

June 14, 1960

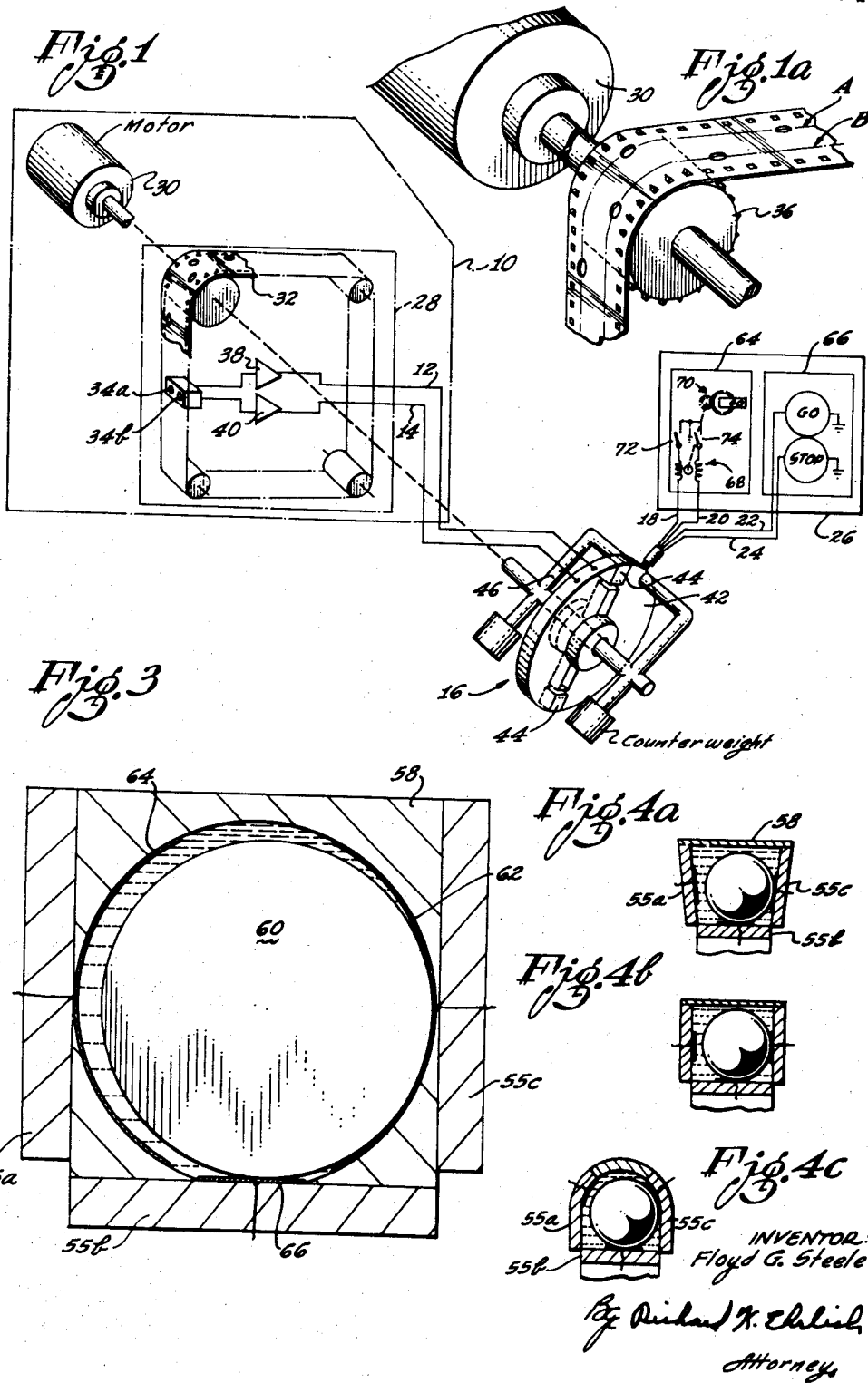
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2,941,097

