Feb. 11, 1969 G. JANOSKA 3,427,411

APPARATUS FOR DRIVING ROTARY ELECTRIC SWITCHES

Filed July 11, 1966 Sheet 1 of 5

Fig. 1

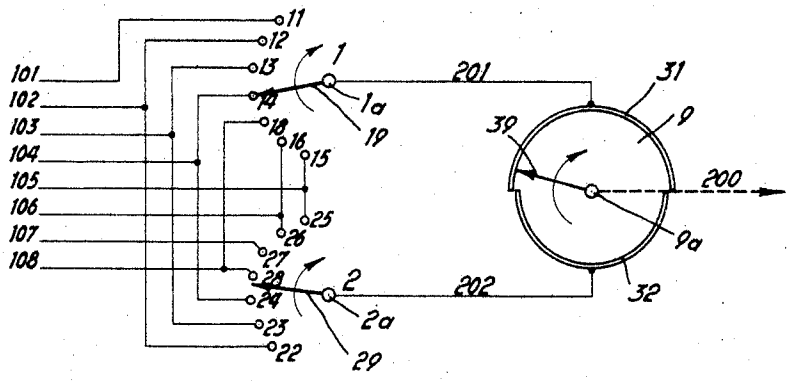

Fig. 2

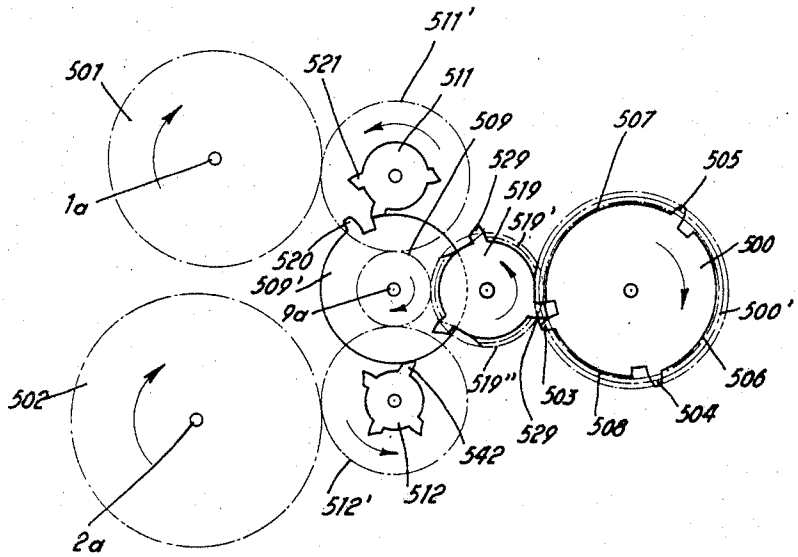

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Fig. 3

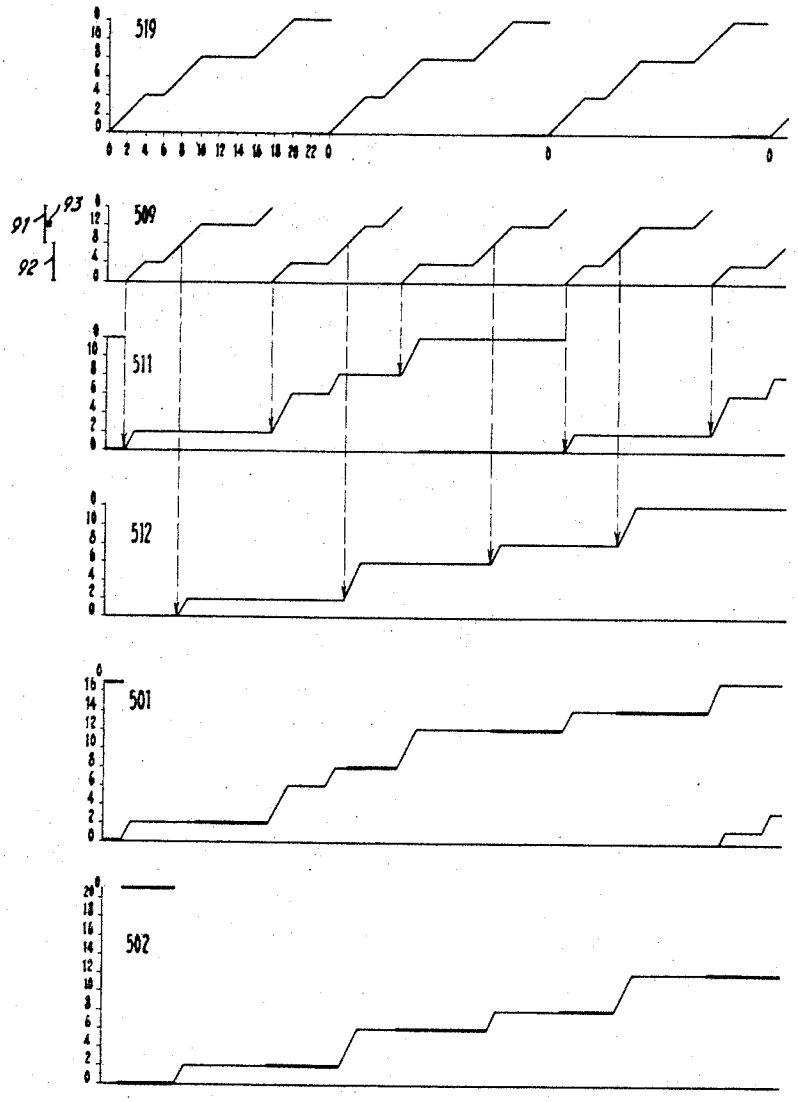

