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A. M. SKELLETT

2,243,399

CONTACT OPERATING DEVICE

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FIG. 1

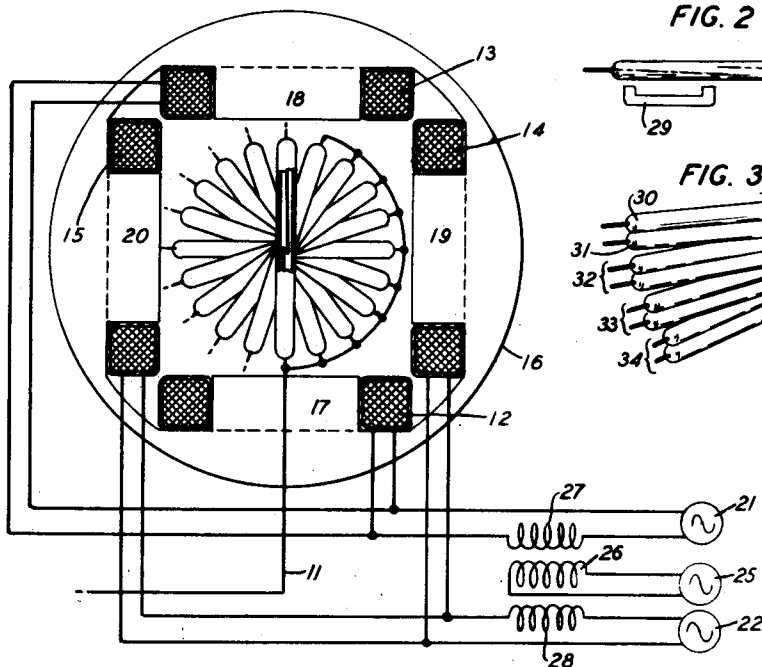


FIG. 2

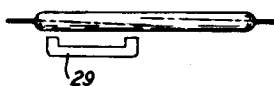


FIG. 3

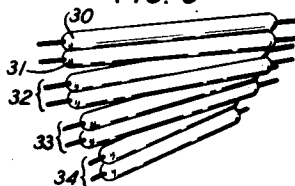


FIG. 4

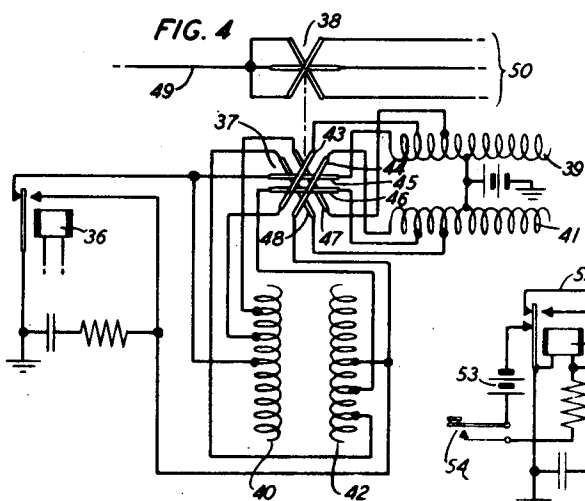
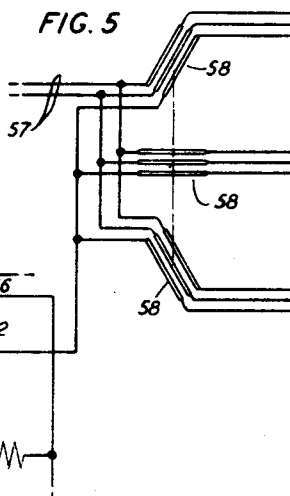


FIG. 5



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## UNITED STATES PATENT OFFICE

2,243,399

## CONTACT OPERATING DEVICE

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15 Claims. (Cl. 175-330)

This invention relates to contact operating devices and particularly to devices of this kind suitable for use in telephone switching systems.

An object is to generally improve and simplify switching devices, to increase their speed of operation and to reduce the cost and the number of parts required in such devices to establish electrical connections.

