

Nov. 3, 1942.

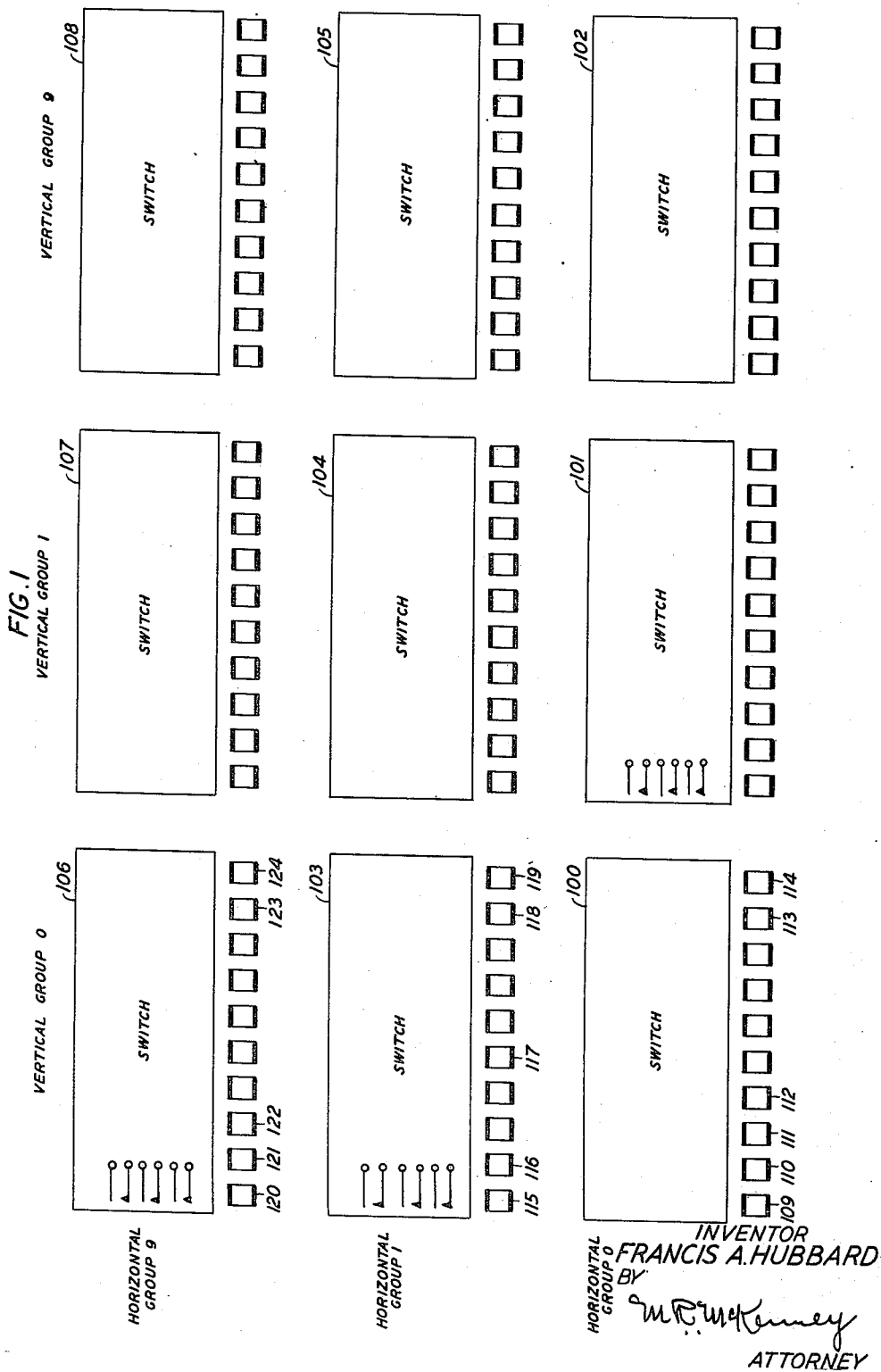
F. A. HUBBARD

2,300,505

SELECTIVE SYSTEM

Filed Oct. 31, 1940

3 Sheets-Sheet 1



Nov. 3, 1942.

