

Sept. 1, 1942.

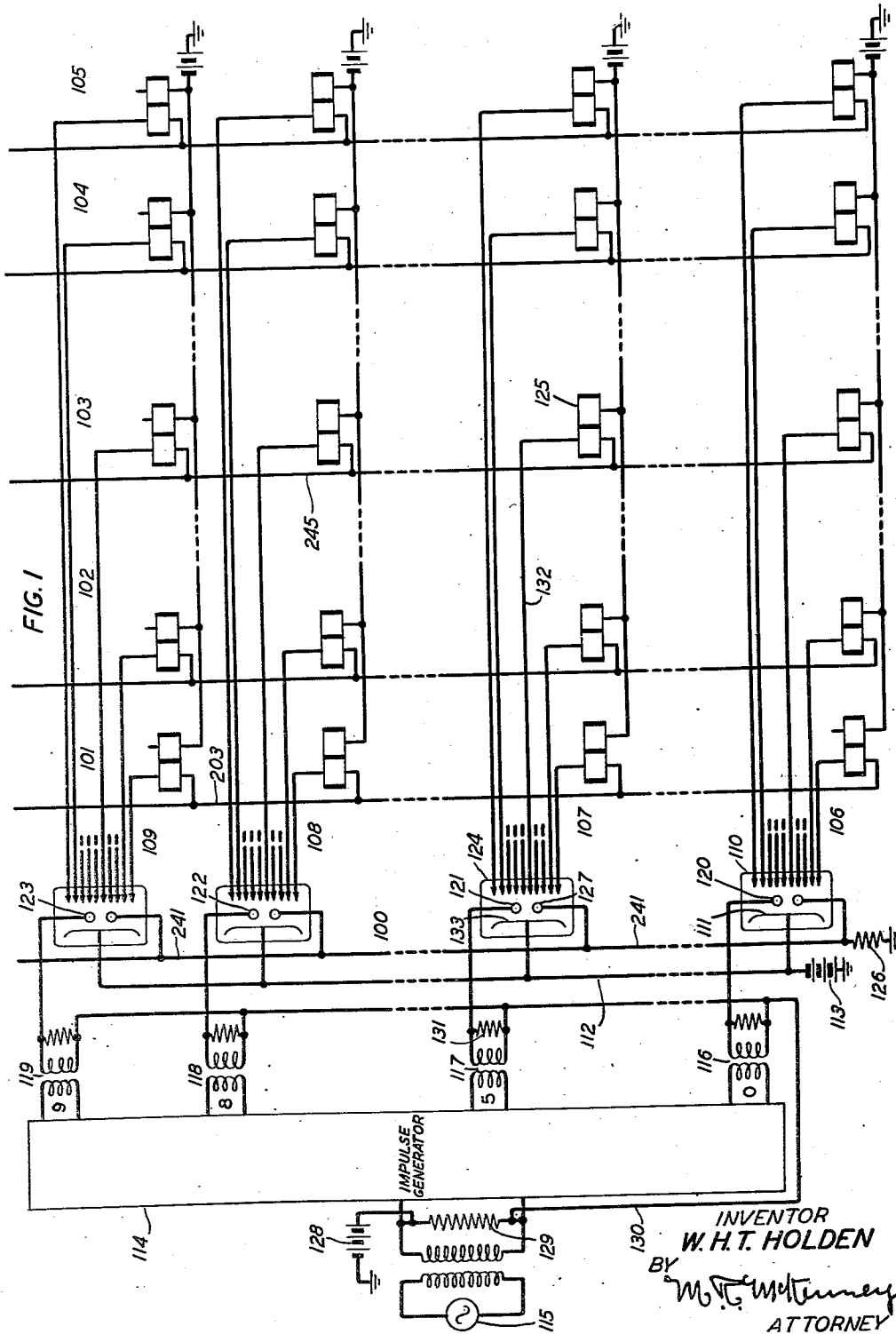
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2,294,457