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Fig. 4

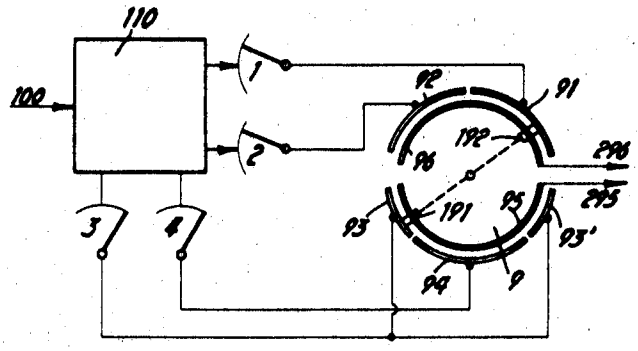

Fig. 6

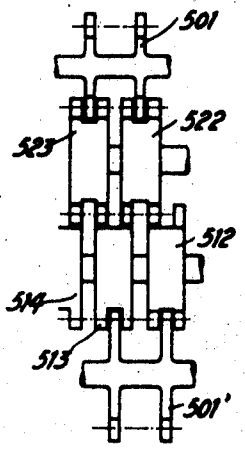

Fig. 7

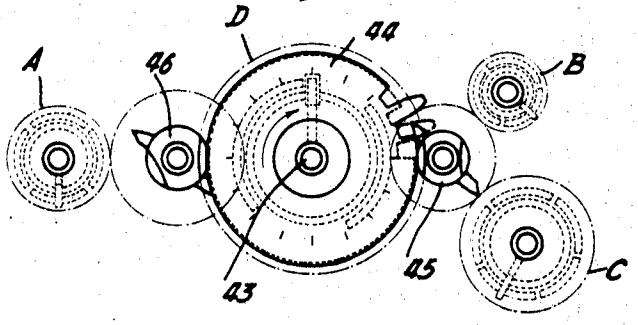

Fig. 8

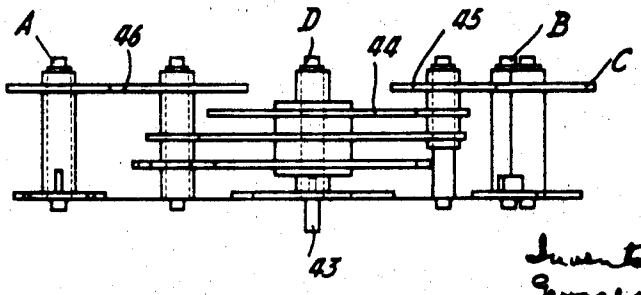

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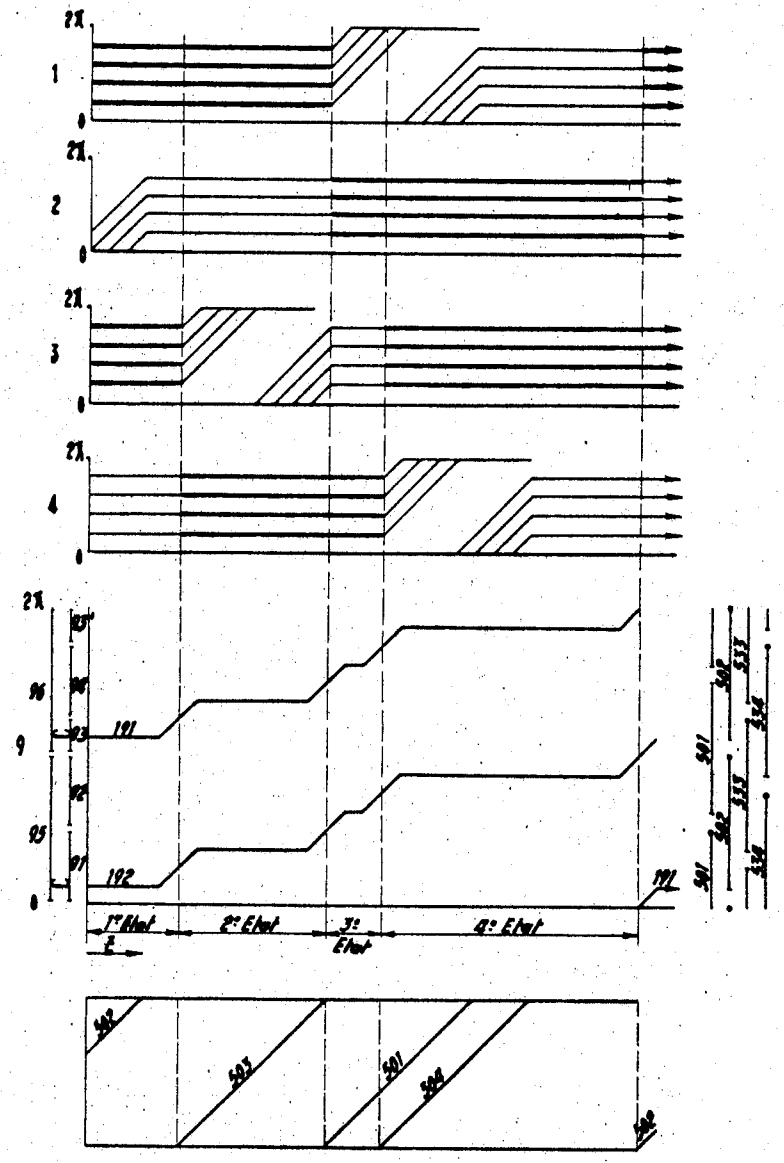
Fig. 5