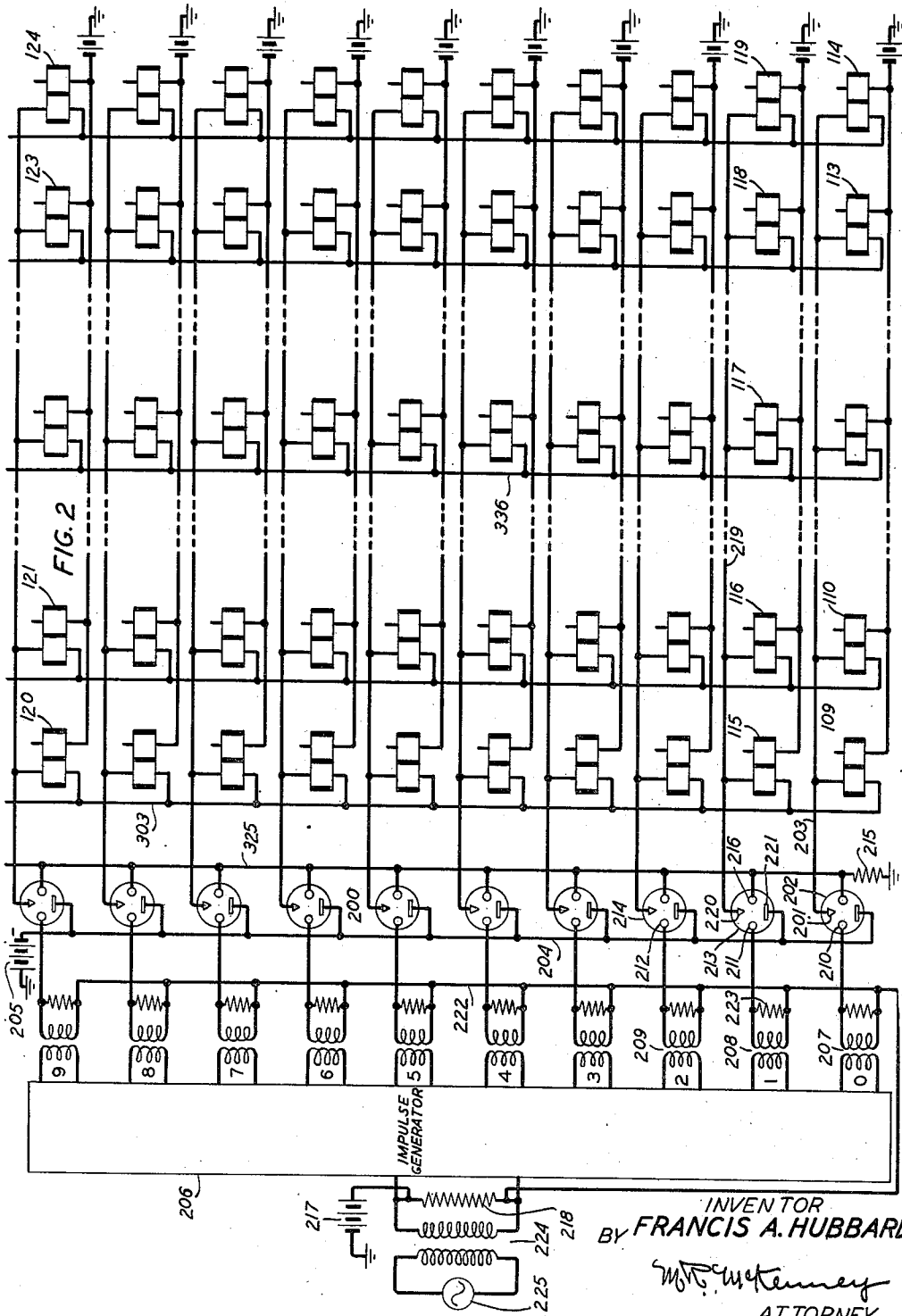
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