Heretofore devices for switching have been provided in which contacts were enclosed in airtight vessels operated upon magnetically to establish connections such as are disclosed in the copending application of W. B. Eliwood Serial No. 198,629, filed March 29, 1938. This application also discloses a permanent magnet arranged to move in proximity to such vessels containing magnetically responsive contacts to cause the closing and opening of electrical connections through said contacts.

It is a feature of the present invention to provide a switching mechanism for operating contacts in succession, comprising a plurality of airtight vessels containing contacts of magnetic material, said vessels being arranged spirally across a common axis and means for producing a rotating magnetic field across said axis to actuate the contacts in succeeding vessels.

Another feature is an arrangement whereby momentary successive magnetic fields may be produced across the axis in parallel with succeeding vessels to actuate the contacts in said succeeding vessels.

Another feature is the provision of means for causing the rotating magnetic field across the axis to actuate the contacts of succeeding vessels once only for each revolution.

Another feature is an arrangement whereby a plurality of units containing contacts of magnetic material may be arranged in parallel relation to each other in each position to provide a plurality of connections at each position.

Another feature is an arrangement whereby the field may be rotated in steps under control of a stepping magnet and another feature is an arrangement whereby a stepping magnet having a self-interrupting circuit for operating it is associated with means for controlling this self-interrupting circuit to advance the magnetic field in a hunting manner as in the operation of step-by-step switches for hunting where, for example, a ground indicates an idle position.

This invention has been illustrated in the accompanying drawing in which the Figs. 1 to 5 show different aspects of the applicant's invention.

Fig. 1 shows an arrangement of applicant's invention for operating contacts in vessels in succession by a rotating magnetic field;

Fig. 2 shows an arrangement whereby such contacts are operated only once for each revolution of the field;

Fig. 3 shows two such vessels at each angular position;

Fig. 4 shows the arrangement of Fig. 1 controlled in steps; and

Fig. 5 shows the arrangement of Fig. 4 arranged for hunting.

In Fig. 1 a series of ten units containing magnetic contacts are arranged spirally around a common axis and if spaced at equal distance from each other they would be 18 degrees apart. The contacts from one end of the tubes are connected together through a common conductor 11 and the other contacts are connected to individual conductors. If connections are established through these tubes individually and in succession, the lead 11 will therefore be connected to the individual leads for the succeeding tubes and thus these units will act as a selector switch.

To cause these connections to be made, the units are surrounded by two pairs of coils placed at right angle to each other, the coils in one set are marked 12 and 13 and the others are marked 14 and 15. These coils are wound on a common core structure 16 so that when either one of these pairs of coils are energized, the magnetic flux will be caused to flow between the associated pole-pieces. For example, if coils 12 and 13 are energized, the flux will flow between the pole-pieces 17 and 18 and if coils 14 and 15 are energized, flux will flow between the pole-pieces 19 and 20. This flux will be directed to cause contacts in the units 1 to 10 to be operated depending on the relative strength of the two fields.

If coils 12 and 13 are connected to an alternating current source such as 21 and the coils 14 and 15 are connected to the alternating current source 22, and if these currents are 90 degrees apart in regard to their phase, it is evident that the two magnetic fields varying in strength will establish a composite magnetic field of a maximum strength that will rotate around the axis of the units. This field will be directed across the axis in one direction for one half of each revolution and in the opposite direction for the other half of each revolution. Consequently the contacts in succeeding units will be closed twice for each revolution. The alternating current sources 21 and 22 may be so adjusted that the closed period of the contacts in each unit will

merely extend over a few degrees of travel of the field and open for the remainder of the period of travel of the field during each revolution.

If an additional alternating current source such as 25 is provided with an induction winding 26 and corresponding windings 27 and 28 are placed in the circuits from the alternating current sources 21 and 22, these currents from the sources 21 and 22 may be modulated by a higher frequency from source 25 which may occur at such time intervals when the field would be in any direction between two adjacent units to cause this magnetic field to entirely disappear at these periods. This will insure that a preceding actuated unit would be completely deenergized before the succeeding unit becomes energized.