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APPARATUS FOR DRIVING ROTARY ELECTRIC SWITCHES

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Fig. 10

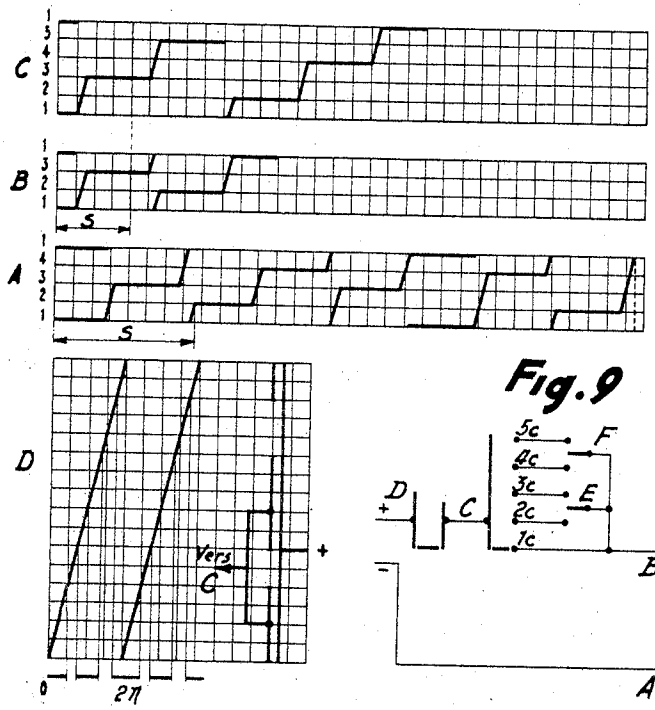
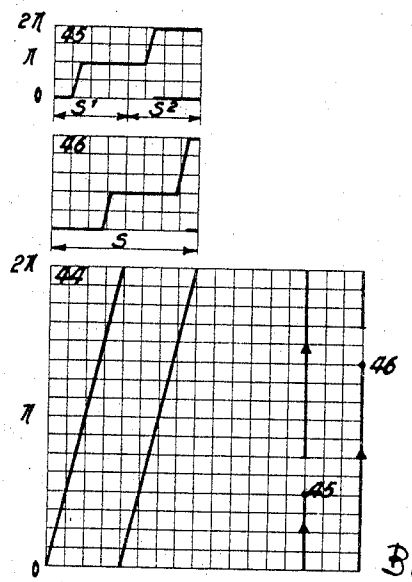


Fig. 9

Fig. 11



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3,427,411

APPARATUS FOR DRIVING ROTARY ELECTRIC SWITCHES

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U.S. Cl. 200—38 6 Claims
Int. Cl. H01h 3/32

ABSTRACT OF THE DISCLOSURE

A programmed sequential switching mechanism wherein rotary scanning switches electrically connected to a rotary timing switch are driven by kinematic chains (interconnecting gears and rotary meshing members) providing both continuous and intermittent drives whereby operation of the scanners and timer may be independently programmed by programming the kinematic chain. In general, one non-activated scanner moves to a new position while another scanner rests in an activated position through operation of the timer switch.

The invention relates to a programmed sequential switching device.

It refers more particularly to a sequential switching device comprising a plurality of rotary switches, wherein the successive switching states are determined by a programme established on the basis of scanning and timing parameters.

In know device the scanning parameters of the switching programme represent the selection of the address or destination corresponding to each input and/or output pole, which forms the stored space division switching programme. The time division switching programme is the rhythm at which are driven the said switches scanning the input and/or the output poles.

In these known devices, one of the switches, being at a given moment in a position n, will next occupy either the position $n+1$ or the position $n-1$, so that these devices are incapable of effecting varied programmes comprising a large number of switching states or comprising a variable succession.

The present invention seeks to make it possible to programme, in any succession, the sequence of states of a switching device.

Another object of the invention is to make the timing parameters and the scanning parameters of the switching devices independent of each other and therefore separately programmable.

A further object of the invention is to provide means for introducing and storing the timing and scanning parameters in the switching device.

The invention has the further aim of permitting the construction of switching devices capable of being driven mechanically, with high positional accuracy, in accordance with programmes comprising stopping and driving phases whose magnitude and duration may be varied.

This invention provides a sequential switching device capable of memorising and operating according to a programme, the device comprising a plurality of rotary switches connected to a common motive power input by kinematic chains comprising uniform motion drive means and intermittent drive means at least one of the switches having contacts for electrical connection to corresponding external signal sources and being capable according to the said programme of alternately moving to act as a

scanning switch for scanning the signals from the said sources and remaining at rest in connection with one of the contacts; in which device each scanning switch is connected in series with a timing switch arranged to close the circuit through the scanning switch during at least part of the time the scanning switch is at rest and of maintaining the said circuit open while the scanning switch is movng, each scanning switch when moving from one rest position to the next rest postion passing over a programmed whole number of contacts, the number being determined by the kinematic chains connecting the scanning switch to the motive power input; the scanning switch being driven via the drive to the timing switch whereby the operation of the scanning switch is always dependent upon the operation of the timing switch.

When the device comprises two scanning switches and a common timing switch, the two scanning switches are successively and alternately driven and stopped, being electrically inhibited while being driven and electrically activated when stopped, one of the switches being activated while the other is stopped, and vice versa; the two scanning switches can thus feed a same set of external circuits (addresses) according to two different intermittent drive programmes and to two programmes of switching on and off the circuits controlled by the common timing switch.

The device may comprise a further rotary switch provided with brushes which are not identically spaced and which are separated always by a whole number of contact studs, the said further switch being connected in series in the circuit connecting the timing switch and the scanning switch, this further switch and the scanning switch being both driven from the timing switch which closes the circuits when the two switches are at rest, the said scanning switch likewise having a plurality of brushes separated one from another, by a whole number of contact studs, the path of the scanning switch being divided in such manner that in each of their rest or switch positions the brushes of the scanning switch designate corresponding circuits which are independent of one another. In such an arrangement, the circuits closed by the brushes represent the Boolean product of the two sets of circuits.

In the device of the invention the intermittent driving programme of each scanning switch may be controlled by the timing switch in such a manner that between two successive active switching positions the scanning switch passes over a whole number of contact, the number being determined by the driving programme and being always greater than one; the scanning switch being stopped during the execution of the programme at least once at each of its switching positions.

The aforesaid intermittent drive means may comprise a looped delay line in which every second element stores one term of the programme, allowing variation of the intermittent drive programme.

When a plurality of switches is driven by a single kinematic chain in accordance with a common intermittent drive programme, each switch may have a number of contacts, and therefore of possible rest positions, different from that of the other switches of the kinematic chain.

