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G. E. GRIGGS ET AL
ROTARY STEPPING RELAY WITH RADIAL SPACED
CONTACTS AND ACTUATOR MEANS

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2 Sheets-Sheet 1

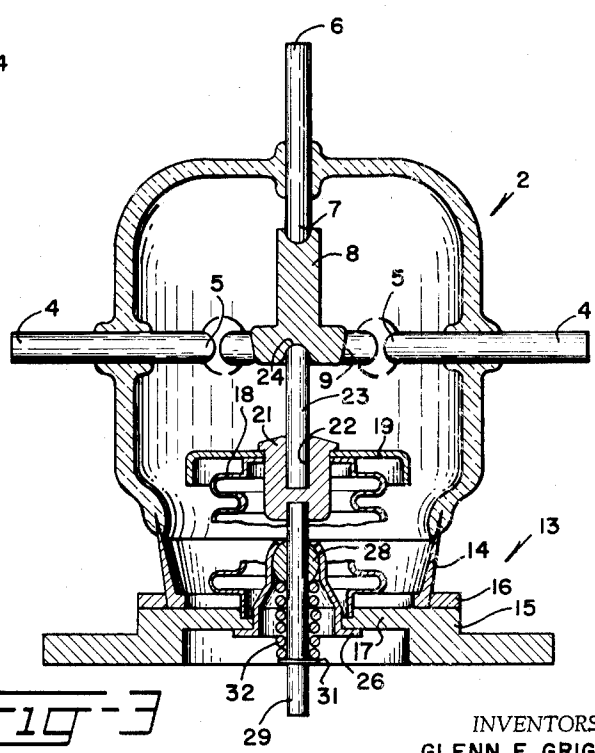
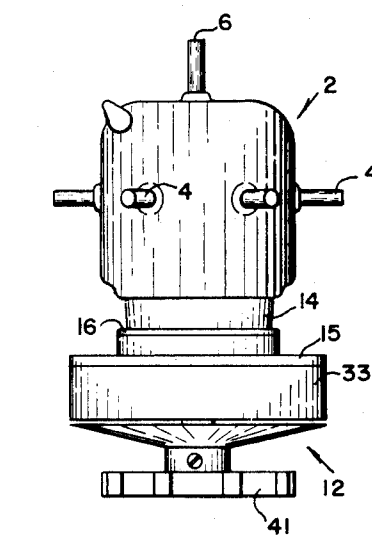
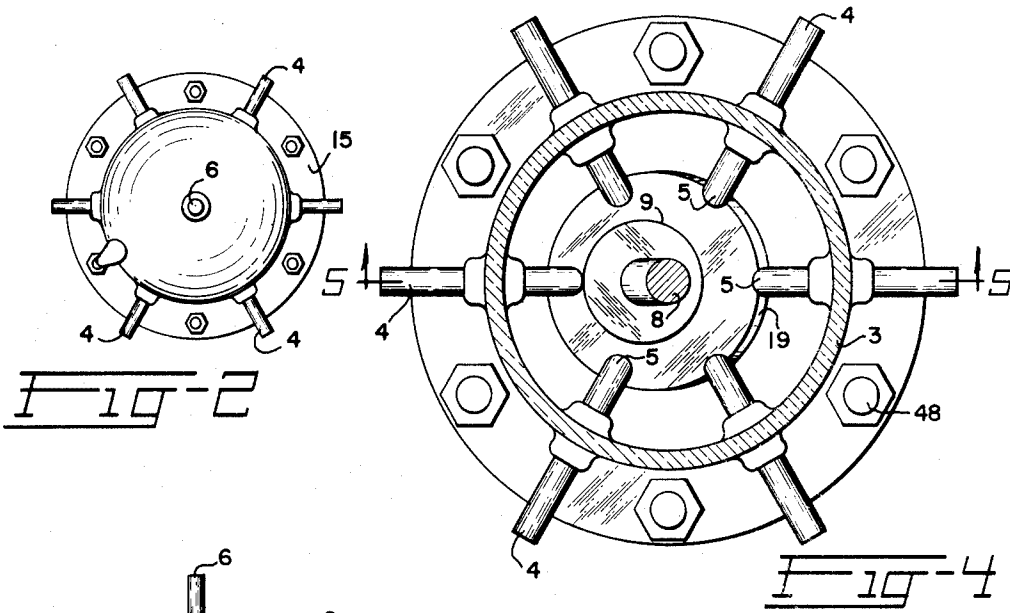