If it is desired that the connection between the contacts in each unit should only occur once during a complete revolution of the field, a permanent magnet 29 such as is shown in Fig. 2 may be placed alongside each unit so that for one direction of the field, it is opposed by the permanent magnet field and in the other it is aided by the permanent magnet field. Consequently when the field is opposed by the permanent magnet field of magnet 29, no connection between the contacts of a unit will be established. If it is not desirable to provide a special permanent magnet like 29 for each unit, the contacts of each unit may be given permanent magnetization somewhat less than that necessary to make the contact self-closing. Thus with the field in one direction, the magnetic field of the contacts would oppose it and with the field in the opposite direction the magnetic field of the contacts will aid it and in this manner the contacts in each unit may be arranged to close only once for each revolution of the field.

Fig. 3 illustrates how a plurality of units may be laid parallel to each other in each position. For example, tubes 30 and 31 may be laid alongside each other in parallel in one direction, and the succeeding three pairs of tubes 32, 33 and 34 may be similarly placed in succeeding directions. In arrangements of this sort, therefore, two connections will be made through a pair of tubes for each position of the field.

Fig. 4 shows an arrangement whereby the control over the actuation of the units is to be exercised by a stepping relay. Coils arranged in accordance with those shown in Fig. 1 may be energized by a direct current and tapped through the pulsing contacts of a stepping relay such as 36 and special control units arranged at 37 so that the field may be held in any desired position each time the stepping relay is released and advanced one step each time the stepping relay is operated. Associated with these special units may be arranged corresponding units such as 38 which operate to establish the desired switching connections. A description will now be made of the functioning of the system under control of the stepping relay 36. The coils in this figure have been illustrated diagrammatically by straight coil windings, for example, the coils corresponding to the coils 12 and 13 are illustrated by the straight coil 39, the coils corresponding to coils 14 and 15 are illustrated by the straight coil 40. These coils 39 and 40 are employed to hold or lock the field produced thereby in any direction as will hereinafter be described. In addition to coils 39 and 40 there is also provided two other sets of coils, for example coil 41, corresponding to coils 12 and 13, and coil 42 corre-

sponding to coils 14 and 15. These latter coils are employed to rotate the field produced thereby into succeeding positions as will hereinafter be described. It should be understood that all of these coils will be arranged like the coils shown in Fig. 1 to control the rotation and locking of the field under the direction of relay 36.

If it is assumed, to start the system to operate, that a connection is established between the contact in the special unit 43, a circuit will be completed from battery through a portion of the winding of coil 39, contacts of unit 43, a portion of the winding of coil 40, contact of relay 36 and ground. The coils 39 and 40 are thereby energized to produce a field in the direction in which the unit 43 is placed. This field would therefore be held or locked in its established first position as long as the connection to ground at relay 36 is maintained. As the unit 44 is located in the same direction as unit 43 this field will also cause a connection between the contacts in this unit to be established. This has no immediate effect. However, when the relay 36 is first operated in response to the first impulse it will be noted that a circuit will be established from battery through a portion of the winding of coil 41, the contacts of unit 44 to ground at the contacts of relay 36. The field is thereby shifted into a second position in the direction of the units 45 and 46 and thus connections through the contacts of these two units will be established and connections through units 43 and 44 will be opened due to the shifting of the field. It should be mentioned here that the connection through unit 44 is somewhat slow in opening for a purpose as will hereinafter become apparent. Shortly thereafter this first pulse ceases and the stepping relay 36 releases. A circuit will now be closed through the contacts of unit 45 from battery, a portion of the winding of coil 39, contacts of unit 45 to ground at the contacts of relay 36. This will produce a field in the same direction as the field produced by the connection through unit 44 and thus the field will be held and locked in this second position to wait for a second impulse, that is, the connection through unit 44 being slow to open is maintained long enough to permit the connection through unit 45 to be made to maintain the field locked in this second position. The connection through the contacts of unit 46 has no effect at this time. However, when relay 36 again operates in response to a second impulse, a circuit will be completed from battery through a portion of the winding of coil 41, contacts of unit 46, a portion of the winding of coil 42 to ground and contacts of relay 36. The effect of this will be that the field will be again shifted into a third position in the direction of units 47 and 48. Connection through units 47 and 48 will thereby be established and the connection through units 45 and 46 will be opened. The connection through unit 46 is slow in opening, the same as the connection through unit 44. Shortly thereafter the second impulse ceases and the relay 36 will be released, thus closing a circuit from battery, a portion of the winding of coil 39, contacts of unit 47, a portion of the winding of coil 40 to ground at contacts of relay 36. This will produce a field in the same direction as the field produced through unit 46 and thus the field will be held locked in this third position to wait for a third impulse, that is, the connection through unit 46 being slow to open remains long enough to permit the connection through unit 47 to be made to maintain the field in this third position. The connection

