Aug. 24, 1943. F. A. HUBBARD 2,327,792

SELECTOR

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FIG. 1

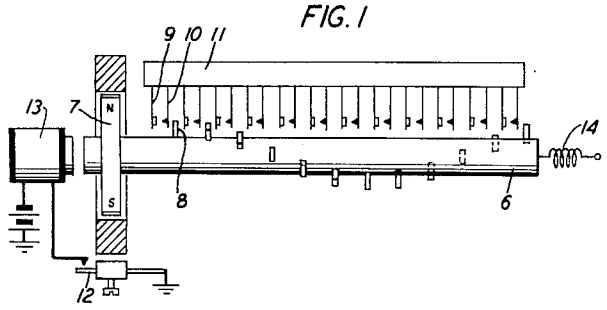

FIG. 2

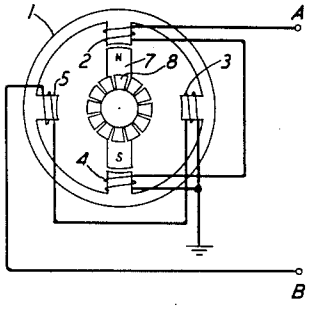

FIG. 3

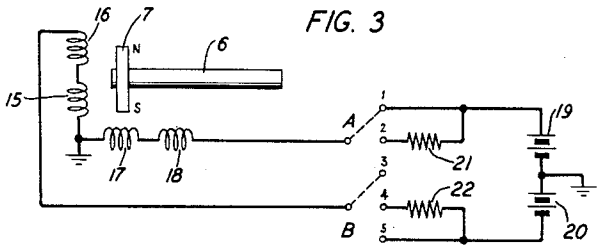

FIG. 4

CODE 1			CODE 2		
ANGLE	A	B	ANGLE	A	B
0°	1	3	0°	1	3
30	1	2	22.5	1	2
60	2	1	45	1	1
90	3	1	67.5	2	1
120	4	1	90	3	1
150	5	2	112.5	4	1
180	5	3	135	5	1
210	5	4	157.5	5	2
240	4	5	180	5	3
270	3	5	202.5	5	4
300	2	5	225	5	5
330	1	4	247.5	4	5
			270	3	5
			292.5	2	5
			315	1	5
			337.5	1	4

