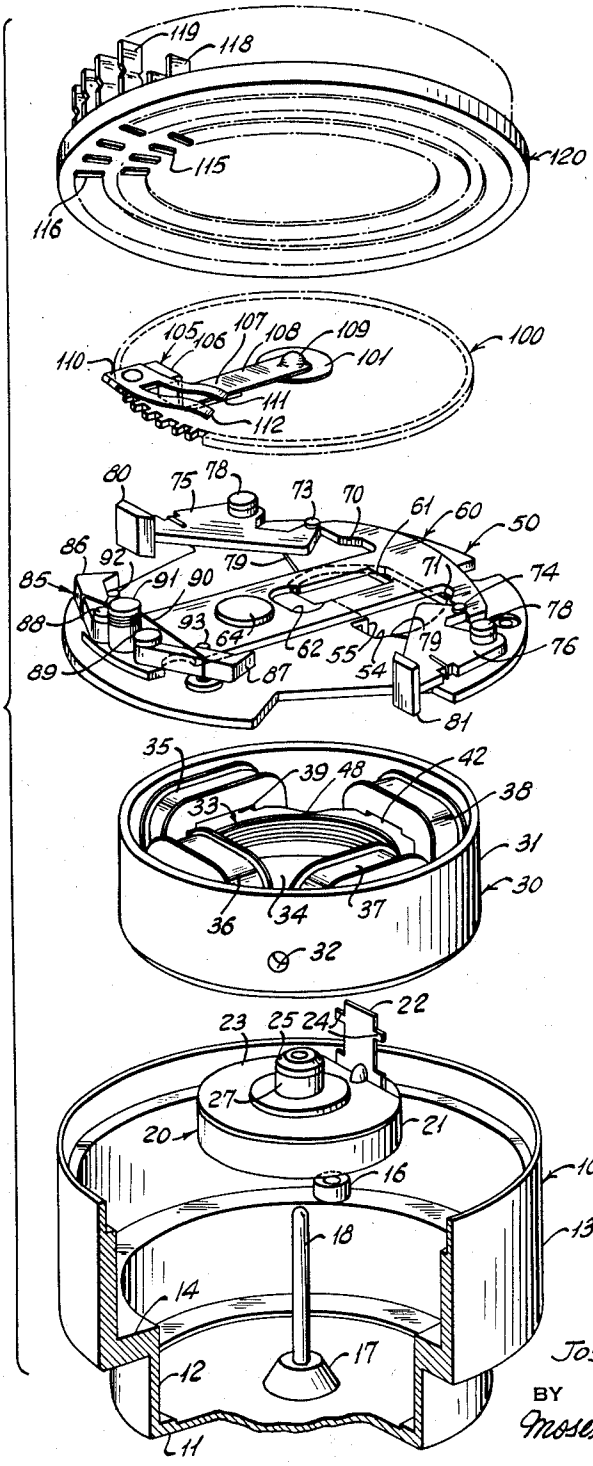
March 15, 1960 J. L. BONANNO 2,928,916

STEPPING SWITCH

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Fig. 1.



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Fig. 2.