through contact of unit 48 produces no effect at this time but comes into play when relay 36 is again operated in the manner hereinbefore described in connection with the preceding unit. Consequently, the field will be rotated one step each time relay 36 is operated and locked each time it is released and a control over the rotation and locking of the field may therefore be exercised by stepping magnet 36 as described.

This arrangement may be used in selecting connections in accordance with digit dialed, for example, the relay 36 will step to shift connections over the regular units such as the group 36 from a common conductor 49 to the individual conductors 50.

If it is desired to apply this kind of system as illustrated in Fig. 4 to a hunting arrangement in which the field is shifted from one position to another until an idle connection is encountered, the arrangement shown in Fig. 5 may be added. In this figure the relay 52 corresponds to relay 36 in Fig. 4 except that it will be controlled to operate and release from the buzzer circuit through battery 53 when a key 54 is closed. As relay 52 is operated and released, it causes the field to be rotated by the closing and opening of the connection at its armature over leads 55 and 56 which correspond to the pulsing leads for relay 36 in Fig. 4. However, it should be noted that at each position of units as illustrated in this figure, there are two units at each position connected through common conductors 57 for the establishing of a tip and ring connection as in a regular selector switch and an additional tube 58 in each position one end of which is connected to one side of the winding of relay 52. Normally, if this corresponds to the sleeve connection as in a selector, when connections are established through these units 58 nothing occurs to prevent the continued operation and release of relay 52 but when a ground occurs on the connection established through any one of these tubes, the relay 52 will be short-circuited and consequently its alternate operation and release functions and the field will be locked in the last position to maintain the connection. It is therefore seen that complete control over the operation of the units may be established either by a pulsing relay such as 36 or by a hunting action as illustrated in Fig. 5.

What is claimed is:

1. A mechanism for operating contacts in succession comprising a plurality of vessels containing contacts of magnetic materials, said vessels being arranged spirally across a common axis, and means for producing a rotating magnetic field across said axis to actuate the contacts in succeeding vessels.

2. A mechanism for operating contacts in succession comprising a plurality of sets of contacts of magnetic material, said sets being arranged spirally across a common axis, two sets of coils arranged at right angles to each other and associated with said contact sets, and means for energizing said coils to produce a rotating magnetic field across said axis to actuate the contacts of succeeding sets.

3. A mechanism for operating contacts in succession comprising a plurality of vessels containing contacts of magnetic material, said vessels being arranged spirally across a common axis, and means for producing momentary succeeding magnetic fields across said axis in parallel with succeeding vessels to actuate the contacts in said succeeding vessels.

4. A mechanism for operating contacts in succession comprising a plurality of vessels containing contacts of magnetic material, said vessels being arranged spirally across a common axis, two sets of coils arranged at right angles to each other and associated with said vessels, an alternating current source for producing an alternating current in each set of coils, said alternating currents being 90 degrees out of phase with each other to produce a rotating magnetic field across said axis to actuate the contacts in succeeding vessels, means for modulating said alternating currents to reduce the magnetic field produced by such coils to zero in the position between any two adjacent vessels.

5. A mechanism for operating contacts in succession comprising a plurality of air-tight vessels containing contacts of magnetic material, said vessels being arranged spirally across a common axis, means for producing a rotating magnetic field across said axis for actuating the contacts of succeeding vessels and means for preventing said field from actuating the contacts in succeeding vessels more than once for each revolution.