FIG-1

FIG-3

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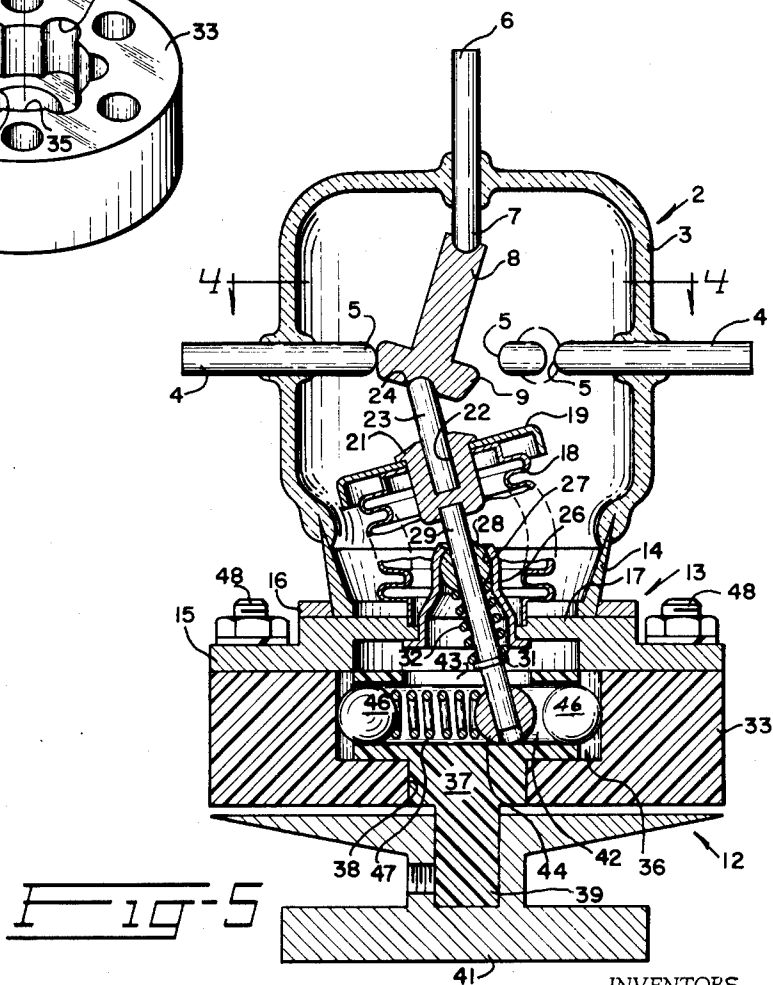
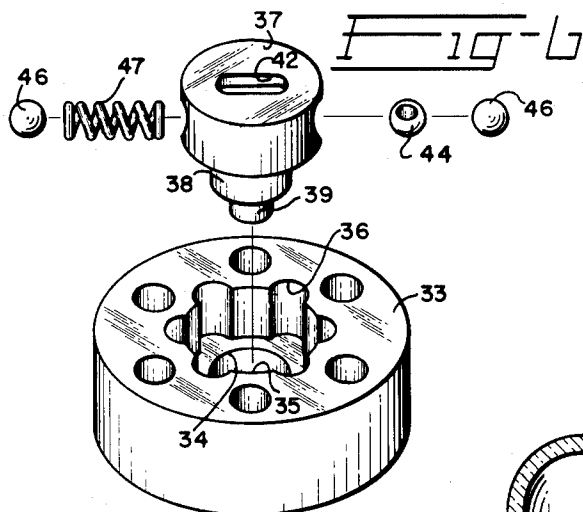
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ROTARY STEPPING RELAY WITH RADIAL SPACED CONTACTS AND ACTUATOR MEANS

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9 Claims. (Cl. 200—6)

This invention relates to stepping relays; and particularly to a single pole-multiple throw rotary stepping relay having a hermetically sealed envelope.