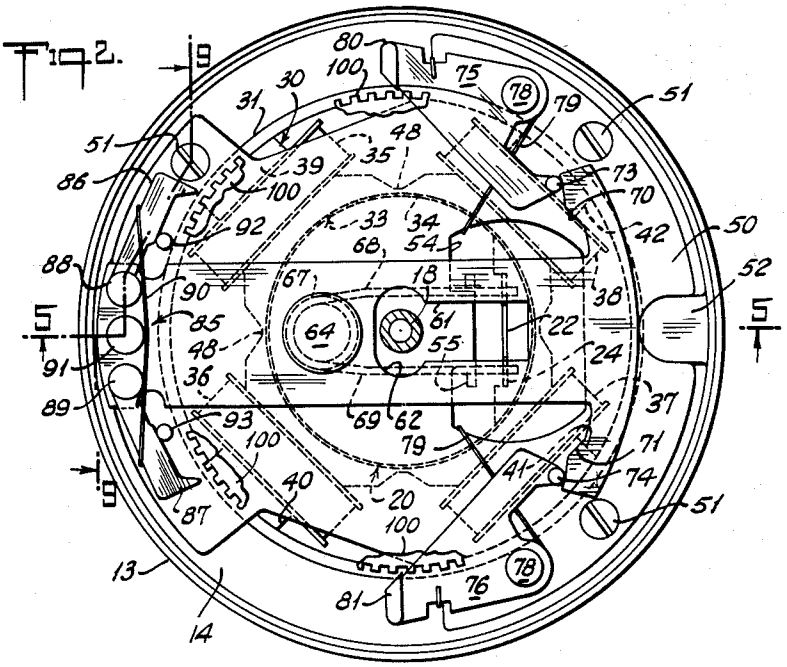
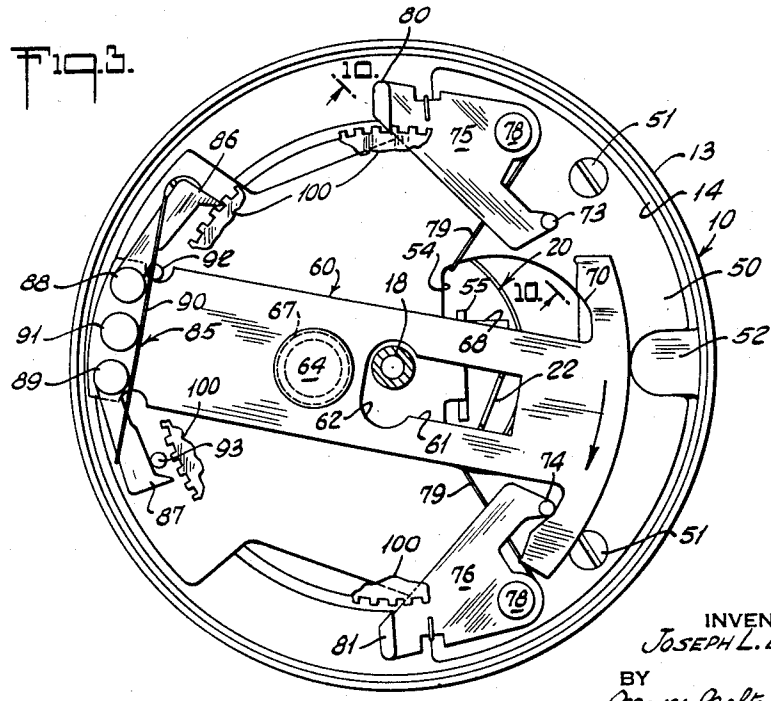


Fig. 3.



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Fig. 4.