The invention is described in greater detail below with reference to the accompanying drawings, in which:

FIGURE 1 illustrates diagrammatically a switching device which can be used for the reception and transmission of signals;

FIGURE 2 illustrates in profile the kinematic driving chains of the switches of the arrangement illustrated in FIGURE 1;

FIGURE 3 represents in cartesian co-ordinates the movements of the elements of said device;

FIGURE 4 illustrates an alternative form of the device;

FIGURE 5 represents in cartesian co-ordinates the movements of the principal elements of the device illustrated in FIGURE 4;

FIGURE 6 illustrates in elevation the components of a delay line;

FIGURE 7 illustrates in plan an arrangement for controlling four switches according of a variable programme;

FIGURE 8 illustrates the arrangement of FIGURE 7 in elevation;

FIGURE 9 shows the electric diagram of the arrangement of FIGURE 7;

FIGURES 10 and 11 are diagrams of the operation of the arrangement of FIGURE 7.

The switching device illustrated in FIGURE 1 comprises two scanning switches **1** and **2**, a timing switch **9**, input circuits **101** to **108**, an output circuit **200**, and internal circuits **201** and **202**.

This device, which is mentioned solely by way of example, is capable of scanning the input circuits **101** to **108** in accordance with a predetermined programme. The number of circuits illustrated is obviously not a limitation; the scanning switches **1** and **2** may, alternatively, be provided with further contact studs, which may be designated **11, 12, 13** . . . and **21, 22, 23** . . . extending along their entire circumferences.

In the position illustrated in FIGURE 1, the active circuit is the circuit which connects the input channel **104** to the output channel **200**, passing through the stud **14** of the switch **1**, the brush **19**, the channel **201** of the internal circuit, the semicircular contact **31** of the switch **9**, and the brush **39** of the latter.

The device may be so associated with external apparatus that the input channel **104** is connected to a signal source and a signal receiving device is connected to the output channel **200**.

The brush **39** of the timing switch **9** is rotated continuously so that, during one half of each revolution the output channel **200** is connected to the brush of one scanning switch while, during the other half revolution, the output channel is connected to the brush of the other scanning switch. The brushes **19** and **29**, of the scanning switches are so driven, intermittently and in co-operation with the brush **39** of the timing switch **9**, that the brush of one scanning switch moves only when the output channel **200** is connected to the brush of the other scanning switch. All the switches are driven according to the aforementioned predeterminde programme.

Thus, for each half revolution of the timing switch, one scanning switch is stopped and activated (connected, or "on") and the other exploring switch is rotating and inhibited (disconnected, or "off").

As long as a scanning switch **1** or **2** is disconnected, it can pass over any number of studs, to reach the next switching position, according to its driving programme. Thus, the space division switching programme, that is to say the sequence in which active switching positions are reached (which sequence is determined by the intermittent driving programme), is independent of the rate at which the exploration is carried out and the duration of each connection between the input and output circuits (which factors are determined by the time division switching programme).

When signals to be selected by the scanning operation are separated in time by periods sufficient to allow the scanning brush to be repositioned between the occurance of two successive signals, a single scanning switch may be used.

FIGURE 2 illustrates the kinematic chains driving the switches **1, 2** and **9**.

The shaft **9***a* of the timing switch brush **39** is driven by a chain of elements **500, 519, 519', 509**, which kinematic chain comprises the means of executing the time division switching programme.

The shaft **1***a* of the scanning switch **1** is driven by the elements **509', 511–511'**, and **501**, and the shaft **2***a* of the scanning switch **2** is driven by the elements **509', 512–512'**, and **502**. These two kinematic chains represent the component elements of the space division switching programme.

In the example illustrated, element **500** is a driving pinion keyed on the driving shaft of the device, which is driven, for example, by a synchronous motor.

This driving pinion is provided with three cylindrical stop surfaces **506, 507**, and **508**, and with three starting teeth **503, 504**, and **505**, each tooth having associated therewith an adjacent recess. In this example the pinion **500** may be considered to have twenty-four circumferential divisions and the three starting teeth are so distributed that there are six circumferential divisions between the tooth **503** and the tooth **504**, ten divisions between the tooth **504** and the tooth **505**, and eight divisions between the latter and the tooth **503**.

A driven pinion **519** has twelve circumferential divisions, over which three teeth **529** are distributed which are spaced apart by four circumferential divisions, that is to say situated at 120° in relation to one another, and their stopping positions correspond to zero, four, and eight divisions.

In a second plane the driving pinion **500** has teeth distributed continuously around its circumference, as indicated at **500'**, co-operating with corresponding teeth **519'** on the pinion **519** and situated in the same plane as the tooth **500'**. The teeth **519'** are removed at points corresponding to the stopping positions of the pinion **519**.

One "cycle" of the movement of the pinion **519** is defined as the movement corresponding to one rotation of the pinion **500**; which rotation comprises the twenty-four circumferential divisions of the driving pinion **500**.

The diagram **519** in FIGURE 3 illustrates graphically the intermittent movement of this pinion **519**, the absissa representing rotation of the pinion **500** and the ordinate rotation of the pinion **519**, both in their respective circumferential divisions. In this example, a cycle of the pinion **519** comprises three equal uniform movements and three motionless intervals, each movement comprising four divisions but the motionless intervals being of different durations, comprising in succession **2, 6** and **4** divisions of the reference pinion **500**.

An element **519''**, toothed over its entire periphery, is solid with the pinion **519** and meshes continuously with a pinion **509** keyed on the shaft **9***a* of the timing switch **9**, the numbers of teeth of the pinion **509** and of the element **519''** being in the ratio of 2/3.

The driving programme of the timing switch is illustrated at **509** in FIGURE 3. A single programme cycle comprises forty-eight circumferential divisions of the reference pinion **500**; each movement covers an angle of π radians.

The scanning switch **1** is driven via a pinion **501**, secured to the brush shaft **1***a*, its cycle comprising stopped and driven phases, as shown at **501** in FIGURE 3; the parts of the horizontal lines shown heavy correspond to the times during which the scanning switch **1** is stationary and its bruch **19** is connected to the output channel **200**; that is the times when the switch is activated. These activated periods constitute the time division switching programme of the said switch.