SELECTIVE SYSTEM

Filed Oct. 31, 1940

2 Sheets-Sheet 1



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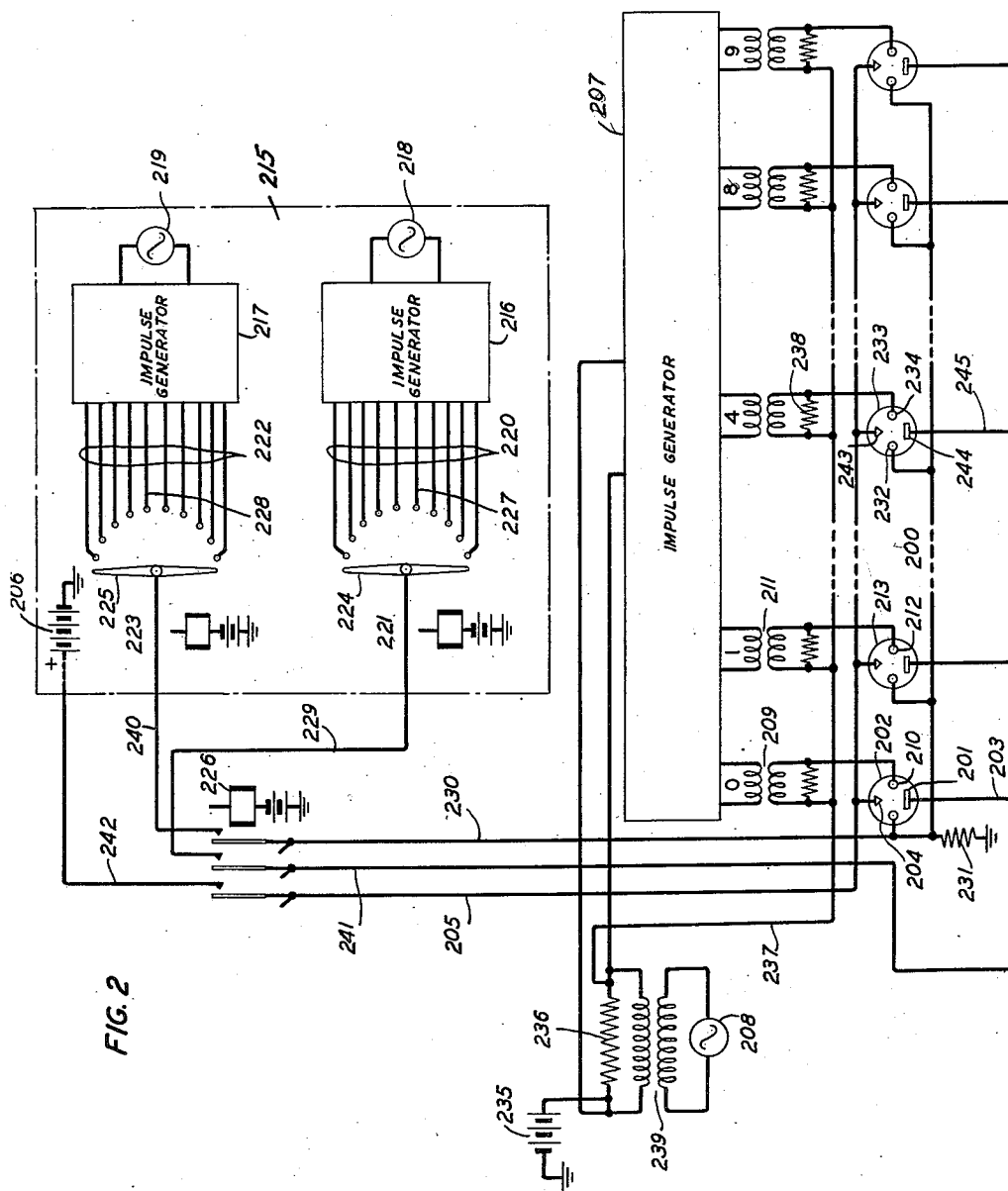
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SELECTIVE SYSTEM

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2 Claims. (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 a 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 proposed in which switching relays or magnets, arranged electrically in coordinate rows, are selected and operated under the control of a relatively small number of space-discharge tubes. A system of this latter type is disclosed in the application of F. A. Hubbard, Serial No. 363,726, filed October 31, 1940.