FIG. 5

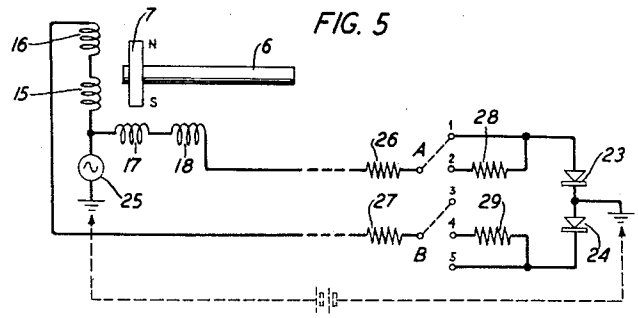

FIG. 6

CODE		
ANGLE	A	B
0°	1	3
22.5	1	2
45	1	1
67.5	2	1
90	3	1
180	5	3
202.5	5	4
225	5	5
247.5	4	5
270	3	5

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FIG. 7

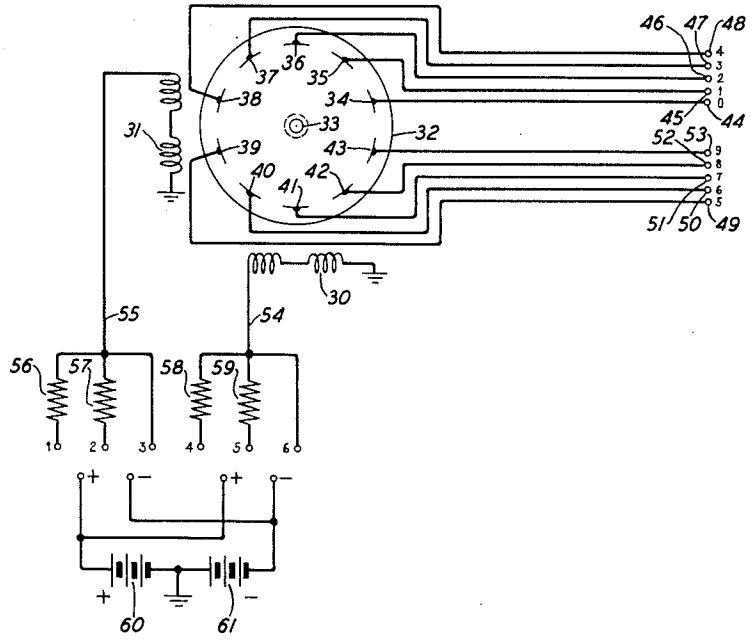

FIG. 8

CODE			
CIRCUIT	ANGLE	+BATTERY	−BATTERY
1	54°	2&5	
2	90	6	
3	126	5	2
4	162	4	1
5	198		1&4
6	234		2&5
7	270		6
8	306	2	5
9	342	1	4
0	18		1&4

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UNITED STATES PATENT OFFICE

2,327,792

SELECTOR

Francis A. Hubbard, Maplewood, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application December 9, 1941, Serial No. 422,206

6 Claims. (Cl. 200—93)

This invention relates to circuit making and breaking devices and particularly to selective response switching means.

The object of the invention is to provide a simple and economical relay device which will respond to a plurality of different energizing conditions and selectively operate a corresponding plurality of different circuit paths. By way of example, one object is to provide a relay device which will respond to any one of ten different digital circuit conditions set up at a telephone substation for properly recording at a central office the digital designation being thereby transmitted.

The device consists essentially of a two phase motor stator provided with coils in quadrature responsive to signals of varying strength and direction to set up a field in any given direction in combination with responsive rotational means for selectively closing a given circuit. This rotational means may take the form of an electron beam or its mechanical analogue in which case it becomes a polarized rotor.

A feature of the invention is a multiposition relay which can be made to close one of several sets of contacts on the basis of direct current signals transmitted over two wires. The control mechanism consists of a stator having two separate windings with their magnetic axes at right angles, like the stator of a two-phase induction motor, and a polarized rotor, preferably using a permanent magnet to provide the polarization. The rotor will take up a position determined by the polarities and relative magnitudes of the currents through the two windings. Attached to the rotor is a shaft with projections arranged helically along it. Adjacent to the shaft is a series of sets of contact springs, placed in a straight line and spaced apart by a distance equal to the axial spacing of the projections along the shaft. The shaft itself, or a sleeve rotating with it and carrying the projections can be moved axially by an auxiliary magnet. The contact springs are so positioned with respect to the shaft that for any angular position of the shaft, one and only one of the projections is immediately adjacent to the corresponding set of contact springs; and when the shaft is moved axially, that one projection will engage with and operate its particular set of springs. Thus, any set of springs can be selected by applying a particular combination of currents to the two windings of the stator, and those springs will then be operated by the auxiliary magnet.

The rotating system is not required to perform any work, beyond accelerating its own mass and overcoming the friction of its bearings. It is not necessary to provide any restoring force, since there is no occasion for the unit to start from any specified position. The rotating system therefore is made very light and is capable of reaching the desired position very rapidly. Since it can rotate in either direction, it will never be required to turn through more than 180 degrees.

In accordance with another embodiment of the invention the auxiliary magnet operates on the springs rather than on the shaft or an attached sleeve.

In accordance with still another embodiment of the invention the contact springs are arranged in a circle around the stator structure and the shaft with its helically arranged projections is replaced by a disc containing a single spring operating finger, or selecting member corresponding to the polarization of the rotor. In this case the auxiliary magnet applies force to the contact springs and only that set which is in cooperative relationship with the operating finger is able to operate.

In another embodiment of the invention only a portion of the possible angular range of the rotor is employed since the stator is energized by direct current in a circuit arrangement designed to provide operation where there is a variable ground potential between the relay and the distant energizing means. Since currents of opposite polarities cannot be used, only the first and third quadrants can be utilized.

In another embodiment of the invention, the mechanical rotor is replaced by an electronic tube similar to that disclosed in Patent 2,217,774 granted October 15, 1940 to A. M. Skellett. By such means an electron beam may be directed toward any given point and one of a plurality of paths selectively completed.

Other features will appear in the following description.