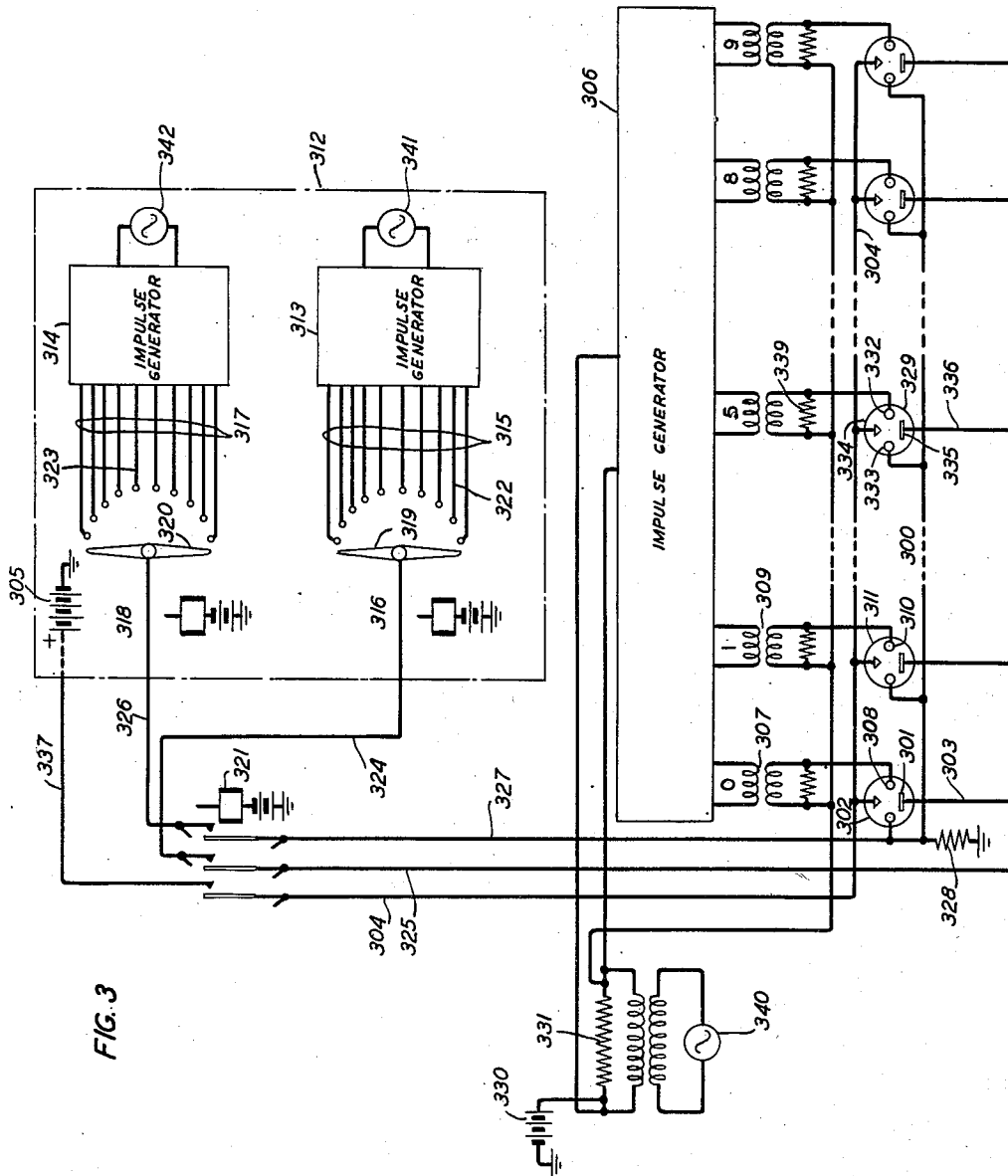
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2,300,505