SELECTIVELY ACTUABLE MULTIPLE SWITCHES

Filed Oct. 14, 1958

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

Fig. 2a

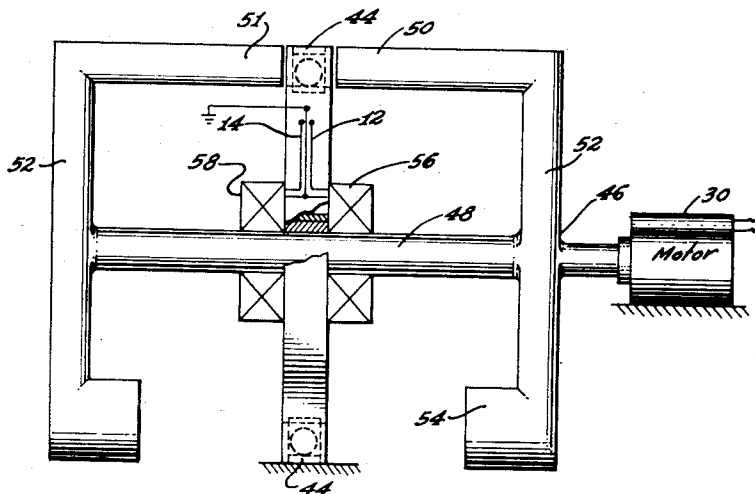


Fig. 2b

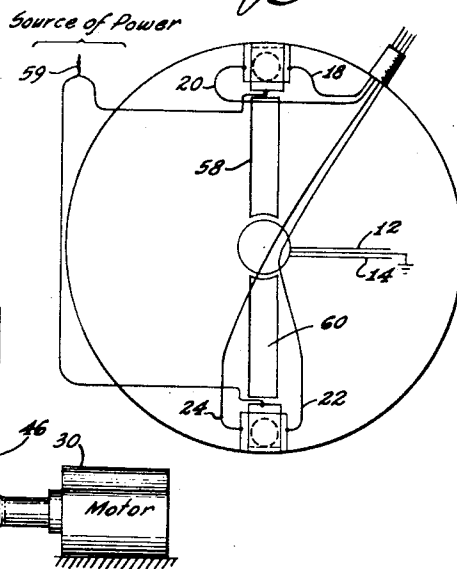
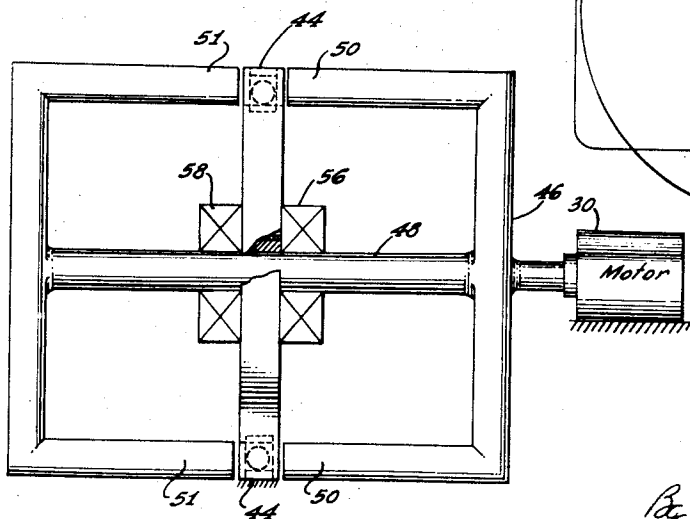


Fig. 5



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SELECTIVELY ACTUABLE MULTIPLE SWITCHES

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13 Claims. (Cl. 307—112)

The present invention relates to apparatus for selectively switching a plurality of switches and more particularly to apparatus for selectively switching a plurality of switches with a magnetic field generated by a moving actuator which successively passes adjacent each of the plurality of switches.

In the last few years, numerous systems have been developed for use in the fields of process control, traffic control, and vehicle guidance wherein a number of operations must be performed in synchronism with some external variable. For example, it might be desired that a number of operations be performed in synchronism with real time or with movement, such as shaft rotation. Generally, the operations to be synchronously performed will be triggered and controlled by a number of relay switches which are synchronously actuated.

The most popular prior art methods of actuating the relay switches hereinbefore mentioned involve the use of a commutator, an actuating signal being applied to the common terminal of the commutator and a commutator armature being rotated in synchronism with, for example, a rotating shaft. Hence, the actuating signal will be applied to a plurality of independent terminals in synchronism with the rotation of the shaft. The independent terminals are then connected to the actuating terminals of a corresponding number of relay switches so that upon application of the actuating signal to the independent terminals the corresponding relay switches are synchronously actuated to close or open.

The use of the commutator, however, to selectively and synchronously actuate the relay switches has several serious disadvantages. Firstly, it should be noted that in most cases the commutator armature must rotate at a fairly rapid rate and a large number of independent terminals must be utilized since in most applications a large set of independent terminals must be searched in a short interval. In such cases each independent terminal will be in contact with the common terminal of the commutator for only a short period of time. Therefore, it is most difficult to transfer to the independent terminal from the common terminal sufficient current to actuate the corresponding relay without burning out the common terminal of the commutator.

This problem becomes even more acute in the case where latching or holding relay switches are to be utilized. This is the case since mechanical latching relays are most often used and substantially more energy must be utilized to actuate a mechanical latching relay than a non-latching relay because energy must be utilized to overcome the latching mechanism. If it is attempted to minimize this problem by using prior art electrical latching relays another serious problem inherent in electrical latching relays of the prior art is encountered. Namely, the fact that a substantial amount of the relay output current must be fed back to the electrical latching mechanism of the relay to hold the relay closed, thereby limiting the current output of the relay. Therefore, it is clear that prior art relay actuating devices

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possess inherent difficulties which seriously limit their usefulness, especially in situations where a large number of relays must be monitored during a relatively short period of time.