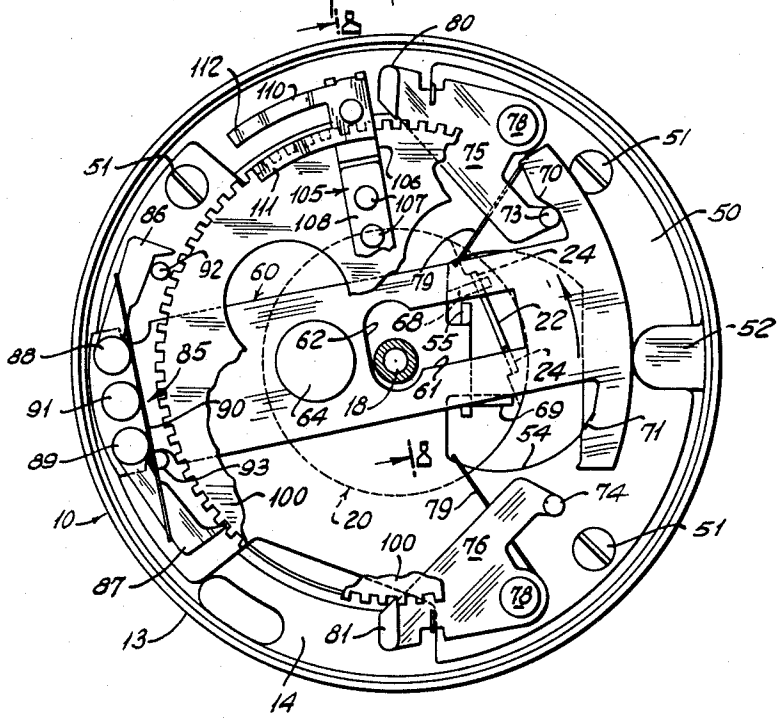
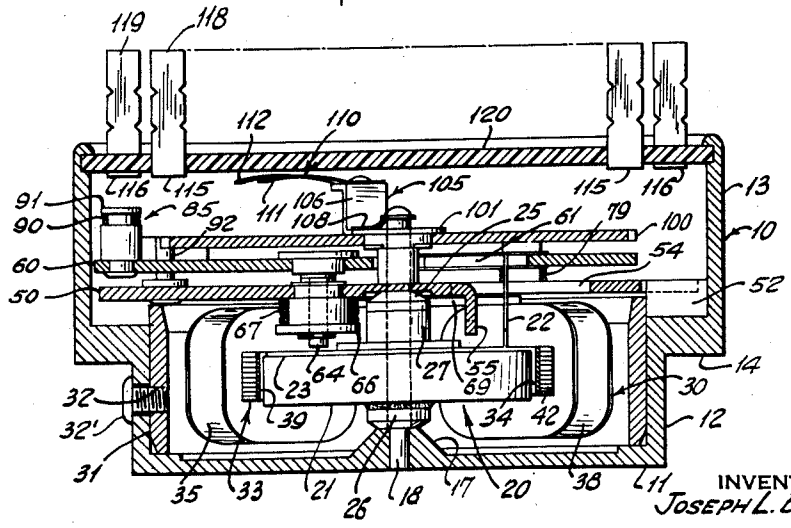


Fig. 5.



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Fig. 6.

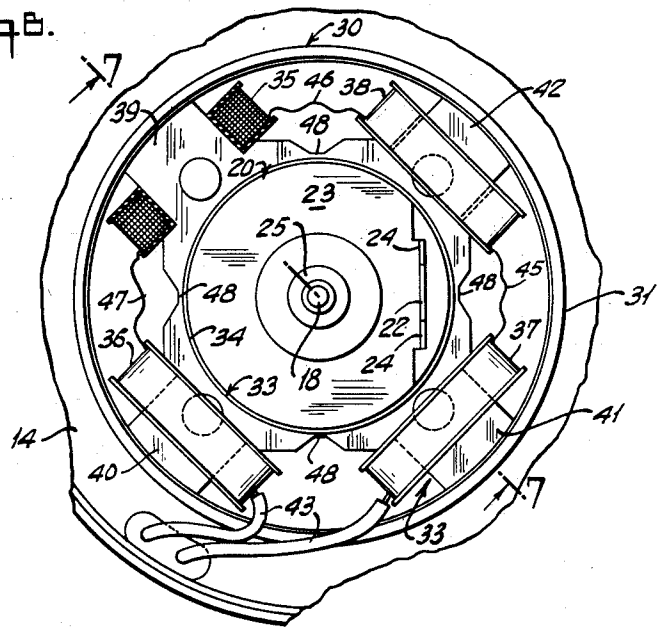


Fig. 7.