SELECTIVE SYSTEM

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Application October 31, 1940, Serial No. 363,726

1 Claim. (Cl. 177-353)

This invention relates to the control and operation of switches and particularly switches used in telephone or other communication systems.

The objects of the invention are to simplify the circuits and devices required for the selective operation of automatic switches; to facilitate the use of common equipment for performing these selective operations; to enable the selective operation of a large number of switching devices over a relatively few signaling or controlling conductors; and in other respects to realize improvements in switching systems.

Switches have been proposed heretofore comprising coordinate rows of relays or magnets together with selective means for selecting and operating any desired one of the relays to close the corresponding set of circuit-making contacts. Also it has been proposed to use space-discharge tubes at the coordinate cross-points for the purpose of effecting the operation of the corresponding relays. Other systems have been devised in which the circuits are established by the coordinately arranged tubes without the aid of relays or magnets.

According to a feature of the present invention advantages are realized over these prior arrangements by means of a switching system in which any one of a large group of switching relays or magnets may be selected and operated under the control of a much smaller group of controlling devices, such as space-discharge tubes. More specifically this improved switching system may comprise a group of switching magnets electrically arranged in vertical and horizontal coordinate rows together with a group of discharge tubes having as many tubes as there are vertical rows of magnets and a second group of discharge tubes having as many tubes therein as there are horizontal rows of magnets. These tubes are connected to the magnets in such a way that the magnet at the intersection of any vertical and horizontal row may be selected and operated by causing the simultaneous discharge of the tube in the first group corresponding to the vertical row and the tube in the second group corresponding to the horizontal row.

Another feature is a system of this kind in which each magnet is included in series with the main discharge gap of a tube in one group and in series with the main discharge gap of a tube in the other group, and in which the tubes are provided with separate control electrodes whereby any pair of tubes, one in each group, may be discharged simultaneously.

Another feature is a switching system of this

kind in which the tubes in each of the two groups are selectively operated over a single conductor by time-separated impulses, each tube in the group being arranged to operate only when it receives impulses of a particular phase.

Another feature of the invention is a switching system in which the operating magnets of a plurality of cross-bar switches on a switch frame may be operated over a pair of signal conductors extending from a common controlling mechanism to the switches, the controlling mechanism being arranged to send signal currents to effect the operation of any desired switch magnet.

These and other features of the invention will be described in detail in the following specification and will also be set forth in the appended claim.

In the drawings accompanying the specification:

Fig. 1 illustrates a frame of switches to which the present invention is applicable; and

Figs. 2 and 3 illustrate a group of magnets or relays together with the associated equipment for selecting and operating them.

The invention is applicable broadly to the selection and operation of magnets, relays and similar devices, such as discharge tubes, when arranged electrically in coordinate groups. In particular it is applicable to the selection and operation of any one of the operating magnets of a plurality of cross-bar switches. Also the invention may be applied to a single switch of the coordinate type in which the cross-point contacts are made by individual relays, magnets or discharge tubes. Furthermore, the invention may be applied to any group of magnets or relays, whatever their purpose, where it is possible to arrange them electrically in coordinate rows for selection.

For the purpose of illustration herein it is assumed that the invention is applied to a cross-bar switching system in which it is desired to selectively operate the hold magnets of a plurality of cross-bar line switches. Referring to Fig. 1, a frame of cross-bar line switches is illustrated diagrammatically comprising ten horizontal and ten vertical groups of switches. Three horizontal groups are illustrated, the No. 0, No. 1 and No. 9 horizontal groups. Similarly three of the ten vertical groups are illustrated, the remaining groups being omitted for the sake of simplicity. For example, horizontal group No. 0 contains ten cross-bar switches including switches 100, 101 and 102. Similarly horizontal group No. 1 contains ten switches including switches 103,

104 and 105; and the same is true of the remaining horizontal groups of switches, the ninth group including the switches 106, 107 and 108. The vertical group No. 0 contains ten switches including the switches 100, 103 and 106, and the same is true of the remaining vertical groups. Each of these cross-bar switches contains select magnets and hold magnets for operating the cross-bars; usually there are ten select magnets and ten hold magnets. For instance, the switch 100 has ten hold magnets 109, 110, 111, 112 . . . 113 and 114. The switch 103 is provided with ten hold magnets 115, 116, 117 . . . 118 and 119. Also the No. 9 switch 106 in the vertical group No. 0 has the ten hold magnets 120, 121, 122 . . . 123 and 124. Similarly, the remaining switches on the frame are provided with these hold magnets.

Although the invention is not particularly concerned with any specific type of cross-bar switch for use in the switching arrangement illustrated in Fig. 1, the switch disclosed in the patent to Reynolds, No. 2,021,329 of November 19, 1935, is suitable for this purpose.