5 The present invention provides apparatus wherein it is unnecessary to use a commutator in order to selectively and synchronously actuate a number of relays. Hence, the limitations of the prior art devices are not present in switching apparatus mechanized according to the basic concepts of the invention.

10 In accordance with one of the concepts of the invention the relay switches are positioned directly on a stator element and an actuator element is cyclically movable successively passed each of the relay switches, the actuator element being moved in synchronism with an external moving element whose motion is indicative of the external variable with which the actuation of the relay switches is to be synchronized. The actuator element is responsive to an applied actuating signal for generating a magnetic field so that when the actuator element passes adjacent each relay switch the electromagnetic field is applied to the relay switch.

20 According to another concept of the invention the relay switch includes an armature and a pair of first and second contact terminals, the armature being positionable at first and second positions for electrically connecting the first and second contact terminals when at the first position and disconnecting the first and second contact terminals when at the second position. The armature is movable to change position in response to the application thereto of the magnetic field generated by the actuator element.

25 According to another concept of the invention, the relay switch includes material having remnant magnetic properties so that the armature remains at the first or second position after the magnetic field generated by the actuator element ceases to be applied thereto. Hence, the relay switch has locking characteristics without having the inherent limitations of prior art mechanical and electrical latching relays.

30 According to still another concept of the invention, the armature of the relay switch is enclosed within a housing and surrounded with a fluid for cooling the armature and for isolating the armature from external shock and vibration. Further, in accordance with the invention, if the armature is shaped so as to have a circular cross-sectional area, the armature can be actuated to change positions by a minimum amount of energy.

35 According to one embodiment of the invention, a series of traffic control signals are selectively actuated in accordance with a repetitive program by utilization of a switching device mechanized in accordance with the teachings of the invention. In accordance with this embodiment of the invention a series of single pole, double throw latching relay switches are coupled to a stator element. In addition, in a first and a second actuator element are coupled to the rotating shaft of a synchronous motor and rotate therewith so that the actuator elements rotate past each of the relay switches in synchronism with the rotation of the synchronous motor.

40 A memory device, such as a punched tape, rotated past a reproducing head by means of a geared mechanism coupled to the rotatable shaft of the synchronous motor generates a first and a second actuating signal in synchronism with the rotation of the motor shaft. The first and second actuating signals are then applied to the first and second actuator elements, respectively, for generating a first and a second magnetic field, respectively. The relay switch adjacent the actuator elements is responsive to the first and second magnetic fields applied thereto and generated by the actuator elements for being

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switched to a first position and a second position, respectively. Each of the traffic signals is actuated and controlled by a corresponding relay switch so that the traffic signals are successively actuated and in the selective manner prescribed by the program recorded on the memory element.

Therefore, it is an object of the invention to selectively actuate a plurality of relay switches.

It is another object of the present invention to provide a relay armature which is responsive to a magnetic field for moving to electrically connect and disconnect terminals of the relay.

It is a still further object of the invention to provide a movable actuator element which is responsive to said actuating signal for generating a magnetic field and is synchronously movable for being positioned successively adjacent each of a plurality of relay switches.

It is a still further object of the invention to provide a relay switch having a circular cross-sectional shaped armature which is submerged in a fluid in order to be easily cooled and to be isolated from external shocks and vibrations.

It is a further object of the present invention to provide an apparatus for selectively actuating a plurality of single pole double throw relay switches.

It is a further object of the present invention to provide a relay switch including material having remnant magnetic properties for latching the relay armature in position when the magnetic field is not applied thereto.

The novel features which are believed to be characteristic of the invention, both as to its organization and method of operation, together with further objects and advantages thereof, will be better understood from the following description considered in connection with the accompanying drawings in which one embodiment of the invention is illustrated by way of example. It is to be expressly understood, however, that the drawings are for the purpose of illustration and description only, and are not intended as a definition of the limits of the invention.

Figure 1 is a schematic view of one embodiment of the invention.

Figure 1a is a fragmentary view of the mechanism.

Figures 2a and 2b are front and side views, respectively, of a multiple switching apparatus of the invention.

Figure 3 is a front view of a switching element of the invention.

Figures 4a, 4b, and 4c are views of modified forms of the switching element shown in Fig. 3.

Figure 5 is a front view of another form of the multiple switching apparatus shown in Figure 2a.