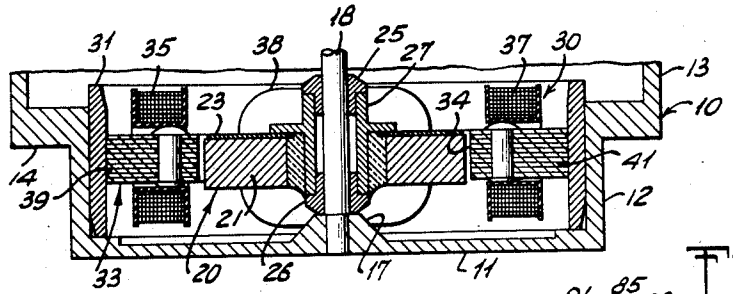


Fig. 8.

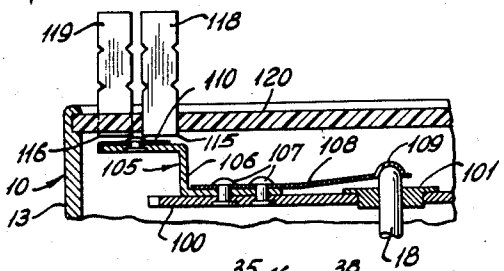


Fig. 9.

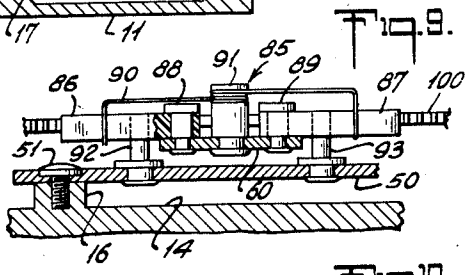


Fig. 10.

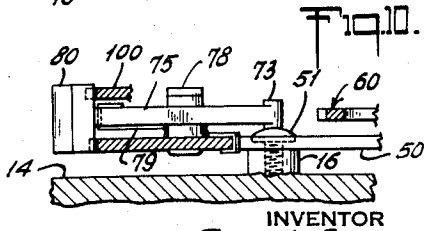
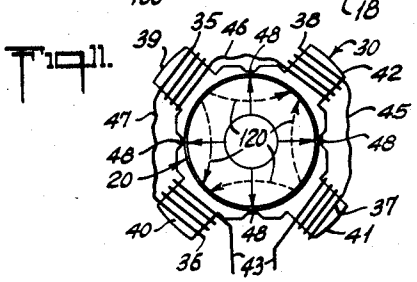


Fig. 11.



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2,928,916

STEPPING SWITCH

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Application April 8, 1959, Serial No. 805,034

8 Claims. (Cl. 200—105)

The present invention relates to an electrically actuated stepping switch.

Stepping switches are used where a large number of automatic switching operations are required. A stepping switch is a controlled step-by-step selector switch having one or more movable contacts and a very large number of stationary contacts adapted to be engaged successively by the movable contacts as the switch is stepped around, generally by the application of electrical impulses to suitable actuating means for the stepping switch. Stepping switches are generally stepped in only one direction.

It is an object of the present invention to provide a stepping switch capable of being stepped in opposite directions with precision and reliability.

It is another object of the invention to provide a compact, highly dependable stepping switch capable of being actuated in both directions by the application of positive and negative current pulses thereto.

The invention will be fully understood and other objects and advantages thereof will become apparent from the following description and the drawings in which:

Fig. 1 is an exploded perspective view of a stepping switch according to the invention;

Fig. 2 is a top view with the contact disc removed and part of the ratchet wheel broken away and with the parts in their neutral position;

Fig. 3 is a view similar to that of Fig. 2 showing the switch actuated in the clockwise direction;

Fig. 4 is a view similar to that of Fig. 3 showing the switch actuated in a counterclockwise direction;

Fig. 5 is a sectional view taken along the line 5—5 of Fig. 2;

Fig. 6 is a top view partly in section showing the stator and rotor arrangement;

Fig. 7 is a sectional view taken along the line 7—7 of Fig. 6;

Fig. 8 is a partial sectional view showing the switch contacts;

Fig. 9 is a partial sectional view taken along the line 9—9 of Fig. 2;

Fig. 10 is a partial sectional view taken along the line 10—10 of Fig. 3; and

Fig. 11 is a diagrammatic view of the rotor and stator assembly.