The switches illustrated in Fig. 1 of the drawings serve to extend calling subscribers' lines to idle trunk circuits, and the selective operation of these switches is determined by controlling circuits which are usually provided in common to the line switch frame. For a better understanding of a line switch system of this kind reference is made to the patent to Carpenter, No. 2,235,803, of March 18, 1941.

The controlling circuits whereby these line switch hold magnets are selectively operated in accordance with the present invention are illustrated in detail in Figs. 2 and 3. These circuits serve a group of one hundred hold magnets, which are arranged electrically in ten horizontal and ten vertical coordinate rows. All ten of the horizontal rows of magnets are shown in the drawings, but only five of the vertical rows are shown to avoid unnecessary duplication. Although any arbitrary grouping of the hold magnets may be employed, it may be assumed that the hundred hold magnets shown in Fig. 2 are the hold magnets of the ten switches in the No. 0 vertical group of Fig. 1. For example, the No. 0 horizontal row of magnets at the bottom of Fig. 2 are the ten hold magnets of switch 100, including magnets 109, 110, 113 and 114; the No. 1 horizontal row of Fig. 2 are the ten hold magnets of switch 103, including magnets 115, 116, 117, 118 and 119; and the magnets in the No. 9 horizontal row are the magnets of switch 106, including magnets 120, 121, 123 and 124.

The operating circuits for the magnets shown in Fig. 2 are controlled by two groups of space discharge tubes 200 and 300, each group containing ten tubes. The tubes of the group 200 are individual respectively to the ten horizontal rows of magnets; and the several tubes of the group 300 are individual respectively to the ten vertical rows of magnets. The anode element of each tube in the horizontal group 200 is connected in multiple to the operating windings of all magnets in the associated horizontal row; and the cathode element of each tube in the vertical group 300 is connected in multiple to the operating windings of all magnets in the associated vertical row. For example, anode 201 of tube 202 is connected to conductor 203 which is wired in multiple to the upper terminals of the left-hand or operating windings of all magnets 109, 110, 113, 114, in the horizontal row; and the

cathode element 301 of tube 302 is connected to conductor 303 which is wired in multiple to the lower terminals of the operating windings of all magnets in the associated vertical row, including magnets 109, 115 and 120. The cathodes of all tubes in the group 200 are connected in multiple over conductor 204 to the negative pole of battery 205; and the anode elements of all tubes in the group 300 are connected over conductor 304 to the positive pole of battery 305.

The tubes of the groups 200 and 300 are discharged selectively by applying to their control gaps brief potential impulses of different phases, that is, impulses occurring at different points in time, the selection of any desired tube being made by applying to its control gap impulses of the appropriate phase. These impulses are preferably of opposite polarities, impulses of one polarity being applied to one of the control electrodes of a tube and impulses of the opposite polarity being applied to the other control electrode. Since these positive and negative impulses are applied simultaneously to the same tube, ionization results, and the tube discharges. Hence it is possible to obtain selection among the ten tubes of the group by applying to one of the control electrodes of each tube impulses of a particular one of the ten different phases and of a given polarity and by applying to the other control electrode of all tubes impulses of a desired phase and of the opposite polarity. Since impulses of only one phase are applied to only one side of all of the control gaps, only one tube in the group operates.

The impulses of the ten different phase positions which are constantly applied to one side of the control gaps of the tubes in the group 200, are supplied by the impulse generator 206, which derives its energy for producing the impulses from a source of alternating current 225. The impulse output circuits of this generator are connected through suitable transformers 207, 208, 209, etc., to the control electrodes 210, 211, 212, etc., of the respective tubes in the group 200. Thus impulses of phase position No. 0 are constantly applied through the transformer 207 to the control electrode 210 of the tube 202, impulses of phase position No. 1 are constantly applied to the control electrode 211 of tube 213, impulses of phase position No. 2 are constantly applied to the control electrode 212 of tube 214, and likewise for the remaining tubes of the group. The impulses of the ten different phases, which are constantly applied to one side of the control gaps of the tubes in the group 300, are supplied by the impulse generator 306, which derives its energy for producing these impulses from a source of alternating current 340. These impulses are also transmitted through transformers in the several supply circuits. For example, impulses of phase position No. 0 are applied through transformer 307 to the control electrode 308 of tube 302, impulses of phase position No. 1 are applied through the transformer 309 to the control electrode 310 of tube 311, and likewise impulses of the remaining phase positions are constantly applied through individual transformers to the control electrodes of the corresponding tubes of the group 300.