Referring now to the drawings, wherein like or corresponding parts are designated by the same reference character throughout the several views, there is shown in Fig. 1 a traffic control system mechanized in accordance with the concepts of the invention. As shown in Fig. 1, an actuating signal source 10 generates a pair of actuating signals 12 and 14 which are applied to a multiple switching apparatus 16. The switching apparatus in turn is selectively operable to switch a number of single pole, double throw latching switches contained therein in accordance with the application of the actuating signals for producing a plurality of current signals 18, 20, 22 and 24. As shown indicated in Fig. 1, the four current signals are applied over a plurality of four correspondingly designed conductors to a traffic control display equipment unit 26, the traffic control display equipment unit being responsive to the current signals to visually present stop and go commands which can be utilized to control the flow of traffic. (For purposes of facilitating and clarifying description, each conductor will be hereinafter similarly designated in terms of the signal applied over the conductor.)

Referring now in more detail to actuating signal source 10, the actuating signal source includes a memory device 28 upon which is recorded a program of operation for

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the traffic control display unit and a synchronous motor 30 which is coupled to the memory unit. A number of different ways in which memory unit 28 can be mechanized will be apparent to those skilled in the art. However, one suitable mechanization of the memory unit is shown in Fig. 1. As shown in Fig. 1, a punched tape loop 32 is driven past a pair of reproduction heads 34a and 34b by a driving wheel 36, the driving wheel being coupled to and rotated by synchronous motor 30.

Referring to Figs. 1a there is shown a fragmentary view of punch tape 32 which specifically reveals the nature of the tape and the manner in which it is driven by driving wheel 36. As is shown in Fig. 1a, punch tape 32 has two columns of uniformly spaced holes thereon, the holes being engaged by the teeth of driving wheel 36 whereby motion of the driving wheel is imparted to the punch tape. As shown in Fig. 1a, punch tape 32 also has a pair of information channels or columns thereon, one being designated channel A and the other being designated channel B. It will be noted that at predetermined points along the channels there are punched apertures or holes therein, the holes in channels A and B passing adjacent reproducing heads 34a and 34b, respectively. Reproducing head 34a is responsive to a hole in channel A for passing adjacent thereto for generating actuating signal 12 and reproducing head 34b is responsive to a punched hole in channel B passing adjacent thereto for generating actuating signal 14. After generation, actuating signal 12 is amplified by an amplifier 38 included within the memory unit and actuating signal 14 is amplified by an amplifier 40 also included within the memory unit.

It is clear in view of the foregoing that actuating signal source 10 functions as follows. Synchronous motor 30 rotates at a predetermined speed which in turn moves punched tape 32 at a predetermined or fixed velocity so that the actuating signals will be produced as directed by the program punched on the punched tape. As hereinbefore mentioned, the actuating signals are applied to switching apparatus 16 which is responsive thereto for operating the traffic control display equipment unit.

Referring now in detail to switching apparatus 16, the switching apparatus includes a stator element 42 having a first and a second switching element 44 thereon and a rotor element 46 which is affixed to the rotating shaft of motor 30. In order to more easily describe the operation of switching apparatus 16, attention is directed to Fig. 2a and Fig. 2b wherein there is shown a front elevational view of switching apparatus 16 and a side view of stator element 42, respectively. As shown in Fig. 2a, rotor element 46 includes a center shaft 48 and a pair of actuating bars 50 and 51 coupled to central shaft 48 by a pair of connecting shafts 52, center shaft 48, bars 50 and 51, and shafts 52 being constructed from low reluctance material. In addition, the rotor element includes a pair of counter weights 54. As shown in Fig. 2a, a coil 56 is wound around central shaft 48 and affixed to one side of stator element 42 while a coil 58 is wound around central shaft 48 and affixed to the opposite side of stator element 42. As further shown in Fig. 2a, switching elements 44 are also located on the stator element such that the butt end of actuating shaft 50 will serially pass adjacent to one of the sides of the switching elements while the butt end of actuating shaft 51 will pass serially adjacent to the opposite sides of the switching elements. In view of the foregoing discussion the operation of switching element 16 can now be readily understood.

Referring now to the operation of switching element 16, actuating signal 12 is applied to coil 56 and actuating signal 14 is applied to coil 58. On application of actuating signal 12a magnetic field is generated by coil 56 which travels through the low reluctance material of central shaft 48, connecting shaft 52, and actuating shaft 50.

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As shown in Fig. 2b, a bar 58 made of low reluctance material is positioned in stator element 42 between one of the switching elements and the center of the stator element while a bar 60 is positioned between the other of the switching elements and the center so that when the butt end of actuating shaft 50 is adjacent one of the switching elements, the magnetic field will pass through the switching element and the low reluctance bar to central shaft 48 thereby closing the magnetic loop. As will be hereinafter discussed switching element 44 is responsive to the passage of the magnetic field therethrough from actuating shaft 50 to the stator element for switching the switch to one of its two positions.