According to a feature of the present invention advantages are obtained over these prior systems, and particularly the one disclosed in said Hubbard application, by means of a switching system in which large groups of switching relays or magnets are disposed electrically in coordinate vertical and horizontal rows; in which the several vertical rows are provided with a group of space-discharge tubes, one for each row, and the several horizontal rows are likewise provided with a second group of tubes, one for each row; in which the magnets in each row in one coordinate direction are all connected to a single electrode of the corresponding tube in the associated group; and in which the magnets in each row in the other coordinate direction are connected to separate electrodes of the corresponding tube in the other group of tubes. By causing the simultaneous discharge of a tube in each of the two groups a circuit is closed for operating the magnet at the corresponding cross-point. The advantage of providing each of the tubes in one of the two groups with a plurality of separate electrodes and connecting the magnets of the corresponding row individually to these electrodes is that the discharge of any pair of tubes for the selective operation of a desired

magnet does not result in the closure of any circuits permitting currents to flow through other magnets. Thus it is not necessary to provide the magnets with marginal characteristics to safeguard them against false operation.

These and other features of the invention will be discussed in the following detailed specification and will also be set forth in the appended claims.

In the drawings accompanying the specification, Figs. 1 and 2 illustrate a group of relays, magnets or other devices 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 or cross-bar 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 may be assumed that the magnets, which are arranged in coordinate groups in Fig. 1, are the hold magnets of a plurality of cross-bar line switches. It is also assumed that there are a total of one hundred magnets arranged in ten vertical rows 101, 102, 103, 104, 105 and in ten horizontal rows 106, 107, 108, 109. The cross-bar switches containing these magnets may, of course, be disposed in any desired manner on the switch frames. If it is assumed that each cross-bar switch has ten hold magnets, the total groups of magnets shown in Fig. 1 illustrates ten of these cross-bar switches.

Although the invention is not particularly concerned with any specific type of cross-bar switch, the switch disclosed in the patent to Reynolds, 2,021,329 of November 19, 1935, is suitable for general switching purposes. If these switches are employed as line switches in a telephone system, their function is to extend calling subscribers' lines to idle trunk circuits. Such a switching system is disclosed in detail in the patent to Carpenter, No. 2,235,803 of March 18, 1941.

The operating circuits for the magnets shown in Fig. 1 are controlled by two groups of space

discharge tubes 100 and 200, each group containing ten tubes. The tubes of group 100 are individual respectively to the ten horizontal rows of magnets 106, 107, 108, 109; and the several tubes of the group 200 are individual respectively to the ten vertical rows of magnets. The anode element of each tube in the vertical group 200 is connected in multiple to the operating windings of all magnets in the associated vertical row. For example, the cathode 201 of tube 202 is connected to conductor 203, which is wired in multiple to the lower terminals of the left-hand or operating windings of all magnets in the vertical row 101, and the same is true of the cathodes of the remaining tubes in the group 200 serving the vertical groups of magnets. The anodes of all tubes in the group 200, such as the anode 204 of tube 202, are connected in multiple to conductor 205, which in turn is connectable to the positive pole of battery 206.

The tubes of the group 100, similar to the tubes 200, are individual respectively to the horizontal rows of magnets 106, 107, etc.; but in this case each tube is provided with ten anodes, one for each of the ten magnets in the associated horizontal row. For instance, the tube 110 has ten anodes, and these anodes are connected individually and respectively to the upper terminals of the operating windings of the ten magnets in the horizontal row 106. Similarly the remaining tubes in the group 100 are provided with ten anodes each, and the anodes of each one of these tubes are connected individually to the operating windings of the magnets in the associated horizontal row. The cathode elements of all tubes of the group 100, such as the cathode 111 of tube 110, are connected in multiple to conductor 112, which in turn is connected to the negative pole of battery 113.