Similarly, the scanning switch **2**, which is driven by a pinion **502**, in FIGURE **2**, whose topped and driven phases are shown at **502** in FIGURE 3, is activated during periods only complementary to the activated periods of the switch **501**. These complementary activated periods correspond to part of the times during which the corresponding exploring switch is stopped.

The pinion meshes with a pinion **511'** in the ratio 17 to 12. The switch **1** comprises seventeen contact studs uniformly spaced apart, of which only seven are shown in FIGURE 1.

The pinion **511'** is fixedly connected to a pinion **511** and receives therefrom an intermittent movement which is imparted to the pinion **511**, via three teeth **521** co-

operating with a single starting tooth **520** of a pinion **509'**, on each revolution of the pinion **509'**.

The sequential space division switching programme of the switch **1** will thus be a sequence of $17 \times 3 = 51$ terms which in order are:

0, 2, 8, 12, 14, 3, 7, 9, 15, 2, 4, 10, 14, 16, 5, 9, 11, 0, 4, 6, 12, 16, 1, 7, 11, 13, 2, 6, 8, 14, 1, 3, 9, 13, 15, 4, 8, 10, 16, 3, 5, 11, 15, 0, 6, 10, 12, 1, 5, 7, 13, 0.

The pinion **502** is keyed on the shaft **2***a* of the scanning switch **2** and meshes with a pinion **512'** in the ratio 21 to 12.

The scanning switch **2** has twenty-one uniformly spaced contact studs.

The pinion **512'** is fixedly connected to a pinion **512** and receives therefrom an intermittent movement, the pinion **512** being driven by four teeth **542**, from the starting tooth **520** of the pinion **509'**. Between each of their stopped positions the pinions **511** and **512** are drive by uniform motion pinions, not illustrated in FIGURE 2.

The sequential space division switching programme of the scanning switch **2** is a sequence of $21 \times 2 = 42$ terms, the intermittent driving programme of said switch **2** being composed of two terms, namely two and four divisions.

In this example, the product 42×51 yields 2142 states which represent the complete space division switching programme of the two scanning switches **1** and **2**. The complete switching programme of the device is provided by the superimposition of the time and space division switching programmes.

FIGURE 4 illustrates a device in which the scanning switches are connected to the lines and to the columns of a conventional switching matrix **110**. The switches **1** and **2** in FIGURE 4 scan the lines, and switches **3** and **4** scan the columns of the matrix **110**, this part of the device being illustrated generally, and only the associated timing switch **9** and its circuits being shown in greater detail.

Table I below indicates the scanning switches which are activated in dependence on the positions of the timing switch brushes, these positions being repeated twice per revolution.

TABLE I

Position of timing switch 9	Scanning switch activated	
1	1	3
2	1	4
3	2	4
4	2	3

The scanning switch **1** is connected to the contact **91** of the timing switch **9**; the scanning switch **2** is connected to the contact **92**; the scanning switch **3** to the two contacts **93** and **93'**; and the switch **4** to the contact **94**.

This arrangement is particularly advantageous for reasons of reliability, because in operation only one scanning switch is moving at one time.

FIGURE 5 illustrates the operation of the device of FIGURE 4. The periods during which each scanning switch is activated by the timing switch **9** are indicated by heavy horizontal lines for the corresponding diagrams **1,2,3,** and **4** in FIGURE 5.

In order to enable programming the driving of the scanning switches and timing switch respectively, the intermittent driving kinematic chains providing a constant stored programme are substituted in the device illustrated in FIGURE 4 and just described by mechanical delay lines, such as those described in U.S. Patent No. 2,978,919. One of the elements of each delay line is fixedly connected to the corresponding switch, so that the delay line can drive the switch according to a programme recorded in the line. After registration of a programme, each delay line is looped on itself during operation, which permits repetition of the recorded programme until a new programme is introduced.

Each of the scanning switches **1**, **2**, **3** and **4**, which receives its drive from the corresponding delay line, may at any moment be in one of the four operational modes illustrated in the corresponding one of the diagrams **1**, **2**, **3** and **4**.

The delay line driving the timing switch **9** receives its drive direct from an input driving shaft constituting the common source of motive power. Each of the delay lines driving the scanning switches **1**, **2**, **3** and **4** is started from the drive of the timing switch **9**. FIGURE 5 illustrates the different resulting movement of the scanning switch driving pinions identified in FIGURE 5 by **501**, **502**, **533**, and **534**.

FIGURE 6 illustrates in elevation the elements constituting a delay line constructed in accordance with the prior patent specification referred to above, in which the shafts carrying the pinions **501** and **501'** are started by the timing switch **9** when the latter passes through position **4**, as shown by the diagram in FIGURE 5.

The delay line comprises a first series of elements **522**, **523** . . . , each of which memorises a term of the driving programme, and a second series which comprises similar elements and which is offset by half a row in order to co-operate with two neighbouring elements of the first series, the second series **512**, **513**, **514** being then empty. In the course of a first part of the driving of the delay line, each element of the first series transmits a term of the programme to an element of the second series, for example the element **522** to the element **513**, the element **523** to the element **514**, and so on.

In the course of a second part of the driving of the delay line, each element of the second series returns the term, which it had stored, to an element of the first series (which will hereinafter be referred to as the main series) but with offsetting by one row.

FIGURES 7 and 8 illustrate another example of the switching device, comprising four switches A, B, C, D, which can constitute a programmer. FIGURE 9 shows the electric diagram of this arrangement.

In this arrangement, the timing switch D is fixedly connected to a driving shaft **43** and is connected to serve as a rotary contact breaker, as shown by the diagram in FIGURE 10, during rotation of the switches A, B, C, to ensure that the signals transmitted will always coincide with a defined state of the switching positions. The time division switching programme comprises two alternating terms (the admission of the current), one of a duration of $\frac{8}{13}$ of a revolution of the driving shaft **43** and the other of $\frac{5}{13}$ of a revolution of the said shaft.

The driving shaft **43** is also fixedly connected to a pinion **44**, arranged to drive the intermittent gears. The pinion **44** controls the pinions **45** and **46** alternately as indicated by the diagrams in FIGURE 11.