Referring now to actuating signal 14, when the signal is applied to coil 58 a magnetic field is generated which passes from actuating arm 51 through switching element 44 to central shaft 48 whenever switching element 44 is adjacent the actuating bar 51. As will be hereinafter fully described, the two switching elements are responsive to the magnetic field transmitted by actuating bar 51 for switching the element to a first switched position. In a like manner, the application of actuating signal 12 to coil 56 when actuating bar 50 passes adjacent one of the switching elements causes the switching element to be switched to a second switched position. Since rotor element 46 is rotated by the shaft of motor 30 as is the punched tape of memory element 28, the tape and the rotor element will always be in synchronism so that the actuating pulses generated in accordance with information stored on the punch tape will always be applied to switching apparatus 16 when actuating bars 50 and 51 are adjacent the switching element which is to be switched.

Directing attention to Fig. 2b, there is shown therein a view of the side of stator element 42 which is adjacent bar 50. As indicated in Fig. 2b, conductor 24 is coupled to a conductive plate in the side adjacent actuating bar 50 of one of switching elements 44 and conductor 20 is coupled to the corresponding side of the other of switching elements 44. Furthermore, conductor 18 is indicated as being coupled to a plate in the side adjacent actuating bar 51 of one switching element while conductor 22 is indicated as being coupled to the corresponding side of the other of switching elements 44. Referring again to Fig. 2b, it is apparent that a conductor 59 connects a conductive plate positioned in the side of the switching elements adjacent the other two sides having conductive terminals therein with a source of power. In order to further understand the structure of switching elements 44 attention is directed to Fig. 3.

Referring now to Fig. 3, there is shown a side elevational view of switching element 44. As shown in Fig. 3, the particular switching element 44 shown therein includes a high reluctance and non-conductive housing 58 having a cavity therein and a plurality of three blocks 55a, b and c positioned adjacent three of the four sides of housing 58 respectively, each of the blocks having low reluctance properties and exhibiting some remnant magnetism. The switching element further includes a circular cross-sectional armature 60 such as a cylinder positioned in the cavity. It should be noted that while in its preferred form armature 60 should have a configuration having a circular cross-section such as a spherical or cylindrical shape, the armature may take any shape and is not to be limited to armatures having circular cross-sections. As shown in Fig. 3, switching element 42 further includes a conductive plate or terminal mounted on a side 62 of the cavity, a conductive plate on an opposite side 64 of the cavity, and a conductive plate on a side 66 of the cavity which is adjacent to both sides 62 and 64.

Directing attention now to the operation of switching element 44, if the switching element is positioned on stator element 42 so that side 62 is adjacent the butt end of actuating bar 50 and that side 64 is adjacent the butt end of actuating bar 51 during a portion of the cycle of rotation of rotor element 46 it will be apparent

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to anyone skilled in the art that the magnetic field passing from actuating bar 50 through the switching element from side 62 through side 66 will attract armature 60 to sides 62 and 66. This is true since the armature is made from low reluctance ferromagnetic material and therefore provides a readily available path for the magnetic field to pass through. Furthermore, armature 60 will remain in contact with sides 62 and 66 even after the magnetic field generated by coil 56 has ceased since blocks 59 exhibit remnant magnetism sufficient to hold armature 60 in position. In accordance with the invention when armature 60 contacts sides 62 and 66, it provides a conductive path between the conductive plates thereon and thus between the conductor connected to the source of power and conductor 24 for one switching element and conductor 20 for the other switching element.

If, on the other hand, a magnetic field is generated by actuating bar 51 when it is adjacent one of the two switching elements, the magnetic field will pass from side 64 to side 66 thereby overcoming the remnant magnetic field holding the armature in position and attracting armature 60 so that it will contact the conductive plates on sides 64 and 66 hence providing a conductive path between the source of power and conductor 22 for one switching element and conductor 18 for the other switching element. It should be noted that a sizable current can be transferred by a switch of the type shown in Fig. 3 since the contact area between the conductive plates and the armature is relatively large. Specifically, if cylindrical shaped armatures are utilized the conductive plates contact the cylinder along the full length of the cylinder thereby providing an unusually large contact area. If a spherical shaped armature is utilized the contact surface is not as large as that of a cylindrical shaped armature, however, if the spherical armature is free to rotate in an unrestrained manner so that the ball cannot only turn about a given axis while performing its rolling action but can also gradually shift its axis of rotation a sizable current can be transferred since the wear on the surface of the armature can be equally distributed over the entire surfaces of the armature.

In order to further increase the magnitude of the switching current and to reduce the wear on the armature it is desirable to submerge the armature in a fluid, the floatation fluid having a density substantially equal to or a little less than the density of armature 60. Any number of non-conductive fluids suitable for use as a floatation fluid for armature 60 will be apparent to one skilled in the art. For example, the floatation fluid can be chosen from one of the fluids used in oil-cooled transformers or from one of the fluids utilized to float gyroscopes. It should be herein noted that armature 60 is not limited in structure to a solid piece of iron or other ferromagnetic material but can be constructed as a hollow shell. Furthermore, it should be noted that armature 60 can be constructed from other than electrically conductive materials since the armature can be easily plated with materials having such properties.