The selection of the proper tube in the vertical group and the proper tube in the horizontal group is determined by a common control mechanism 312. The control mechanism 312 includes impulse generators 313 and 314, supplied by sources 341 and 342, these sources and sources 225 and

340 all being of the same frequency and phase. Each of the generators 313 and 314, therefore, produces impulses of the same phases as those produced by the generators 206 and 306. The polarities, however, are opposite. In other words, if the generators 206 and 306 apply impulses of positive polarity to the tubes in the groups 200 and 300, respectively, the generators 313 and 314 are designed to apply impulses of negative polarity to these tubes. If desired, of course, the generators 206, 306, 313, and 314 may all be supplied from a single source of alternating current.

The impulse generators 206, 306, 313 and 314 for producing impulses of different phases may be of any suitable type, such as those disclosed in detail in the application of W. H. T. Holden, Serial No. 361,536, filed October 17, 1940; and the patents to Holden No. 2,252,766 of August 19, 1941, and No. 2,285,815 of June 9, 1942.

The information identifying the cross-bar switch on the frame and the particular hold magnet that should be operated is transmitted to the control mechanism 312 in any suitable manner and is utilized to select the proper one of the phase output circuits of the generators 313 and 314. The phase output circuits 315 of the generator 313 appear in some suitable selecting device such as the step-by-step switch 316. Likewise the phase output circuits 317 of the generator 314 appear in the contact points of the selector switch 318. The brushes 319 and 320 of these switches are connected through a connector relay 321 to the control electrodes of the tubes in groups 200 and 300, respectively.

A better understanding of the manner in which the system operates may be obtained from a brief description of the operations involved in the selection of a particular one of the hold magnets. For this purpose assume that it is desired to operate the hold magnet 117 of the switch 103. Since the magnet 117 is in the No. 1 horizontal group and in the No. 5 vertical group of the hundred magnets, shown in Fig. 2, the information received by the control mechanism 312 causes the switch 316 to position its brush 319 on the No. 1 phase circuit 322 and the switch 318 to position its brush 320 on the No. 5 phase circuit 323.

At the proper time the connecting relay 321 is operated to connect the control mechanism 312 to the group of one hundred magnets. An impulse transmitting circuit is now completed from the generator 313 over conductor 322, brush 319, conductor 324, contact of relay 321, conductor 325 through resistance 215 to ground and also in multiple to the right control electrodes of all tubes in the group 200. Negative impulses of phase No. 1 are therefore applied over conductor 325 to the right electrodes of all tubes 200. These impulses are in phase with the positive impulses applied to the left electrode 211 of tube 213 and are out of phase with the impulses applied to the left electrodes of all other tubes in the group. The simultaneous application of a negative impulse to electrode 216 and a positive impulse to electrode 211 causes the ionization of the control gap of the tube 213, whereas the remaining tubes in the group remain deionized. Since the ten different phase impulses produced by the generators 206 and 306 occur in one-half cycle of the sources of supply voltage, as disclosed in the Holden patent above mentioned, No. 2,285,815, of June 9, 1942, any tube that is ionized in the group 200 in response to an incoming phase impulse may be locked in an ionized con-

dition for the remainder of said half cycle of the supply voltage. Therefore, the tube 213, when initially ionized in response to the incoming impulse of phase No. 1, is locked in an ionized condition over a circuit from battery 217, resistance 218, resistance 223, control gap 211—216 of tube 213, resistance 215 to ground. Although the battery 217 alone is not sufficient to ionize the control gap of the tube, it is sufficient when supplemented by the voltage produced by the transformer 224 during the remainder of the half cycle to maintain a tube, once fired, in an ionized condition. Therefore, the tube 213, or any other one of the ten tubes that is ionized in any one of the ten corresponding phase positions occurring in the half cycle of the source 225, is maintained in an ionized condition, following the cessation of the ionizing impulse, through the remainder of the half cycle by means of the battery 217 and the voltage produced across the resistance 218 by the transformer 224.