The tubes of the groups 100 and 200 are discharged selectively by applying to their control gaps brief potential impulses of different phases, 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 electrodes. 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 phases, which are constantly applied to one side of the control gaps of the tubes in the group 100, are supplied by the impulse generator 114, which derives its energy for producing the impulses from a source of alternating current 115. The impulse output circuits of the generator 114 are connected through suitable transformers 116, 117, 118, 119 to the control electrodes 120, 121, 122, 123 of the respective tubes of the group 100. Thus impulses of phase No. 0 are constantly applied through the transformer 116 to the control electrode 120 of the tube 110, impulses of phase No. 5

of tube 124, and likewise for the remaining tubes of the group 100. The impulses of the ten different phases, which are constantly applied to one side of the control gaps of the tubes of the group 200, are supplied by the impulse generator 207, which derives its energy for producing these impulses from a source of alternating current 208. These impulses are also transmitted through transformers in the several phase supply circuits to the tubes of group 200. For example, impulses of phase No. 0 are applied through the transformer 209 to the control electrode 210 of tube 202, impulses of phase No. 1 are applied through the transformer 211 to the control electrode 212 of tube 213, and similarly impulses of the remaining phases are constantly applied through individual supply circuits to the control electrodes of the corresponding tubes of the group 200.

Selection of the proper tube in the vertical group and the proper tube in the horizontal group is determined by a common control mechanism 215. The control mechanism 215 includes impulse generators 216 and 217, supplied by sources 218 and 219, these sources and the sources 115 and 208 all preferably being of the same frequency and phase. Each of the generators 216 and 217, therefore, produces impulses of the same phases as those produced by the generators 114 and 207. The polarities, however, are opposite. In other words, if the generators 114 and 207 apply impulses of positive polarity to tubes 100 and 200, respectively, the generators 216 and 217 are designed to apply impulses of negative polarity to these tubes. If desired the generators 114, 207, 216 and 217 may all be supplied from a single source of alternating current.

The impulse generators 114, 207, 216 and 217 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. 2,285,815 of June 9, 1942, and No. 2,252,766 of August 19, 1941.

The information identifying the particular magnet that should be operated is transmitted to the control mechanism 215 in any suitable manner and is utilized to select the proper one of the phase output circuits of the generators 216 and 217. The phase output circuits 220 of the generator 216 appear in some suitable selecting device such as the step-by-step switch 221. Likewise the phase output circuits 222 of the generator 217 appear in the contact points of the selector switch 223. The brushes 224 and 225 of these switches are connected through a connector relay 226 to the control electrodes of the tubes in groups 100 and 200, respectively.

A better understanding of the system may be obtained from a brief description of the operations involved in the selection of a particular one of the magnets. For this purpose assume that it is desired to operate the magnet 125, which lies at the intersection of the No. 4 vertical group 103 and the No. 5 horizontal group 107. Since the magnet 125 is in the No. 4 vertical group and in the No. 5 horizontal group, the information received by the control mechanism 215 causes the switch 221 to position its brush 224 on the No. 4 phase circuit 227 and the switch 223 to position its brush 225 on the No. 5 phase circuit 228.

At the proper time the connecting relay 226 is operated to connect the control mechanism 215 to the group of one hundred magnets. An impulse transmitting circuit is now completed from

the generator 216 over conductor 227, brush 224, conductor 229, contacts of relay 226, conductor 230 through resistance 231 to ground and also in multiple to the left-hand control electrodes of all tubes in the group 200. Negative impulses of phase No. 4 are therefore applied over conductor 230 to the left-hand electrodes of all tubes in the group 200, including the electrode 232 of tube 233. These impulses are in phase with the positive impulses applied to the right-hand electrode 234 of tube 233 and are out of phase with the impulses applied to the right-hand electrodes of all other tubes in the group. The simultaneous application of a negative impulse to electrode 232 and a positive impulse to electrode 234 causes the ionization of the control gap of the tube 233, whereas the remaining tubes in the group remain deenergized. Since the ten different phase impulses produced by the generators 114 and 207 occur in one-half cycle of the energizing sources, 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 condition for the remainder of said half cycle of the energizing supply source. Therefore, the tube 233, when initially ionized in response to the incoming impulse of phase No. 4, is locked in an ionized condition over a circuit from battery 235, resistance 236, conductor 237, resistance 238, control gap 234—232 of the tube 233, resistance 231 to ground. Although the battery 235 alone is not sufficient to ionize the control gap of the tube it is sufficient when supplemented by the voltage produced by the transformer 239 during the remainder of the half cycle to maintain a tube, once fired, in an ionized condition. Therefore, the tube 233, 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 208, 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 235 and the voltage produced across the resistance 236 by the transformer 239.