It should be apparent from the foregoing discussion that armature 60 and housing 58 can be modified in many particulars without departing from the basic concepts of the invention. To further demonstrate this fact there are shown in Figs. 4a and 4b and 4c a trapezoidal, a rectangular, and an elliptical shaped housing 58 containing spherical armatures therein. In view of the foregoing discussion, it is apparent that while the configurations of the switching elements shown in Figs. 4a, 4b and 4c are somewhat different than shown in Fig. 3 the operation of the switching elements when positioned on stator element 42 of Fig. 2a is identical with that of the switching element shown in Fig. 3.

In view of the foregoing discussion, it is clear that switching apparatus 16 is operable in the following manner. When actuating bars 50 and 51 are adjacent the switching element to which conductors 18 and 20 are

coupled and a magnetic field is generated by coil 56 in response to actuating signal 12, current signal 20 is generated. If, on the other hand, coil 58 generates a magnetic field in response to actuating signal 14 current signal 18 is generated instead of current signal 20. In a like manner, when actuating bars 50 and 51 are adjacent the other switching element current signals 22 and 24 are generated in response to actuating signals 14 and 12, respectively. As is hereinbefore mentioned, the four current signals 18, 20, 22, and 24 are, after generation, applied to traffic control display unit 26 for directing the operation of the traffic control display equipment unit.

Referring now to Fig. 1 and to traffic control display equipment unit 26 particularly, it is clear that traffic control display equipment unit 26 includes a traffic signal 64 and a traffic signal 66 and that current signals 18 and 20 are applied to traffic control signal 64 and current signal 22 and 24 are applied to traffic signal 66. Directing attention to traffic signal 64, the signal is responsive to current signal 18 to raise a signal arm having the word GO printed thereon and to current signal 20 for lowering the signal arm to a position where it is out of view. Specifically, a motor 68 within traffic signal 64 is responsive to current signal 18 to rotate the motor shaft in one direction which thereby raises the signal arm by means of gear 70 until the signal arm is raised into position at which time a limit switch 72 stops the motor shaft rotation. In a similar manner application of current signal 20 to motor 68 causes the motor shaft to be rotated in the opposite direction until the signal arm is out of view at which time a limit switch 74 causes the motor shaft rotation to cease.

As shown in Fig. 1, traffic signal 66 is responsive to current signal 22 to illuminate a GO signal indicator and to current 24 to illuminate a STOP signal indicator. It should be noted that traffic signal 64 and 66 are only two of many types of traffic signals known in the art and that any of such signals can be utilized in the present invention with equally successful results. Furthermore, it should be noted that only two traffic signals are shown in the present embodiment of the invention for ease of description only, and that any number of traffic signals can be controlled by apparatus mechanized in accordance with the invention. It should be apparent that it is only necessary to add more switching elements on stator element 42 of switching apparatus 16 to control more traffic signals.

Referring now to the overall operation of the traffic control system shown in Fig. 1, it is clear from the foregoing that the traffic signals contained within traffic control display equipment 26 can be actuated for indicating GO or STOP in any predetermined manner which is recorded on punched tape 32, a complete cycle of commands being applied to the traffic signals during each complete cycle of movement of the punched tape. In a preferred manner of operation of the invention switching apparatus 16 executes a plurality of complete rotations during each complete cycle of movement of the punched tape so that during each cycle of rotation of the switching apparatus each of the traffic signals can change from a GO to a STOP state or vice versa or can remain unchanged depending upon whether the punched tape is programmed to generate an actuating signal during that cycle of rotation of the switching apparatus. It should be noted that many and varied modifications are possible in the traffic control system presented in Fig. 1 and particularly many modifications can be made in switching apparatus 16. For example, a modified form of switching apparatus 16 is shown in Fig. 5 which is capable of actuating two switching elements simultaneously as well as successively.

Referring to Fig. 5, there is shown a modified form of switching apparatus 16 which has two actuating bars 50 disposed 180° from each other. In view of the foregoing discussion in connection with the operation of the

switching element shown in Fig. 1 the operation of the present modified form of the switching apparatus to switch two switching elements simultaneously will be apparent. This embodiment of the invention is particularly useful where it is desired to switch a particular switch element twice in one revolution of the rotor element of the switching apparatus.

It is to be expressly understood, of course, that the basic concepts herein disclosed can be embodied in different structure from the specific structure shown without departing from the spirit and scope of the invention. For example, armature 60 can be made from almost any type of material even non-ferromagnetic materials which do not exhibit high permeability. Accordingly, it is to be understood that the spirit and scope of the invention is to be limited only by the scope of the intended claims.