The drawings consist of two sheets having eight figures, as follows:

Fig. 1 is a side view of the essential elements of the device embodying the present invention, shown schematically;

Fig. 2 is an end view of the same;

Fig. 3 is a circuit diagram with the device shown schematically;

Fig. 4 is a chart showing the connections to be made in one case to provide twelve selective positions and in another case sixteen selective positions;

Fig. 5 is a circuit diagram similar to that of

Fig. 3, but providing an alternative arrangement by which the device can be worked at a distant point regardless of a ground potential which may exist between the point at which the device is situated and the point at which control of the device is exercised;

Fig. 6 is another chart showing the connections to be made to provide ten selective positions of the device;

Fig. 7 is a circuit diagram showing how a ten-element electronic tube can be operated to selectively close one of ten paths therethrough; and

Fig. 8 is another chart showing the connections to be made to provide ten selective settings of the tube.

The device consists essentially of a stator having a magnetic frame 1 provided with four poles 2, 3, 4 and 5. Connections are made from ground in series through windings on poles 4 and 2 to terminal A and from ground in series through windings on poles 3 and 5 to terminal B. A rotor comprises a rotatable shaft 6 which carries a permanent magnet 7, so it will be easily understood that with terminal A alone connected to a source of current the magnet 7 will assume either the position shown in Fig. 2 or a position 180 degrees therefrom in accordance with the polarity of the said source of current. With both terminals A and B connected to sources of current of different strengths and polarities, the magnet 7 may be made to assume any desired position.

The shaft 6 has mounted thereon helically, a number of lugs, such as lug 8. When the terminal A is connected to a source of current of the proper polarity to cause the magnet 7 to assume the position indicated in Fig. 2, then the first movement is one of rotation so that the lug 8 will come into cooperative relationship with the pair of contact springs 9 and 10, mounted in any convenient manner as indicated schematically by the block of insulating material 11. This movement may be extremely rapid. Thereafter a slow-moving contact member 12 influenced by the magnetization of the frame 1 will close a circuit for the energization of an electromagnet 13, which will move the shaft 6 bodily toward the left against the force of spring 14 and cause a connection to be made between springs 9 and 10. In this manner an appropriate number of pairs of springs may be selectively actuated. The contact member 12 may be rendered slow acting in any accepted and well-known manner. As indicated in Fig. 1, it has sufficient mass so that when it is energized by the leakage field external to the field structure 1 its movement will be comparatively slow. The adjustable weight shown mounted on the member 12 indicates sufficient mass to produce the desired result.

By the aid of Fig. 3 and the cole 1 of Fig. 4 it will be seen how a set of twelve spring combinations may be selectively operated and by the aid of Fig. 3 and the code 2 of Fig. 4, it will be seen how a set of sixteen spring combinations may be selectively operated. It will be understood that coils 15 and 16 represent windings on poles 4 and 2, respectively, and that coils 17 and 18 represent windings on poles 3 and 5 respectively. The terminals A and B are shown in Fig. 3 as connected to battery terminals by dotted lines. The five terminals connected to batteries 19 and 20 and to resistances 21 and 22 may be interconnected with the terminals A and B to give the desired results charted in Fig. 4. It will, furthermore, be understood that means for making such interconnections may be incorporated in properly designed keys so that the selection of a set of contacts may be carried out substantially instantaneously. It will further be understood that the difference between the arrangements for code 1 and for code 2 of Fig. 4 will consist in different values of battery potentials and different values of the resistances 21 and 22.

In Fig. 5 an alternative arrangement is shown in which the effects of a ground potential, indicated by the dotted circuit arrangement, may be avoided. This consists in the use of two varistors 23 and 24 and a source of alternating current 25 instead of the direct current sources 19 and 20 of Fig. 3. The portion of the circuit to the right of the dotted portion of the two conductors may be a substation circuit, whereas the remainder of the circuit may be at a central office. Using the proper values of resistances 26, 27, 28 and 29 and the circuit combinations shown in the chart of Fig. 6, a ten-place selection may be made. This would be useful in a telephone system where the ten-place selection could be used for the registration at the central office of the digits of a telephone number.

The resistances 26 and 27 are provided so that adjustments made therein will make the total series resistance about the same on all lines.

With the arrangement of Fig. 5, only the first and third quadrants can be used, since currents of opposite polarities cannot be permitted in the two windings. It will be clear that since the operation of the device requires simultaneous fluxes from the two windings, they must both use either the positive or the negative half waves of the alternating current.