The driven pinion **45**, arranged for a programme, having a single term, advances, for each revolution of the pinion **44**, by half a revolution corresponding to two switching positions of the switches B and C, which are driven by the pinion **45** in different ratios. The switch B in fact has three switching positions and its driving ratio is therefore $\frac{3}{4}$, while the switch C has five switching positions and is driven in the ratio 5/4.

The driven pinion **46** is arranged for a programme comprising two terms, the first corresponding to the driving of the exploring switch **1**, comprising four switching positions, and the second to a three-posiiton drive. The output signals are transmitted by the scanning switch A having four poles and by the scanning switch B having three poles. Thus $3 \times 4 = 12$ different output signals are obtained which are established as follows:

TABLE II

Reference letter for signal	Circuits established by— A	and	B
I	1a		1b
J	1a		2b
K	1a		3b
L	2a		1b
M	2a		2b
N	2a		3b
O	3a		1b
P	3a		2b
R	3a		3b
S	4a		1b
T	4a		2b
U	4a		3b

If it is assumed that the switch C is short-circuited, the switching programme would in this case be reduced to the emission of $4 \times 12 = 48$ signals, that is one of the signals in each rest position. This is equivalent to exploring a conventional matrix in four different ways.

However, the switch C permits the programme of the device to be varied. It can interrupt the circuits in accordance with its own programme. This programme is modified by means of the contactors E and F (FIGURE 9) which have three positions and are controlled manually.

It is thus possible to choose from nine switching programmes, which can be established as follows:

TABLE III

Programmes	Selection of programmes by contractors E and F	Circuits established for B through C
P_1	E and F central position	1c.
P_2	E on 2c—F central position	1c and 2c.
P_3	E on 3c—F central position	1c and 3c.
P_4	F on 4c—E central position	1c and 4c.
P_5	F on 5c—E central position	1c and 5c.
P_6	E on 2c—F on 4c	1c, 2c, and 4c.
P_7	E on 2c—F on 5c	1c, 2c, and 5c.
P_8	E on 3c—F on 4c	1c, 3c, and 4c.
P_9	E on 3c—F on 5c	1c, 3c, and 5c.

Because of the driving of the switch A, which alternates in relation to the switches B and C, the switching sequence of the switch A provides for the emission of sixteen signals.

The switching sequence of the switch B provides for the emission of six signals, and the switching sequence of the switch C of ten signals.

The smallest whole common multiple of 16, 6 and 10 is 240. Each programme can therefore be composed of 240 terms.

Table IV below shows: in the first column, the serial number of the signals emitted; in the next three columns the switching positions of the switches A, B and C and in the next nine columns the performance of the nine programmes.

In the three columns indicating the positions of the switches, the actual sequences of the switches are demarcated by horizontal lines.

It may be observed that these limits coincide:

every thirty switching positions for the switches B and C (the smallest common integral multiple of 6 and 10)

every forty-eight switching positions for the switches A and B (the smallest integral common multiple of 16 and 6)

every eighty switching positions for the switches A and C (the smallest integral common multiple of 16 and 10) and

only after two hundred and forty switching positions for the switches A, B and C.

TABLE IV

	Position of switches			Signals transmitted in dependence on programme								
Δt	A	B	C	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	P_9
1	1a	1b	1c	I	I	I	I	I	I	I	I	I
2	1a	3b	3c			K		K			K	K
3	3a	3b	3c			R					R	R
4	3a	2b	5c					P		P		P
5	2a	2b	5c					M		M		M
6	2a	1b	2c		L				L	L		
7	4a	1b	2c		S				S	S		
8	4a	3b	4c				U		U		U	
9	3a	3b	4c				R		R		R	
10	3a	2b	1c	P	P	P	P	P	P	P	P	P
11	1a	2b	1c	J	J	J	J	J	J	J	J	J
12	1a	1b	3c			I					I	I
13	4a	1b	3c			S						S
14	4a	3b	5c					U		U		U
15	2a	3b	5c					N		N		N
16	2a	2b	2c		M				M	M		
17	1a	2b	2c		J				J	J		
18	1a	1b	4c				I		I		I	
19	3a	1b	4c				O		O		O	
20	3a	3b	1c	R	R	R	R	R	R	R	R	R
21	2a	3b	1c	N	N	N	N	N	N	N	N	N
22	2a	2b	3c			M					M	M
23	4a	2b	3c			T					T	T
24	4a	1b	5c					S		S		S
25	3a	1b	5c					O		O		O
26	3a	3b	2c		R				R	R		
27	1a	3b	2c		K				K	K		
28	1a	2b	4c				J		J	J		
29	4a	2b	4c				T		T	T		
30	4a	1b	1c	S	S	S	S	S	S	S	S	S
31	2a	1b	1c	L	L	L	L	L	L	L	L	L
32	2a	3b	3c			N					N	N
33	1a	3b	3c			K					K	K
34	1a	2b	5c					J		J		J
35	3a	2b	5c					P		P		P
36	3a	1b	2c		O				O	O		
37	2a	1b	2c		L				L	L		
38	2a	3b	4c				N		N		N	
39	4a	3b	4c				U		U		U	
40	4a	2b	1c	T	T	T	T	T	T	T	T	T
41	3a	2b	1c	P	P	P	P	P	P	P	P	P
42	3a	1b	3c			O					O	O
43	1a	1b	3c			I					I	I
44	1a	3b	5c					K		K		K
45	4a	3b	5c					U		U		U
46	4a	2b	2c		T				T	T		
47	2a	2b	2c		M				M	M		
48	2a	1b	4c				L		L		L	
49	1a	1b	4c				I		I		I	
50	1a	3b	1c	K	K	K	K	K	K	K	K	K
51	3a	3b	1c	R	R	R	R	R	R	R	R	R
52	3a	2b	3c			P					P	P
53	2a	2b	3c			M					M	M
54	2a	1b	5c					L		L		L
55	4a	1b	5c					S		S		S
56	4a	3b	2c		U				U	U		
57	3a	3b	2c		R				R	R		
58	3a	2b	4c				P		P		P	
59	1a	2b	4c				J		J		J	
60	1a	1b	1c	I	I	I	I	I	I	I	I	I
61	4a	1b	1c	S	S	S	S	S	S	S	S	S
62	4a	3b	3c			U					U	U
63	2a	3b	3c			N					N	N
64	2a	2b	5c					M		M		M
65	1a	2b	5c					J		J		J
66	1a	1b	2c		I				I	I		
67	3a	1b	2c		O				O	O		
68	3a	3b	4c				R		R		R	
69	2a	3b	4c				N		N		N	
70	2a	2b	1c	M	M	M	M	M	M	M	M	M
71	4a	2b	1c	T	T	T	T	T	T	T	T	T
72	4a	1b	3c			S					S	S
73	3a	1b	3c			O					O	O
74	3a	3b	5c					R		R		R
75	1a	3b	5c					K		K		K
76	1a	2b	2c		J				J	J		
77	4a	2b	2c		T				T	T		
78	4a	1b	4c				S		S		S	
79	2a	1b	4c				L		L		L	
80	2a	3b	1c	N	N	N	N	N	N	N	N	N
81	1a	3b	1c	K	K	K	K	K	K	K	K	K
82	1a	2b	3c			J					J	J
83	3a	2b	3c			P					P	P
84	3a	1b	5c					O		O		O