What is claimed as new is:

1. An apparatus for successively and selectively actuating switches in response to a selectively applied electrical signal, said apparatus comprising: movable actuator means responsive to the application of the selectively applied electrical signal for generating a magnetic field; a plurality of armature housings each having therein first and second conductive contacts and a conductive armature positionable at first and second positions, said armature interconnecting said first and second contacts at said first position and disconnecting said first and second contacts at said second position, said armature being movable in response to the application of said magnetic field thereto for changing from one of said positions to the other of said positions; and means for moving said actuator successively past each of said armature housings to apply said magnetic field to each of said armatures successively.

2. The combination defined in claim 1 wherein said armature housing further includes material having remanent magnetic properties whereby said armature will remain fixed in position after said magnetic fields cease to be applied to said armature.

3. An apparatus for selectively and sequentially actuating each of a plurality of double throw switches, said apparatus comprising: a stator element having a plurality of switches substantially circumferentially positioned about a predetermined point on said stator element, each of said switches having first, second, and third electrical contact terminals and an armature movable in response to the application thereto of first and second magnetic fields for electrically connecting said first and second conductive terminals and said first and third conductive terminals, respectively; first actuator means responsive to application of a predetermined actuating signal for generating the first magnetic field; second actuator means responsive to application of the predetermined actuating signal for generating the second magnetic field; rotation means for rotating said first and second actuator means successively adjacent each of said switches; a signal source coupled to said rotation means for selectively generating the predetermined actuating signal when said first and second actuator means are adjacent predetermined ones of said switches and when said second actuator means is adjacent the predetermined ones of said switches; and actuating signal application means for selectively applying the predetermined actuating signal to said first actuator means to electrically connect said first and second conductive terminals of the predetermined ones of said switches and to said second actuator means to electrically connect said first and third conductive terminals of the predetermined ones of said switches.

4. An apparatus for selectively and successively switching each switch of a plurality of switches, said apparatus comprising: a stator element including a plurality of switches, each of said switches including a housing having first, second, and third sides having a substantially plane surface, said first and second sides adjoining said third side at substantially opposite ends of

said third side and said first and second sides being positioned with respect to said third side at a substantially acute angle, said first, said second, and third sides having first, second, and third conductive terminals mounted thereon, respectively, each of said switches further including an armature having a circular cross-section and movable in response to the applications thereto of first and second magnetic fields for electrically connecting said first and third conductive terminals and said second and third conductive terminals, respectively; a non-conductive fluid filling the interior of said housing of each of said switches for isolating said armature positioned therein from external shocks and vibrations; first actuator means responsive to application of a predetermined actuating signal for generating the first magnetic field; second actuator means responsive to application of the predetermined actuating signal for generating the second magnetic field; rotation means for rotating first and second actuator means successively adjacent each of said switches; a signal source coupled to said rotation means for selectively generating the predetermined actuating signal when said first and second actuator means are adjacent predetermined ones of said switches and when said second actuator means is adjacent the predetermined ones of said switches; and actuating signal application means for selectively applying the predetermined actuating signal to said first actuating means to electrically connect said first and third conductive terminals of the predetermined ones of said switches and to said second actuator means to electrically connect said second and third conductive terminals of the predetermined ones of said switches.

5. The combination defined in claim 4 wherein said armatures have a spherical configuration.

6. The combination defined in claim 4 wherein said armature has a cylindrical configuration.

7. The combination comprising: first and second switches, each of said switches including a housing having first and second conductive terminals therein and including an armature selectively positionable in said housing in both a first and a second position, said armature being adapted when in said first position for electrically connecting said conductive terminals and adapted when in said second position for disconnecting said conductive terminals, said armature being movable in response to the application of a magnetic field thereto for changing positions; movable actuator means responsive to the application of a selectively applied electrical signal for generating the magnetic field; first means for cyclically moving said actuator means successively adjacent each of said switches; and second means coupled to said actuator means for selectively generating in synchronism with the movement of said actuator means the selectively applied electrical signal to move only predetermined ones of said armatures.

8. The combination defined in claim 7 wherein said armature has a circular cross-sectional area.

9. An apparatus for selectively and successively switching each switch of a plurality of switches, said apparatus comprising: a stator element including a plurality of switches, each of said switches including a housing having first and second adjacent sides and each side having a conductive terminal thereon, each of said switches further including an armature positioned in said housing, said armature being movable in response to the application of a magnetic field thereto for electrically connecting said conductive terminals; actuator means responsive to the application of an actuating signal for generating the magnetic field; first means for cyclically moving said actuator means successively past each of said switches; and second means for selectively generating the actuating signal when said actuator passes predetermined ones of said switches whereby said switches are selectively actuated.