The fact that currents of opposite polarities are not used in any signal prevents the system from being affected by differences in ground potential at the two ends of the line. With the arrangement of Fig. 3, the introduction of such potentials might cause errors in signals belonging to the second or fourth quadrants, since they would increase the current in one winding and decrease that in the other. In the first and third quadrant signals, however, ground potential would merely increase or decrease the voltage applied to both wires and since the position of the rotor or shaft 6 depends merely on the ratio of the currents in the two windings, no error would be caused.

In Fig. 7 another form of the invention is illustrated. In this case the equivalent of a stator having two coils in quadrature is provided by the two coils 30 and 31 disposed so as to set up a magnetic field in the tube 32 in any given direction. The tube 32 is constructed and operated in accordance with the Patent 2,217,774 granted October 15, 1940 to A. M. Skellett and when properly energized by the coils 30 and 31 will direct an electron beam from the cathode 33 to any one of the ten anodes 34 to 43, thus closing an electrical circuit to any one of the terminals 44 to 53, respectively.

The two coils 30 and 31 are connected to lines 54 and 55, respectively, which branch out through resistors 56 to 59 to a set of terminals marked 1 to 6. A positive battery 60 and a negative battery 61 are provided with terminals marked (+) and (−). When these battery terminals and the terminals 1 to 6 are variously interconnected according to the code of Fig. 8, the circuits con-

nected to terminals 44 to 53 are selectively rendered effective.

While the values of the battery potentials and the resistances 56 to 59 are not given, it will be understood that they may be chosen so that the strength of the combined field from the two coils 30 and 31 will be the same in any position.

It will again be understood that the means for interconnecting the coils, the batteries and the resistors may be of any convenient design of switches or keys.

It will be understood that the invention is capable of other variations and is to be limited only by the following claims.

What is claimed is:

1. A relay comprising a stator having coils in quadrature responsive to selective energization to set up a field in a predetermined number of rotational positions, a polarized rotor, a set of contacts for each rotational position of said rotor, magnetic means for moving said rotor longitudinally, and means responsive to said longitudinal movement of said rotor for operating a rotatably selected set of said contacts.

2. A relay comprising a stator having coils in quadrature responsive to selective energization to set up a field in a predetermined number of rotational positions, a polarized rotor, a set of contacts for each rotational position of said rotor, magnetic means responsive to the energization of said coils for moving said rotor longitudinally and means responsive to said longitudinal movement of said rotor for operating a rotatably selected set of said contacts.

3. A relay comprising a stator having coils in quadrature responsive to selective energization to set up a field in a predetermined number of rotational positions, a rotor polarized by a permanent magnet, a set of contacts for each rotational position of said rotor, magnetic means for moving said rotor longitudinally, and means responsive to said longitudinal movement of said rotor for operating a rotatably selected set of said contacts.

4. A relay comprising a stator having coils in quadrature responsive to selective energization to set up a field in a predetermined number of rotational positions, a polarized rotor, a set of contacts for each rotational position of said rotor, said sets of contacts being arranged in a row parallel to the axis of said rotor, a stem having an axis coinciding with the axis of said rotor and a pin carried by said stem for each said set of contacts, said pins being helically arranged so that in each rotational position of said rotor one of said pins will be moved into cooperative relationship with a corresponding one of said sets of contacts, and magnetic means for moving said stem longitudinally to operate said one of said sets of contacts.

5. A relay comprising a stator having coils in quadrature responsive to selective energization to set up a field in a predetermined number of rotational positions, a polarized stator, a set of contacts for each rotational position of said rotor, magnetic means for moving said rotor longitudinally, slow-operating means responsive to the energization of said coils for operating said magnetic means, and means responsive to said longitudinal movement of said rotor for operating a rotatably selected set of said contacts.

6. A relay comprising a polarized rotor, a stator having coils in quadrature responsive to energization in various strengths and directions to move said rotor to various rotational positions, a set of contacts for each said rotational position of said rotor, magnetic means for moving said rotor longitudinally, slow-operating means responsive to the energization of said coils for operating said magnetic means, and means responsive to said longitudinal movement of said rotor for operating a rotatably selected set of said contacts.

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