

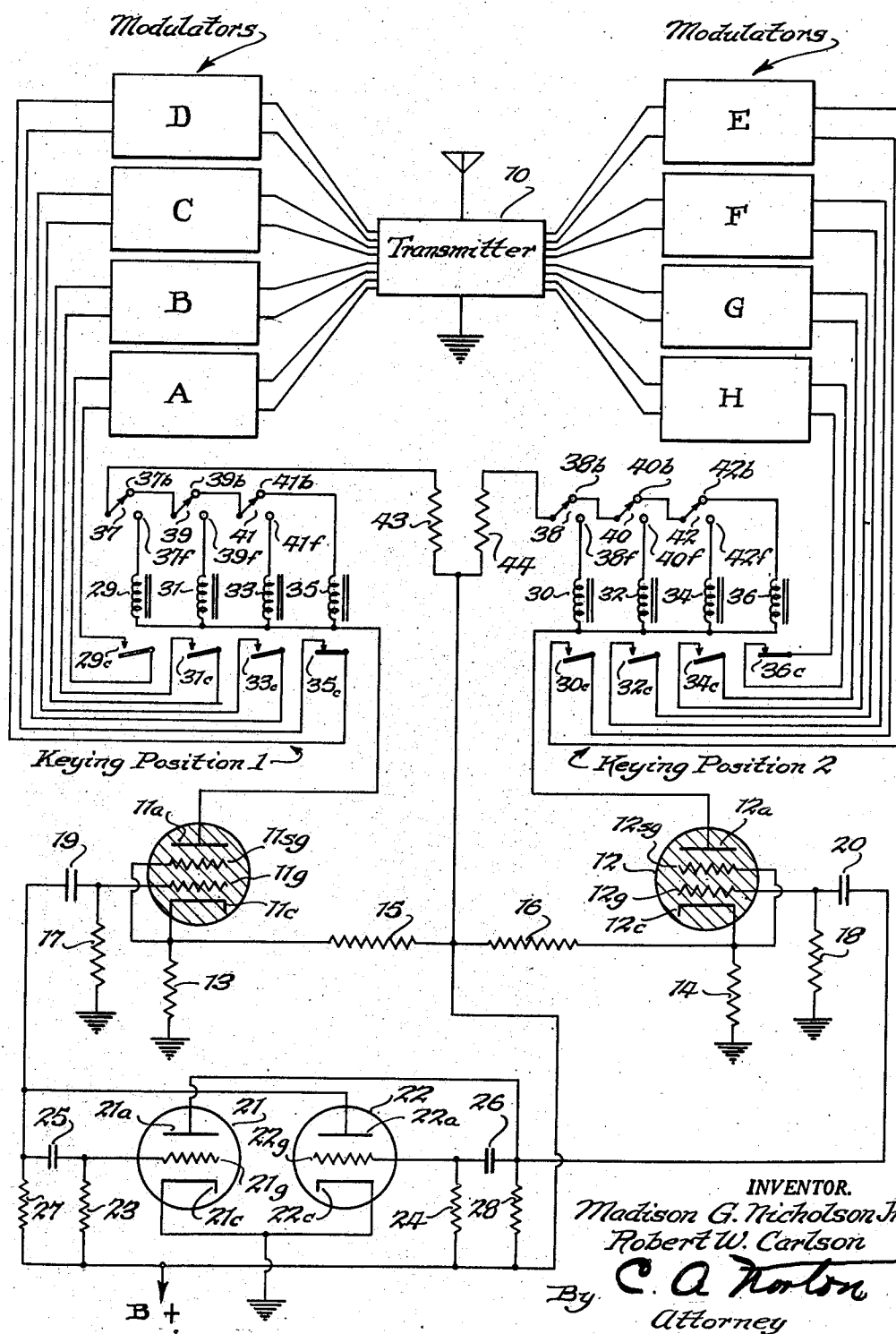
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DUPLEX CONTROL CIRCUIT

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DUPLEX CONTROL CIRCUIT

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This invention relates to duplex control circuits, and more particularly to such circuits as may be employed to control a transmitter which may operate with one of a number of different characteristics; that is to say, the transmitter may be controlled from two different keying positions 1 and 2 and each of the keying positions may control a number of different modulators, each having its own particular characteristic which it impresses on the carrier.