6. A mechanism for operating contacts in succession comprising a plurality of sets of contacts of magnetic material, said sets being arranged spirally across a common axis, means for producing a rotating magnetic field across said axis for actuating the contacts of succeeding sets, a permanent magnet adjacent each set so located as to counteract the magnetic field in one of its two directions during each revolution when it passes the sets to permit the operation of the contacts in said sets once only during each revolution of the field.

7. A mechanism for operating contacts in succession comprising a plurality of air-tight vessels containing contacts of magnetic material, said contacts being permanently magnetized slightly less than would be required to cause them to attract each other, said vessels being arranged spirally across a common axis, means for producing a rotating magnetic field across said axis to actuate the contacts of said vessels for each revolution in succession when the direction of the magnetic field is in the same direction as the magnetic field of the contacts and for preventing the actuation of the contacts of said vessels when the direction of the magnetic field is opposed by the magnetic field in the contacts.

8. A mechanism for operating groups of contacts in succession comprising groups of tubes, each tube containing a set of contacts of magnetic material, the tubes in each group being arranged in parallel relation to each other and the groups of tubes being arranged spirally across a common axis, and means for producing a rotating magnetic field across said axis that actuates all the contacts in each group of tubes with one group succeeding another.

9. A mechanism for operating groups of contacts in succession comprising groups of air-tight vessels, each vessel containing a set of contacts of magnetic material, the vessels in each group being arranged in parallel relation to each other and adjacent each other in a plane parallel to a common axis, said groups being also arranged spirally across said axis, two groups of coils arranged at right angles to each other around said axis, and means for energizing said coils to produce a rotating magnetic field across said axis for operating all the contacts in each group of vessels with one group succeeding another.

10. In a mechanism for operating contacts in succession, a plurality of sets of contacts of magnetic material arranged spirally across a common axis, a stepping relay, means responsive to the operation of said stepping relay for producing a magnetic field for operating the contacts of said sets in succession, one set of contacts being operated for each succeeding step of said relay.

11. In a mechanism for operating contacts in succession, a plurality of air-tight vessels containing contacts of magnetic material arranged spirally across a common axis, a stepping relay, coils grouped around said axis, means controlled by the operation and release of said relay for actuating said coils to operate the contacts of one vessel after another, one set of contacts being operated during the release of said relay.

12. In a mechanism for operating contacts in succession, a plurality of air-tight vessels containing contacts of magnetic material arranged spirally across a common axis, a stepping relay, coils grouped around said axis, means including other air-tight vessels containing contacts of magnetic material controlled by the operation of said relay for actuating portions of said coils through succeeding closed connections through contacts of said last-mentioned vessels for operating the contacts of said first-mentioned vessels in succession, one set of contacts being operated each time said relay is released.

13. In a mechanism for operating contacts in succession, a plurality of air-tight vessels containing contacts of magnetic material arranged spirally across a common axis, a relay, a self-

interrupting circuit for said relay, means controlled by said relay when it operates and releases for producing a rotating magnetic field for operating the contacts of said vessels in succession, and means for stopping the operation of said self-interrupting circuit to permit said magnetic field to remain in any operated position.

14. A mechanism for operating contacts in succession comprising a plurality of air-tight vessels containing contacts of magnetic material, said vessels being arranged spirally across a common axis, means for producing a rotating magnetic field across said axis for actuating the contacts of succeeding vessels, and means for counteracting said field for one half of each revolution to prevent it from actuating the contacts of succeeding vessels more than once for each revolution.

15. In a mechanism for operating contacts in succession, sets of air-tight vessels containing contacts of magnetic material, said sets arranged spirally across a common axis, a relay, a self-interrupting circuit for said relay, means controlled by said relay when it operates and releases for producing a rotating magnetic field for operating the contacts of the set of vessels in succession and means operative at any angular position of the field when it has actuated the contacts of the set of vessels at said position for short-circuiting the self-interrupting circuit to stop the operation of the relay so that said field will remain at said angular position to maintain the contacts of the set at this position operated.

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