Referring to the drawing, cylindrical case 10 may be formed of an aluminum alloy or other suitable material. It includes a base 11 and sides 12 and 13 joined by a shoulder 14. A plurality of tapped bosses 16 are provided along shoulder 14. The base has a bushing 17 supporting fixed center pin 18, which may be formed of stainless steel. A permanent magnet rotor assembly 20 is mounted on pin 18 against the bushing or bearing 17. Rotor 20 comprises a cylindrical permanent magnet 21 and an actuating plate 22 integral with a disc 23 which overlies the mganet 21. Actuating plate 22 may be formed of Phosphor bronze and includes a pair of projecting ears 24. Magnet 21 and plate 23 are held assembled by any suitable means such as stainless steel bushings 25

and 26 and the tubular sleeve 27 through which the pin 18 passes. The rotor 20 is thus assembled and mounted as shown in Fig. 7.

A stator 30 is mounted in the lowermost portion of casing 10 around the rotor 20. The stator comprises a steel ring 31 having a tapped hole 32 into which a screw 32' is adapted to extend for holding the ring 31 fixed within the casing. A magnetizable core 33 consisting of a plurality of laminations suitably riveted or otherwise fastened together is fixedly mounted in ring 31. The core 33 has a circular opening 34 for receivng rotor 20. The core has a plurality of poles which are, in the present embodiment, shown as being four poles 39–42 on which coils 35—38 are mounted. The coils are connected in series with a pair of input leads 43 and are interconnected by wires 45, 46 and 47. The coils are so connected and wound that coils 35 and 37 will produce N-poles on the inner ends of pole pieces 39 and 41, and coils 36 and 38 will produce S-poles at the inner ends of pole pieces 40 and 42 when the current flows through the coils in one direction, and will produce the opposite magnetic polarity when the current flows in the other direction. Intermediate the four poles 39–42 the laminations are notched at 48 so as to define distinct poles. In cooperation with the stator arrangement just described the rotor is magnetized so that it has two N-poles and two S-poles as shown in Fig. 11, when in its neutral position.

Overlying the stator 30 and the rotor 20 is an assembly comprising a base plate 50 formed of a non-magnetic material such as brass. Plate 50 is fastened to the case 10 by screws 51 which enter the bosses 16. A projection 52 on case 10 helps to position the base plate. Plate 50 has a cut-out 54 and a downwardly projecting lug 55 the purpose of which will be described later. Mounted over the plate 50 is an indexing plate 60 made of a non-magnetic material and having an opening 61 through which the actuating plate 52 is adapted to extend, with the shoulders 24 of the actuating plate abutting the bottom of indexing plate 60. The inner end of opening 61 is notched or enlarged at 62 to permit the indexing plate to move in both directions without striking pin 18. A stud 64 in plate 60 forms a pivot for it and extends through the base plate 50 as shown in Fig. 5. The lower end of stud 64 has thereon a bushing 66 on which a centering spring 67 is mounted. The spring 67 has two side arms 68 and 69 which engage the lug 55. Thus, the centering spring 67 tends to return the indexing plate 60 to its center or neutral position when the latter is turned by the actuating plate 22. At one end, the indexing plate 60 is provided with a pair of arms having cam surfaces 70 and 71. These surfaces are adapted to engage cam followers 73 and 74 integral with locking pawl assemblies 75 and 76. The locking pawl assemblies are mounted by means of studs 78 around which there are mounted biasing springs 79 for biasing the locking pawls 80, 81 inwardly. Pawl 80 is shaped to prevent counterclockwise rotation and pawl 81 is shaped to prevent clockwise rotation.