Similarly, an impulse circuit is established from the generator 217 over conductor 228, brush 225, conductor 240, contacts of relay 226, conductor 241 through resistance 126 to ground and in multiple to the lower control elements of all tubes in group 100. Thus an impulse of phase No. 5 is transmitted over conductor 241 to the tubes 100. Only the tube 124 responds to the impulses applied to its control electrodes 121 and 127 since these impulses, one positive and the other negative, are of the same phase. Hence the tube 124 ionizes, and a locking ionizing circuit is closed from battery 128, resistance 129, conductor 130, resistance 131, control gap 121—127 of tube 124, conductor 241, resistance 126 to ground. The voltage of battery 128 when supplemented by the voltage produced across the resistance 129 during the remaining half cycle of the source 115 is sufficient to maintain the control gap of the tube 124 ionized.

Since both tubes 233 and 124 now have their control gaps in an ionized condition, a main discharge circuit is closed through these tubes and through the operating winding of the desired magnet 125. This circuit may be traced from the positive pole of battery 206, conductor 242, contacts of relay 226, conductor 205, anode 243 and cathode 244 of tube 233, conductor 245, left-hand or operating winding of magnet 125, con-

ductor 132 to the individual anode of tube 124 to which conductor 132 is connected, cathode 133 of said tube, conductor 112 to the negative pole of battery 113. The current flowing in this series circuit operates the magnet 125, which closes a holding circuit in any well-known manner through its right-hand winding and the contacts of the switch controlled by the magnet. At the end of the half cycle of the supply sources 115 and 208 and at the end of each successive corresponding alternation the voltage across the control gaps of tubes 233 and 124 drops to the voltage of the batteries 128 and 235, respectively, which is insufficient to maintain these control gaps in an ionized condition.

As soon as the common control circuit 125 has completed its functions the connector relay 226 is released to disconnect the control circuit from the switch frame. The release of relay 226 opens the circuit of battery 206, or if desired this circuit may be opened at any other point, and the tubes 233 and 124 are deenergized, thus preventing the further flow of current through the operating magnet 125. As above mentioned, however, the magnet 125 has already locked over its right-hand winding.

One of the advantages, hereinbefore mentioned, of the present selecting system is the use of a multiplicity of anodes in each of the tubes 100. Since each one of the magnets in any horizontal row has its own individual anode in the associated tube, the closure of an operating circuit for any one of these magnets does not result in the simultaneous closure of undesired circuits through other magnets in the same or other rows.

In the manner above 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 100 and an impulse of the proper phase to the group of tubes 200, both of these impulses occurring within the same half cycle of the sources 115 and 208, which may be of the same frequency and phase.

Although the impulse generators described herein are arranged to produce impulses of the several phases within a half cycle of the supply source, it will be obvious that other kinds of generators may be used, including those in which the several phases are spread over the entire cycle of the source.

What is claimed is:

1. In combination, a plurality of electromagnets arranged electrically in coordinate rows, a series of discharge tubes, one for each row of magnets in one coordinate direction, each tube having an electrode connected in common to the windings of the magnets in the associated row, a second series of discharge tubes, one for each row of magnets in the second coordinate direction, each of the tubes in said second series having a plurality of electrodes connected individually to the windings of the magnets in the associated row, means for operating any discharge tube in the first series and any discharge tube in the second series, and circuit means controlled by the operated tubes and including only one of the individually connected electrodes of the operated tube of said second series for energizing the winding of the electromagnet represented by the operated tubes to the exclusion of the other electromagnets.

2. In combination, a plurality of magnets, switching contacts for each of said magnets, said

magnets being arranged electrically in vertical and horizontal rows, a series of discharge tubes, said tubes associated respectively with the vertical rows of magnets, each tube having an electrode connected in common to the windings of the magnets in the associated vertical row, a second series of discharge tubes associated respectively with the horizontal rows of magnets, each tube in said second series having a separate electrode connected individually to the windings of the magnets in the associated horizontal row, means for operating any tube in the first series

and any tube in the second series to select the magnet at the intersection of the vertical and horizontal rows represented by the operated tubes, and an operating circuit for the selected magnet closed through the discharge gaps of the operated tubes in the series including the individually connected electrode of the operated tube of said second series which corresponds to the selected magnet and excluding the other individually connected electrodes.

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