One of the principal objects of the invention is to provide a novel actuating mechanism for a rotary stepping relay of the type disclosed in United States Patent No. 3,079,481, assigned to the assignee of the present invention.

Another object of the invention is to provide an actuating mechanism which translates controlled motion of a control shaft outside a hermetically sealed envelope into controlled movement of a contact member within the hermetically sealed envelope.

Still another object of the invention is the provision of an actuating mechanism capable of manual or mechanical operation to make and break circuits through a stepping relay at speeds enabling use of the relay in radio frequency applications.

A still further object of the invention is the provision of a rotary stepping relay in combination with an actuating mechanism which is electrically insulated from the high potential current-carrying members of the relay.

The invention possesses other objects and features of advantage, some of which, with the foregoing, will be apparent from the following description and the drawings. It is to be understood however that the invention is not limited to the particular embodiment illustrated and described as it may be embodied in various forms within the scope of the appended claims.

Broadly considered, the rotary stepping relay and actuator of the invention comprises an hermetically sealed envelope having a multiplicity of spaced inwardly extending terminal leads projecting hermetically into the envelope to provide therewithin an array of circumferentially spaced fixed conductive contact points circularly arranged about a longitudinal axis. A common terminal lead extends into the envelope along the longitudinal axis and provides a common contact point adapted for connection with a selected one of the array of fixed contacts by a movable conductive contact member pivotally interposed between the common contact and an actuator mechanism supported on the envelope. The actuator mechanism broadly comprises a cam ring detachably secured to the envelope and providing a recess or housing within which is operatively disposed a detent carriage provided with spring-pressed detents movable by the carriage past a multiplicity of circumferentially spaced detent receiving recesses formed in the cam ring and cooperating with the detents to lock the detent carriage in selected positions. Interposed between the spaced detents in the detent carriage is one end of an actuator shaft which is movable transversely by movement of an adjacent detent. The actuator shaft is journaled intermediate its ends by an appropriate bearing structure and is provided with an extension within the envelope engaging the movable contact to move it in a predetermined circular or other path upon rotation of the detent carriage.

Referring to the drawings:

FIG. 1 is an elevation of the rotary stepping relay equipped with an actuator mechanism adapted to be manually operated.

FIG. 2 is a plan view of the relay illustrated in FIG. 1.

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FIG. 3 is a vertical cross sectional view of the relay with the actuator mechanism detached therefrom and showing the movable contact in a neutral position.

FIG. 4 is a horizontal cross sectional view through the relay with the actuator mechanism attached and illustrating the movable contact biased into conductive engagement with one of the fixed contacts making up the circular array of fixed contacts. The plane of section is taken along the line 4—4 in FIG. 5.

FIG. 5 is a vertical sectional view illustrating the operative relationship of the detent carriage, detents, and cam ring of the actuator mechanism with the movable contact actuator shaft of the relay. The plane of section is taken along the line 5—5 in FIG. 4.

FIG. 6 is a perspective view illustrating the relationship of parts in the actuator mechanism.

FIGS. 1 and 2 and 6 are shown approximately actual size, and FIGS. 3, 4 and 5 are drawn approximately twice actual size.

In terms of greater detail, the rotary stepping relay and actuator of the invention comprises an hermetically sealed envelope designated generally by the numeral 2, conveniently formed in part as illustrated from a dielectric shell 3 provided with a multiplicity of circumferentially spaced radially inwardly extending terminal leads 4 supported thereon, providing circumferentially spaced contact points 5 disposed within the shell in a circular array arranged generally concentrically about the longitudinal axis of the envelope. Extending into and supported on the envelope perpendicular to the terminal leads 4, and in the embodiment illustrated lying along the longitudinal axis of the envelope, is a common terminal lead 6 having a rounded contact point 7 axially spaced from the circular array of contact points 5.

Pivotally engaging the common contact 7 is a movable conductive contact member 8, having a conical contact surface 9 adapted to move in a circular path for successive engagement with the spaced contacts 5. To actuate the movable contact, an actuator mechanism designated generally by the numeral 12 is supported on the metallic envelope sealing structure 13 which includes a copper flange 14 and mounting plate 15, these two elements being hermetically united as by Heliarc welding at 16.