At the other end of indexing plate 60 there is an escapement 85 comprising indexing pawls 86 and 87. The pawls are provided with pivots 88 and 89 and an indexing spring 90 mounted on a stud 91. Pins 92 and 93 are positioned for moving the pawls 86 and 87 out of engagement when the indexing plate 60 is moved in one direction or the other. A ratchet wheel 100 formed of a non-magnetic material is provided with a center bushing 101 adapted to fit over the pin 18. The diameter of the ratchet wheel is such that it is engaged by the indexing pawls 86 and 87 and the locking pawls 80 and 81. On the upper face of the ratchet wheel 100 there is mounted at least one movable contact assembly 105. The contact assembly comprises a spring contact supporting bracket

106 which may be fastened by rivets 107 to the ratchet wheel. A center spring 108 is also fastened by rivets 107 to the bracket 106. The spring 108 is formed of any suitable spring material such as silver and is provided with a loop 109 which engages the rounded head of center pin 18. The upper end of bracket 106 supports the spring contact 110 which has a pair of arms 111 and 112 and is preferably formed of sterling silver. Arms 111 and 112 are adapted to engage the lower ends 115 and 116 of two or more circular rows of lugs or terminals 118 and 119 of a fixed contact disc 120 so as to interconnect one or more of the terminals 118 with one or more of the terminals 119. It is apparent that other arrangements of terminals and spring contacts can be used. The case 10 may be crimped at its upper edge to hold disc 120 fixed.

The operation of the stepping switch is as follows. When no current is supplied to the leads 43 and coils 35—38 are not energized, indexing plate 60 is held in a neutral or center position by means of spring 67. In this position the rotor is oriented with respect to the stator as shown in Fig. 11 and Fig. 6. When current or a current pulse in one direction is supplied to the stator coils they produce a magnetic field as indicated by the lines 120 of Fig. 11 causing the rotor to rotate in one direction. Actuating plate 22 fixed to the rotor is therefore moved, turning the indexing plate 60, say, in the clockwise direction. As indicated in Fig. 3, the indexing plate is thus pivoted about the stud 64 and moves the escapement in a clockwise direction, causing indexing pawl 86 to move out of engagement with pin 92 and into engagement with ratchet wheel 100, thus moving the ratchet wheel in the clockwise direction. Simultaneously, the camming surface 71 of indexing plate 60 moves the locking pawl 81 out of engagement with the ratchet wheel in order to permit the latter to rotate. At the same time the camming surface 70 moves out of engagement with the cam follower 73 and permits the locking pawl 80 to engage the ratchet wheel 100 so as to prevent counterclockwise rotation and to limit the rotation of ratchet wheel 100 so that it moves only a distance of one tooth. Accordingly, the spring contact assembly 105 is also moved to switch the connections with terminals 118 and 119. In this manner the switch performs one step for each pulse which is applied, regardless of the length of the pulse or its magnitude, and the number of steps which are executed is exactly equal to the number of pulses which is applied, provided that the pulses are spaced in conformance with the operating time of the stepping switch. If current pulses of the opposite polarity are applied it will be evident that the magnetization of the stator poles by the mode of operation above described the switch will be stepped in the opposite direction.

Although I have illustrated my invention by fully describing one particular embodiment thereof, it will be understood by those skilled in the art that many variations and modifications thereof may be made without departing from the spirit and scope of my invention as defined in the following claims.

What is claimed is:

1. A stepping switch comprising a casing, a stator assembly in said casing, said stator assembly including a multi-pole magnetic core having a circular opening and a plurality of interconnected coils mounted on the poles of the stator, a permanent magnet rotor in said opening, means for mounting said rotor for oscillation about an axis of said circular opening, an indexing plate, means for pivotally mounting said indexing plate, means connecting said indexing plate to said rotor, spring means for urging said indexing plate to a center position, an escapement connected to one end of said indexing plate and a ratchet wheel pivotally mounted on said axis in engagement with said escapement for rotating said ratchet wheel one tooth at a time in response to oscillation of the indexing plate, a pair of locking pawl means engaging said ratchet wheel for locking it against rotation in either direction, means on said indexing plate for actuating said locking pawls and switching means including stationary circumferentially arranged contacts and a cooperating contact mounted on said ratchet wheel for engagement with the stationary contacts.