Similarly, an impulse circuit is established from the generator 314 over conductor 323, brush 320, conductor 326, contacts of relay 321, conductor 327, through resistance 328 to ground and in multiple to the left control elements of all tubes in the group 300. Thus impulses of phase No. 5 are transmitted over the conductor 327 to the tubes 300. Only the tube 329 responds to these impulses since both positive and negative impulses of the same phase are being applied to its control electrodes. When the tube 329 ionizes in the fifth phase position of the half cycle of the source 340, which source may be of the same phase and frequency as the source 225, a locking ionizing circuit is closed from battery 330, resistance 331, resistance 339, control gap 332—333 of tube 329, resistance 328 to ground. The voltage of battery 330 when supplemented by the voltage produced across the resistance 331 during the remaining half cycle of the source 340 is sufficient to maintain the control gap of the tube 329 ionized.

Since both tubes 213 and 329 are now in an ionized condition, a main discharge circuit is closed through these tubes and through the operating winding of the desired magnet 117. This circuit may be traced from the positive pole of battery 305, conductor 337, contacts of relay 321, conductor 304, anode 334 and cathode 335 of tube 329, conductor 336, left winding of magnet 117, conductor 219, anode 220 and cathode 221 of tube 213, conductor 204 to the negative pole of battery 205. The current flowing in this series circuit operates the magnet 117, which closes a holding circuit in any well-known manner through its right winding and the contacts of the switch controlled by the magnet. At the end of the half cycle of the supply sources 225 and 340 and at the end of each successive corresponding alternation the voltage across the control gaps of the tubes 213 and 329 drops to the voltage of the batteries 217 and 330, respectively, which is insufficient to maintain these control gaps in an ionized condition.

As soon as the control circuit 312 has completed its functions, the connector relay 321 is released to disconnect the control circuit from the switch frame. The release of relay 321 opens the circuit of battery 305, or if desired this circuit may be opened at any other point, and the tubes 213 and 329 deionize, thus opening the circuit for the further flow of current through the operating winding of the magnet 117. As above mentioned,

however, the magnet 117 has already locked over its right winding.

In the manner already described it is possible to select and operate the magnet at the intersection of any one of the horizontal and vertical rows by applying an impulse of the proper phase to the group of tubes 200 and an impulse of the proper phase to the group of tubes 300, both of these impulses occurring within the same half cycle of the sources 225 and 340.

As above noted, the selecting arrangement shown in Figs. 2 and 3 serves the magnets of the vertical group No. 0 of switches illustrated in Fig. 1. It will also be understood that similar switching arrangements may be provided for each of the remaining vertical groups of switches on the frame.

Although the operating windings of the magnets shown in Fig. 2 are connected to common circuits on both sides, no interference will be encountered provided the magnets are designed to operate within certain limiting values of current.

What is claimed is:

In combination, a plurality of electromagnets, separately operable switching contacts for each of said magnets, first and second series of discharge tubes, each of said tubes having a pair of control electrodes and main electrodes, the selection of any one of said electromagnets being determined by a particular tube in the first series

and a particular tube in the second series, means for generating repeatedly impulses of a succession of different phases, circuit means for applying the impulses of the successive phases respectively to one of the control electrodes of the successive tubes of each series, circuit means for applying selectively impulses of any one of said phases to the other control electrode of each of the tubes in the first series to cause the selective ionization of the particular tube therein having impulses of the same phase applied to both of its control electrodes, circuit means for applying selectively impulses of any one of said phases to the other control electrode of each of the tubes in the second series to cause the selective ionization of the particular tube therein having impulses of the same phase applied to both of its control electrodes, means for maintaining any one of the tubes in either one of said series in its ionized condition following the application of the ionizing phase impulses to the control electrodes thereof and until one of said tubes in the other series is ionized by the application of the corresponding phase impulses to the control electrodes thereof, and a main discharge circuit including the main electrodes of each of the pair of ionized tubes in said series and also including the operating winding of the electromagnet represented by said pair of tubes.

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