The mounting plate 15 is provided with a radially inwardly extending annular flange 17, centrally apertured as shown, and having the open end of a bellow 18 hermetically brazed about the opening. The closed inner end of the bellow extends into the shell and is provided with a shield plate 19 and a mounting plug 21 having an axially extending recess 22 therein proportioned to snugly receive one end of a dielectric rod 23. The other end of the dielectric rod lies trapped in a semi-spherical recess 24 formed in the movable contact 8.

Fixed in the mounting plate aperture and extending into the bellow is a bearing assembly including a hollow metallic thimble member 26 having a cupped bearing portion 27 apertured as shown and slidably supporting a journal ball 28. The journal ball is provided with a central bore as shown in which is slidably disposed an intermediate portion of a metallic actuator rod or shaft 29, one end of which is fixed in mounting plug 21 as shown. The journal ball thus also functions as a bearing for the shaft. The other end of the actuator shaft extends out of the thimble and is provided adjacent its outer end with a split spring keeper ring 31 keeping spring 32 trapped between the keeper ring and journal ball 28. Atmospheric pressure pressing inwardly on the flexible bellow thus maintains the movable contact 8 resiliently trapped between common contact 7 and dielectric rod 23. The spring 32 exerts a force opposing atmospheric pressure, but the force exerted by the spring is not sufficient to overcome the force exerted by atmospheric pres-

sure. It is the relatively small differential force imposed by atmospheric pressure which retains the parts in physical engagement in all positions of the movable contact. It is of course contemplated that where use of the relay precludes dependence on atmospheric pressure to maintain the operative relationship of the parts, a spring (not shown) may be inserted within the bellow so as to exert an inward force on the inner end thereof.

From FIG. 3 it will be seen that transverse movement of the free end of the actuator rod 29 will cause a corresponding movement of the inner end of dielectric rod 23, which in effect is an axially aligned extension of shaft 29.

The movement of the dielectric rod, however, will be in the opposite direction inasmuch as it lies on the opposite side of the fulcrum formed by journal ball 28 and bearing 27. The movable contact will of course follow movement of the dielectric rod 23 and will move in a generally circular path having circumferentially spaced transverse components.

To effect movement of the actuator shaft, the actuator mechanism includes a cam ring 33, centrally apertured as shown in FIG. 6 to provide a bearing surface 34. A relatively larger diameter recess is provided having a cylindrical side wall divided into a multiplicity of circularly arranged arcuate surfaces 35 separated by circumferentially spaced semi-spherical depressions 36.

Rotatably journaled in the cam ring is a detent carriage 37 having a cylindrical journal surface 38 adapted to bear on bearing surface 34, and a stem 39 extending out of the cam ring for engagement by any suitable actuating means such as nob 41. The detent carriage is provided with a transverse bore 42 shown best in FIGS. 5 and 6, and a slot 43 communicating with the transverse bore. The free end of the actuator shaft 29 extends through the slot in the detent carriage and slidably engages an appropriately proportioned bore in a movable carriage ball 44 contained within the transverse bore of the detent carriage. It will thus be seen that as the carriage ball 44 moves transversely through the bore 42, the free end of the actuator shaft 29 will follow the carriage ball and cause pivotal movement of the actuator shaft about the fulcrum 27-28.

To effect horizontal displacement of the carriage ball within the bore 42, a pair of detent balls 46 are provided, one detent ball being positioned adjacent each opposite end of the bore 42 so as to provide a spherical surface portion projecting beyond the cylindrical surface of the detent carriage and engageable with the arcuate surfaces 35 and recesses 36 in the cam ring. A spring 47 interposed in the bore 42 between one of the detents and the carriage ball insures that the detents will engage arcuate surfaces 35 and recesses 36 with a resilient force. While only a single spring 47 is shown, it will be obvious to those skilled in the art that two springs may be used, one on each side of the carriage ball and proportioned in force so that the shaft and movable contact are resiliently biased in one direction or the other by the force of spring 47. The small clearance between the carriage ball and the nearest detent 46 insures that the full force of the spring 47 will be transmitted through to the shaft to the movable contact. This permits variation of contact pressures, and thus contact resistance, by merely substituting a weaker or stronger spring. As shown in FIG. 5, the actuator mechanism is detachably secured to the envelope by appropriate bolts 48.