TABLE IV—Continued

Position of switches				Signals transmitted in dependence on programme								
Δt	A	B	C	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	P_9
85	2a	1b	5c					L		L		L
86	2a	3b	2c		N				N	N		
87	4a	3b	2c		U				U	U		
88	4a	2b	4c				T		T		T	
89	3a	2b	4c				P		P		P	
90	3a	1b	1c	O	O	O	O	O	O	O	O	O
91	1a	1b	1c	I	I	I	I	I	I	I	I	I
92	1a	3b	3c			K					K	K
93	4a	3b	3c			U					U	U
94	4a	2b	5c					T		T		T
95	2a	2b	5c					M		M		M
96	2a	1b	2c		L				L	L		
97	1a	1b	2c		I				I	I		
98	1a	3b	4c				K		K		K	
99	3a	3b	4c				R		R		R	
100	3a	2b	1c	P	P	P	P	P	P	P	P	P
101	2a	2b	1c	M	M	M	M	M	M	M	M	M
102	2a	1b	3c			L					L	L
103	4a	1b	3c			S					S	S
104	4a	3b	5c					U		U		U
105	3a	3b	5c					R		R		R
106	3a	2b	2c		P				P	P		
107	1a	2b	2c		J				J	J		
108	1a	1b	4c				I		I		I	
109	4a	1b	4c				S		S		S	
110	4a	3b	1c	U	U	U	U	U	U	U	U	U
111	2a	3b	1c	N	N	N	N	N	N	N	N	N
112	2a	2b	3c			M					M	M
113	1a	2b	3c			J					J	J
114	1a	1b	5c					I		I		I
115	3a	1b	5c					O		O		O
116	3a	3b	2c		R				R	R		
117	2a	3b	2c		N				N	N		
118	2a	2b	4c				M		M		M	
119	4a	2b	4c				T		T		T	
120	4a	1b	1c	S	S	S	S	S	S	S	S	S
121	3a	1b	1c	O	O	O	O	O	O	O	O	O
122	3a	3b	3c			R					R	R
123	1a	3b	3c			K					K	K
124	1a	2b	5c					J		J		J
125	4a	2b	5c					T		T		T
126	4a	1b	2c		S				S	S		
127	2a	1b	2c		L				L	L		
128	2a	3b	4c				N		N		N	
129	1a	3b	4c				K		K		K	
130	1a	2b	1c	J	J	J	J	J	J	J	J	J
131	3a	2b	1c	P	P	P	P	P	P	P	P	P
132	3a	1b	3c			O					O	O
133	2a	1b	3c			L					L	L
134	2a	3b	5c					N		N		N
135	4a	3b	5c					U		U		U
136	4a	2b	2c		T				T	T		
137	3a	2b	2c		P				P	P		
138	3a	1b	4c				S		S		S	
139	1a	1b	4c				I		I		I	
140	1a	3b	1c	K	K	K	K	K	K	K	K	K
141	4a	3b	1c	U	U	U	U	U	U	U	U	U
142	4a	2b	3c			T					T	T
143	2a	2b	3c			M					M	M
144	2a	1b	5c					L		L		L
145	1a	1b	5c					I		I		I
146	1a	3b	2c		K				K	K		
147	3a	3b	2c		R				R	R		
148	3a	2b	4c				P		P		P	
149	2a	2b	4c				M		M		M	
150	2a	1b	1c	L	L	L	L	L	L	L	L	L
151	4a	1b	1c	S	S	S	S	S	S	S	S	S
152	4a	3b	3c			U					U	U
153	3a	3b	3c			R					R	R
154	3a	2b	5c					P		P		P
155	1a	2b	5c					J		J		J
156	1a	1b	2c		I				I	I		
157	4a	1b	2c		S				S	S		
158	4a	3b	4c				U		U		U	
159	2a	3b	4c				N		N		N	
160	2a	2b	1c	M	M	M	M	M	M	M	M	M
161	1a	2b	1c	J	J	J	J	J	J	J	J	J
162	1a	1b	3c			I					I	I
163	3a	1b	3c			O					O	O
164	3a	3b	5c					R		R		R
165	2a	3b	5c					P		P		P
166	2a	2b	2c		M				M	M		
167	4a	2b	2c		T				T	T		
168	4a	1b	4c				S		S		S	