2. A stepping switch according to claim 1, wherein each locking pawl has spring means biasing it against the ratchet wheel and the actuating means for said pawls include a cam follower fixed to each pawl and a pair of cam surfaces on the indexing plate positioned to engage said cam followers.

3. A stepping switch comprising a casing, a stator assembly in said casing, said stator assembly including a mulit-pole magnetic core having a circular opening and a plurality of interconnected coils mounted on the poles of the stator and a permanent magnet rotor in said opening, means for mounting said rotor for oscillation about an axis of said circular opening, an indexing plate, means for pivotally mounting said indexing plate, means connecting said indexing plate to said rotor, spring means for urging said indexing plate to a center position, an escapement connected to one end of said indexing plate, and a ratchet wheel pivotally mounted on said axis in engagement with said escapement for rotating said ratchet wheel one tooth at a time in response to oscillation of the indexing plate, and switching means including stationary circumferentially arranged contacts and a cooperating contact connected to said ratchet wheel for engagement with the stationary contacts.

4. A stepping switch comprising a casing, a stator assembly in said casing, said stator assembly including a multi-pole core having a circular opening and a plurality of interconnected coils mounted on the poles of the stator, a disc shaped permanent magnet rotor having alternating N and S poles round its circumference, means for mounting said rotor in the opening of said stator for oscillation about an axis of said circular opening, an indexing plate, means for pivotally mounting said indexing plate, means connecting said indexing plate to said rotor, spring means for urging said indexing plate to a center position, an escapement connected to one end of said indexing plate, and a ratchet wheel pivotally mounted on said axis in engagement with said escapement for rotating said ratchet wheel one tooth at a time in response to oscillation of the indexing plate, and switching means including stationary circumferentially arranged contacts and a cooperating contact connected to said ratchet wheel for engagement with the stationary contacts.

5. A stepping switch comprising a casing, a stator assembly in said casing, said stator assembly including a multi-pole magnetic core having a circular opening and a plurality of interconnected coils mounted on the poles of the stator, a permanent magnet rotor, means for mounting said rotor in said opening for oscillation about an axis of said circular opening, an escapement, a ratchet wheel pivotally mounted on said axis in engagement with said escapement, means connecting said escapement to said rotor for rotating said ratchet wheel one tooth at a time in response to oscillation of the indexing plate, and switching means including stationary contacts and a cooperating contact connected to said ratchet wheel for engagement with the stationary contacts.

6. A stepping switch according to claim 5, including a pair of locking pawl means engaging said ratchet wheel for locking it against rotation in one direction.

7. A stepping switch according to claim 6 including means connected to said rotor for moving one of locking pawls from one tooth of the ratchet wheel to the next tooth in response to each oscillation of the rotor.

8. A stepping switch comprising a cylindrical casing, a stator assembly in said casing, said stator assembly including a closed magnetic ring on a unitary core having a plurality of radially extending poles and a circular

opening and a plurality of interconnected coils mounted on the poles of the stator, a permanent magnet rotor having a like plurality of circumferentially arranged poles, means for mounting said rotor for oscillation about an axis of said circular opening, an indexing plate, means for pivotally mounting said indexing plate, means connecting said indexing plate to said rotor, spring means for urging said indexing plate to a center position, an escapement connected to one end of said indexing plate, and a ratchet wheel pivotally mounted on said axis in engagement with said escapement for rotating said ratchet wheel in a given fixed distance at a time in response to an oscillation of the indexing plate, means engaging said ratchet wheel for locking it against further rotation after it has moved said fixed distance, and switching means including stationary arranged contacts and a cooperating contact mounted on said ratchet wheel for engagement with the stationary contacts.

No references cited.