

the energy stored in spring arm **15** will return roller **16** back to *a*, and thus shaft **10** to its initial angular position.

FIGS. 2 to 4 illustrate the preferred embodiment of the invention, which incorporates the principles and operation described in connection with FIG. 1A. In FIG. 2, all of the component parts of the non-dead centering device are shown disassembled. The conventional electric switch **11** has a control shaft **10** extending a short distance beyond its frame. The stator plate **12** is in the form of a disk with a large central aperture **24** and an upstanding shoulder **25**. Notches **13**, which have a flat bottom as shown by FIG. 4B, are located in one face of stator **12** opposite shoulder **25**, along a portion of the edge of aperture **24**. They do not extend entirely across the face of stator **12**, as before. See particularly FIG. 4A. In the preferred embodiment, intended for use with the fuzes, the indexing spring arm **15** is separately carried by a rotor member **20**. Rotor **20**, in turn, couples with the switch control shaft **10** through a torque arm **22** fitted within a channel member **23**. This torque coupling device will be more completely described subsequently.

A dial plate **27** is adapted to revolve within aperture **24**. Dial **27** comprises a flat circular disk **28** with an extended rim **29**, the disk portion **28** being inserted into aperture **24** with rim **29** abutting shoulder **25**. A circular boss **30** containing a square hole **31** is centrally located in the outer face of dial plate **27**. The dial **27** is rigidly secured to rotor **20** by four bolts (not shown) passing through holes **32** in dial plate **27** and threaded into tapped holes **39** in rotor **20**. With this arrangement, rotor **20** may be manually positioned with respect to stator **12** with a standard Allen wrench inserted in hole **31**.

Rotor **20** comprises a drum body **35** together with an integral shaft portion **42**. The front face of drum **35** is provided with a radial channel **36** of substantial width and depth within which indexing arm **15** is mounted. Referring to FIG. 3, a hole **37** in the end wall of channel **36** receives one end of spring arm **15**. Hole **37** is oriented at a small angle α, preferably of about 5°, from an axis parallel to the plane of the face of stator **12**. This allows roller **16** on the other end of arm **15** to register within notches **13**. Arm **15** may be securely engaged with rotor **20** by two set screws (not shown) placed in holes **38** in drum **35**. Shaft **42** terminates in an end section **43** of reduced diameter.

A torque arm or bar **22** is directly connected to rotor **20** in order to rotate with the latter. For this purpose, the end **43** of shaft **42** is inserted in an aperture **45** at one end of arm **22**. A coupling stud **47** set within a pair of aligned holes **44** and **46** engages torque arm **22** with shaft **42**. A generally U-shaped channel member **23** is positioned so that torque arm **22** meshes with the inner surfaces of side walls **52** of channel **23**. Channel **23**, in turn, is mounted upon the control shaft **10** which is placed within an aperture **48** in the base of channel **23**. A set screw **50** located in a tapped hole **49** at the bottom of channel **23** serves to firmly clamp the latter to shaft **10**.

Each side wall **52** includes a section **53** of greater thickness at the outer end of channel member **23**, so that the channel is reduced in width and thus has a larger clearance for torque arm **22** at the root than at its tip. The torque coupling device described permits considerable misalignment of the axis of rotor **20** with respect to shaft **10**, while angular motion is transmitted via tip section **53** with a minimum of angular slack. Therefore, close angular tolerance between the positions of rotor **20** and control shaft **10** is achieved.

The operation of the embodiment illustrated in FIGS. 2–5 is the same as that set forth above regarding the diagram of FIG. 1A. In brief, stator **12** and the frame of switch assembly **11** are affixed to suitable stationary parts of the missile so that dial plate **27** faces outward. A cover plate (not shown) forming a portion of the surface of the missile is removed to gain access to the switch setting device. As dial plate **27** and rotor **20** together are turned to the required setting, shaft **10** follows the rotation of rotor **20** by reason of its coupling to shaft **42** through arm **22** and channel **23**. Indexing spring arm **15** and roller **16** co-operate with notches **13** in stator **12** in the manner previously described to establish discrete predetermined rest positions of control shaft **10**. Dial plate **27** may be provided with a suitable indicating scale **54** to show the switch position selected.

While the switch positioning device described and illustrated in the drawing involves rotary motion of the component parts, it should be understood that the invention is not limited to configurations involving rotation, but encompasses longitudinal or translational movement as well. Further, where desired the indexing spring arm **15** may be mounted upon the stationary member **12** with the series of notches **13** suitably located on the rotor **20**. Obviously, a larger number of notches **13** may be provided in stator **12** to establish angular positions of shaft **10** through 360° of its rotation. If higher restoring torques produced by spring arm **15** are required, with a single spring arm the maximum or limiting stress of available spring materials might be exceeded. In such situations, the spring arm may be formed by a plurality of separate spring members acting together. It can be shown that the stresses encountered in the multiple spring arrangement will be considerably lower than in a single spring arm. However, tests performed on single spring arm devices in accordance with the invention have proved entirely satisfactory. While the invention has been shown controlling an electric switch, the non-dead centering device is not limited to such applications, but may be used for any control shaft, for example in the setting of potentiometers, valves, or the like.

The non-dead centering mechanism disclosed herein is simple in construction and reliable in its operation. Inadvertent mis-setting of the electric switch is entirely prevented. The ball bearing roller **16** serves to minimize the friction between the relatively moving parts. Since spring arm **15** is strong enough to overcome any friction in the system, the necessity for a separate locking means to hold the shaft once it is set is obviated. Moreover, the spring action of indexing arm **15** aids in overcoming harmful inertial effects of the vibrations associated with the missile environment.

It will be apparent that the embodiment shown is only exemplary and that various modifications can be made in construction and arrangement within the scope of the invention as defined in the appended claims.

Even though the spring indexing arm **15** is shown with a roller **16** on its registering end, it is obvious that, in cases where friction is negligible, roller **16** can be eliminated and arm **15** be used alone.

I claim as my invention:

1. A non-dead centering device for unambiguous setting of the control shaft of an electric switch comprising a stationary disk having a central aperture, a plurality of notches within said disk, a rotor positioned within said aperture, a spring indexing arm having one end connected to said rotor and the other end contacting said notches, said spring arm deflecting both parallel and normal to the plane of rotation of said spring arm when said rotor is rotated, and means for coupling said rotor to said control shaft.

2. A mechanism for positioning the control shaft of a rotary electric switch at one of a plurality of predetermined positions without stopping between adjacent positions, comprising, in combination: a stationary disk having a central aperture, a plurality of notches corresponding to said switch positions located within said disk, a rotor positioned within said aperture, means for applying an input torque to said rotor, a cantilever spring indexing arm carried by said rotor with the free end of said arm registering with said notches, said spring arm deflecting

both parallel and normal to the plane of rotation of said spring arm when said rotor is rotated, a torque arm rigidly coupled to said rotor, a U-shaped channel having an end section of reduced width, said torque arm fitting within said channel, and means for rigidly coupling said control shaft to said channel so that unambiguous setting of said electric switch is assured.

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