10. An apparatus for sequentially actuating each of a plurality of double throw switches selectively, said ap-

paratus comprising: a stator element having the plurality of switches established thereon, each of said switches including first, second, and third electric contact terminals in said first position and said first and third contact terminals in said second position; holding means for normally holding said armature in said first and second positions in the absence of the action of either of the magnetic fields on said armature; first actuator means responsive to the application of a predetermined actuating signal for generating said first magnetic field; second actuator means responsive to the predetermined actuating signal for generating said second magnetic field; means for cyclically moving said first and second actuator means successively past each of said switches substantially concurrently; a signal source coupled to said first means for selectively generating the actuating signal when said first and second actuator means are adjacent predetermined ones of said switches, said signal source including apparatus for selectively applying the actuating signal to said first actuator means for electrically connecting said first and second conductive points and for disconnecting said first and third conductive points and for selectively applying the actuating signal to said second actuator means for electrically connecting said first and third conductive points and for disconnecting said first and second conductive points.

11. An apparatus for sequentially actuating selectively each of a plurality of double throw switches, said apparatus comprising: a stator element having a plurality of switches established thereon, each of said switches including a housing having first, second, and third sides each having a substantially plane surface, said second and third sides adjoining said first side at substantially opposite ends of said first side and said second and third sides being positioned with respect to said first side at a substantially acute angle, said first, second, and third sides having first, second, and third electric contact terminals thereon, respectively, each of said switches further including a cylindrical armature movable to first and second positions in response to the application thereto of first and second magnetic fields, respectively, said armature electrically connecting said first and second contact terminals in said first position and said first and third contact terminals in said second position, each of said switches further including material having remnant magnetic properties for holding said armature in position after said magnetic fields cease to be applied thereto; first and second actuator means each responsive to the application of a predetermined actuating signal for generating said first and second magnetic fields, respectively; a non-conductive fluid filling said housing of each of said switches for isolating said armature from external shocks and vibrations and for cooling said armature and said contact terminals; first means for cyclically moving said first and second actuator means successively adjacent each of said switches; first ferromagnetic means intercoupling said first actuator means and each of said switches for providing a low reluctance path between said first actuator means and each of said switches; third ferromagnetic means intercoupling said second actuator means and each of said switches for providing a low reluctance path between said second actuator means and each of said switches and for providing a low reluctance path between said first actuator means and each of said switches; a signal source coupled to said first means for selectively generating the predetermined actuating signal when said first and second actuator means are adjacent predetermined ones of said switches, said signal source including apparatus for selectively applying the predetermined actuating signal to said first actuator means for electrically connecting said first and second conductive points and for disconnecting said first and third conductive points and for selectively applying the actuating signal to said second actuator means for electrically connecting said first and

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third conductive points and for disconnecting said first and second conductive points.

12. An apparatus for sequentially actuating each of a plurality of double throw switches selectively, said apparatus comprising: a stator element having a plurality of switches established thereon, each of said switches including first, second, and third electric contact terminals and a circular cross-sectional armature movable to first and second positions in response to the application thereto of first and second magnetic fields, respectively, said armature electrically connecting said first and second contact terminals in said first position and said first and third contact terminals in said second position, each of said switches further including material having remnant magnetic properties for holding said armature in position after said magnetic fields cease to be applied thereto; first and second actuator means each responsive to the application of a predetermined actuating signal for generating said first and second magnetic fields, respectively; first means for cyclically moving said first and second actuator means successively adjacent each of said switches; first ferromagnetic means intercoupling said first actuator means and each of said switches for the duration of time during which each of said switches is adjacent said first actuator means for providing a low reluctance path between said first actuator means and each of said switches; second ferromagnetic means intercoupling said second actuator means and each of said switches for the duration of time during which each of said switches is adjacent said second actuator means for providing a low reluctance path between said second actuator means and each of said switches; a signal source coupled to said first means

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for selectively generating the predetermined actuating signal when said first and second actuator means are adjacent predetermined ones of said switches, said signal source including apparatus for selectively applying the predetermined actuating signal to said first actuator means for electrically connecting said first and second conductive points and for disconnecting said first and third conductive points and for selectively applying the actuating signal to said second actuator means for electrically connecting said first and third conductive points and for disconnecting said first and second conductive points.

13. The combination comprising: first and second switches having first and second modes of operation, each of said switches having a pair of electric terminals and including apparatus for electrically connecting said terminals when said switch is operating in its first mode of operation and for electrically isolating said terminals when said switch is operating in its second mode of operation, said switch being responsive to the application of a predetermined actuating signal for changing from its first to its second mode of operation and for continuing to operate in its second mode of operation after the application of the predetermined actuating signal; actuating means cyclically movable successively adjacent each of said switches, said actuating means being selectively operative for generating the predetermined actuating signal when said actuating means is adjacent a predetermined one of said switches to apply the predetermined actuating signal to the predetermined one of said switches; and first means for cyclically moving said actuating means successively adjacent each of said switches.

No references cited.