In operation, rotation of the detent carriage in either direction from the position shown in FIG. 5 will cause the detents to climb out of the recesses 36 and onto the adjacent arcuate surfaces 35. As the detents move out of the recesses, they move toward each other in the bore 42 and the carriage ball 44 is caused to move transversely through the bore 42, thus affecting a transverse movement of the free end of actuator shaft 29. It will thus be seen that when the detents are engaged in opposed

recesses 36, the movable contact 8 lies in resilient conductive contact with a selected one of the contact points 5. Since the speed of rotation of the detent carriage may vary within wide limits, it is obvious that make-and-break operation of the relay may be effected at very high speed.

We claim:

1. A switch comprising a hermetically sealed envelope closed at one end with a mounting structure having an aperture therein, a bellows having a closed end and an open end hermetically sealed to the mounting structure about the aperture, a bearing assembly fixedly supported on the mounting structure, an actuator shaft pivotally and slidably supported in the bearing assembly and connected at one end to the closed end of the bellows, an actuator shaft extension mounted on the closed end of the bellows within the envelope, a plurality of conductive terminal leads extending into the envelope to provide therewithin a circularly arranged array of spaced contacts radially spaced about the longitudinal axis of the envelope, a common contact axially spaced from said array of contacts and having a common terminal lead extending out of the envelope, a conductive contact pivotally interposed between the common contact and the actuator shaft extension and movable into and out of engagement with a selected one of the array of fixed contacts, and an actuator mechanism detachably mounted on the envelope and operatively engaging the end of the actuator shaft remote from the closed end of the bellows to effect rotary displacement of both ends of the actuator shaft to move the movable contact into or out of engagement with a selected one of the array of contacts.

2. The relay according to claim 1, in which said bearing assembly comprises an elongated hollow shell fixed at one end on the mounting structure and which at its other end encloses a journal ball forming a fulcrum for the actuator shaft.

3. The relay according to claim 1, in which the actuator shaft is pivotally and slidably journaled intermediate its ends on the bearing assembly.

4. The relay according to claim 1, in which atmospheric pressure acting on the bellow exerts an axially directed force tending to trap the movable contact between the common contact and the actuator shaft extension, and spring means on the actuator shaft exerts a relatively smaller force opposing atmospheric pressure.

5. The relay according to claim 1, in which the actuating mechanism includes a cam ring detachably secured to the envelope, and a detent carriage rotatably journaled within the cam ring and operatively connected to the actuator shaft to effect rotary displacement of both ends of the actuator shaft upon rotation of the detent carriage.

6. An actuating mechanism for transmitting rotary motion through the wall of a hermetically sealed envelope, comprising an apertured envelope wall portion, a flexible wall portion sealing the aperture in the wall, an actuator shaft connected to the flexible wall portion and extending out of the aperture, a bearing assembly associated with the apertured wall and the actuator shaft to provide a fulcrum for the actuator shaft at a point spaced from the apertured wall and the flexible wall portion, and drive means engaging the end of the actuator shaft remote from the flexible wall portion and operable to swing both ends of the actuator shaft in a circular path about the fulcrum.

7. The actuating mechanism according to claim 6, in which the flexible wall comprises a tubular bellow having a closed end remote from the apertured wall, and the fulcrum provided by the bearing assembly lies intermediate the closed end of the bellow and the apertured wall.

8. The actuating mechanism according to claim 6, in which the drive means comprises a cam ring detachably secured to the apertured wall, a detent carriage assembly journaled for rotation within the cam ring and oper-

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actively engaging the associated end of the actuator shaft, and means to effect rotation of the detent carriage.

9. The actuating mechanism according to claim 8, in which an inner peripheral surface of said cam ring is provided with a plurality of circumferentially spaced recesses separating a plurality of circularly arranged arcuate surfaces, said detent carriage assembly comprises a cylindrical member journaled within said inner peripheral surface and having a transverse bore there-through, spring-pressed detents adjacent each opposite end of said bore and movable along said bore, and a carriage ball in said bore engaging the actuator shaft and interposed between said detents and movable therewith

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to shift the associated end of the actuator shaft in a circular path about said fulcrum.

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