TABLE IV—Continued

Position of switches				Signals transmitted in dependence on programme								
Δt	A	B	C	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	P_9
169	3a	1b	4c				O		O		O	
170	3a	3b	1c	R	R	R	R	R	R	R	R	R
171	1a	3b	1c	K	K	K	K	K	K	K	K	K
172	1a	2b	3c		J						J	J
173	4a	2b	3c		T						T	T
174	4a	1b	5c					S		S		S
175	2a	1b	5c					M		M		M
176	2a	3b	2c		N				N	N		
177	1a	3b	2c		K				K		K	
178	1a	2b	4c				J		J		J	
179	3a	2b	4c				P		P		P	
180	3a	1b	1c	O	O	O	O	O	O	O	O	O
181	2a	1b	1c	L	L	L	L	L	L	L	L	L
182	2a	3b	3c				N				N	N
183	4a	3b	3c				U				U	U
184	4a	2b	5c					T		T		T
185	3a	2b	5c					P		P		P
186	3a	1b	2c		O				O	O		
187	1a	1b	2c		I				I	I		
188	1a	3b	4c				K		K		K	
189	4a	3b	4c				U		U		U	
190	4a	2b	1c	T	T	T	T	T	T	T	T	T
191	2a	2b	1c	M	M	M	M	M	M	M	M	M
192	2a	1b	3c			L					L	L
193	1a	1b	3c			I					I	I
194	1a	3b	5c					K		K		K
195	3a	3b	5c					R		R		R
196	3a	2b	2c		P				P	P		
197	2a	2b	2c		M				M	M		
198	2a	1b	4c				L		L		L	
199	4a	1b	4c				S		S		S	
200	4a	3b	1c	U	U	U	U	U	U	U	U	U
201	3a	3b	1c	R	R	R	R	R	R	R	R	R
202	3a	2b	3c			P					P	P
203	1a	2b	3c			J					J	J
204	1a	1b	5c					I		I		I
205	4a	1b	5c					S		S		S
206	4a	3b	2c		U				U	U		
207	2a	3b	2c		N				N	N		
208	2a	2b	4c				M		M		M	
209	1a	2b	4c				J		J		J	
210	1a	1b	1c	I	I	I	I	I	I	I	I	I
211	3a	1b	1c	O	O	O	O	O	O	O	O	O
212	3a	3b	3c			R					R	R
213	2a	3b	3c			N					N	N
214	2a	2b	5c					M		M		M
215	4a	2b	5c					T		T		T
216	4a	1b	2c		S				S	S		
217	3a	1b	2c		O				O	O		
218	3a	3b	4c				R		R		R	
219	1a	3b	4c				K		K		K	
220	1a	2b	1c	J	J	J	J	J	J	J	J	J
221	4a	2b	1c	T	T	T	T	T	T	T	T	T
222	4a	1b	3c			S					S	S
223	2a	1b	3c			L					L	L
224	2a	3b	5c					N		N		N
225	1a	3b	5c					K		K		K
226	1a	2b	2c		J				J	J		
227	3a	2b	2c		P				P	P		
228	3a	1b	4c				O		O		O	
229	2a	1b	4c				L		L		L	
230	2a	3b	1c	N	N	N	N	N	N	N	N	N
231	4a	3b	1c	U	U	U	U	U	U	U	U	U
232	4a	2b	3c				T				T	T
233	3a	2b	3c				P				P	P
234	3a	1b	5c					O		O		O
235	1a	1b	5c					I		I		I
236	1a	3b	2c		K				K	K		
237	4a	3b	2c		U				U	U		
238	4a	2b	4c				T		T		T	
239	2a	2b	4c				M		M		M	
240	2a	1b	1c	L	L	L	L	L	L	L	L	L

The examples described make it clear that the invention provides for the separation of the means effecting the time division switching programme from the means effecting the space division switching programme.

It is seen that as the result of this feature and through the selection:

(1) of the number of switches;
(2) of the number of poles of each of the switches;
(3) of the connection diagram,

by means of the device of the invention it is possible to provide different and variable switching programmes.

What is claimed is:

1. In a sequential switching device capable of storing and operating according to a programme comprising a plurality of rotary switches connected to a common motive power input by kinematic chains comprising uniform motion drive means and intermittent drive means, at least one of the switches having contacts for electrical connection to corresponding external signal sources and being capable according to the said programme of alternately moving to act as a scanning switch for exploring signals from said sources and remaining at rest connection through one of the contacts; a timing switch, electrical connection means connecting the timing switch in series with each rotary switch, the timing switch arranged to close the circuit through the scanning switch during at least part of the time the scanning switch is at rest and of maintaining a circuit open while the scanning switch is moving, kinematic chain means driving the timing switch from said common power input, and kinematic chain intermittent drive means driving each rotary switch from the timing switch so that it is successively at rest on one contact and moving from one rest position to the next rest position, passing over a whole number of contacts determined by the kinematic chains connecting the scanning switch to the motive power input.

2. A device according to claim 1 comprising two scanning switches and a common timing switch; electrical connection means connecting corresponding contacts of the scanning switches together to form pairs for connection to the said signal sources; and separate kinematic chain drive means drivably connecting each scanning switch to the timing switch, the various drive means cooperating so that one scanning switch is at rest and, in use, connecting with a signal source, while the other is moving and is disconnected from the timing switch.

3. A device as claimed in claim 1 comprising at least one scanning switch having rotary mounting means, a plurality of brushes mounted on the said mounting means, adjacent brushes being separated by a distance corresponding to a whole number of contacts, the brushes

being so spaced that, in each rest position of the scanning switch, the brushes will be connected to circuits which are independent of one another; a further rotary switch having rotary mounting means and a plurality of brushes mounted thereon, the brushes being unequally spaced, adjacent pairs of brushes being separated by distances corresponding to a whole number of contacts; and connection means connecting the further rotary switch in series between the timing switch and the scanning switch.

4. A device according to claim 1 wherein the said kinematic chain intermittent drive means is so arranged that there is a plurality of predetermined rest positions on the scanning switch, the scanning switch moves over a plurality of contacts between adjacent rest positions, and the scanning switch stops at least once at each of the said rest positions during the execution of the programme.

5. A device according to claim 1 wherein the said intermittent drive means comprises a mechanical delay line looped back on itself and having a plurality of sequential elements, every second element being capable of storing a term of the programme so as to permit varying of an intermittent drive phase of the programme.

6. A device according to claim 1 comprising at least two switches having different numbers of contacts, and a common intermittent kinematic drive chain arranged to drive the switches.

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