For instance, in keying position 1 there may be, for example, four different modulators A, B, C, and D. Modulator A may, for example, cause the transmitter to send two pulses of predetermined length with a predetermined spacing between them. Modulator B may cause the transmitter to send three pulses of predetermined length and spacing, modulator C four pulses of predetermined length and spacing, and modulator D five pulses of predetermined length and spacing, and any one of these may be operated from its particular switch or key in keying position 1.

Keying position 2 may similarly control four modulators, such as E, F, G, and H. E may cause the transmitter to send two pulses of predetermined length with a predetermined spacing between them, and these pulse and space lengths may be different from those of the modulators in keying position 1. Similarly, modulators F, G, and H may cause the transmitter to send 3, 4, and 5 pulses of predetermined length and spacing differing from the length and spacing of the pulses controlled by modulators A, B, C, and D.

It is to be understood that the action of the modulators is not repeated; that is to say, if the key controlling modulator A be closed in keying position 1, the transmitter will send two pulses separated by a space of predetermined length, and no further action will occur unless the key is opened and closed again, at which time the transmitter will again send two pulses with a predetermined space between them.

This action, as will be understood, is analogous to that of a magnetically operated bell which has no interrupter in its circuit so that when the switch is closed, the bell will strike only once and not ring continuously. Furthermore, the transmission is completed in a few milliseconds so that it is possible for a modulator in keying position 2 to follow very rapidly the action of a modulator in keying position 1.

It is desired to provide a control circuit which will permit operation of any modulator at will, as may be desired, but it is also important to prevent blocking of the modulators or improper or faulty operation which might occur provided the control keys for the modulators in position 1 and position 2 were operated simultaneously. Since only one modulator can be permitted to operate at a time on the transmitter, it is neces-

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sary to provide arrangements for locking one out when the other is in.

At the same time, to prevent one modulator being rendered inoperative, it is desirable to provide control circuits whereby these modulators may be alternately operable in turn for a period of time which is sufficient to permit them to send out the desired signal.

For example, in the operation of our control circuit, supposing that a key in keying position 1 and another key in keying position 2 are closed simultaneously. Then, under such conditions, one key will operate its modulator to send out the signal characteristic of the operating modulator, and after this action is completed, control is transferred to the other modulator, which causes the transmitter to send out a signal modulated with the characteristic of the other modulator, and the entire process of operation may be completed in an extremely short period of time; for example, of the order of $\frac{1}{100}$ of a second.

Thus, while the two modulators act successively and never simultaneously in point of time, yet their operations follow each other so quickly that for all practical purposes they may be regarded as simultaneous, and this, in effect, provides for duplex operation of the transmitter.

The invention herein is an improvement on the invention described and claimed in the co-pending application of Madison G. Nicholson, Jr., entitled "Duplex control circuit," owned by the assignee of the present application.

It is an object of this invention to provide an improved duplex control circuit which will prevent one modulator from controlling the transmitter while the other is in control.

It is a further object of this invention to provide such a circuit in which the operation of the second modulator, although temporarily prevented from occurring while the first modulator is in control of the transmitter, will, nevertheless, occur within an extremely short interval of time after the control key is operated.

It is still a further object of our invention to provide an improved control circuit for applying two modulators to a transmitter alternately for very short periods of time whereby in effect duplex operation is provided.

It is still a further object of our invention to provide such a control circuit in which more than two modulators may be employed, the first being any one of a group of modulators which may be selectively employed and the second being any one of another group of modulators which may be selectively employed.

Still other objects and advantages of our invention will be apparent from the specification.

The features of novelty which we believe to be characteristic of our invention are set forth with particularity in the appended claims. Our inven-

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tion itself, however, both as to its fundamental principles and as to its particular embodiments, will best be understood by reference to the specification and accompanying drawing, in which

The single figure is a circuit diagram of an improved duplex control system in accordance with our invention.

Referring now more particularly to the drawing, 10 indicates the transmitter, which may be controlled by any one of the modulators A, B, C, or D in keying position 1, and by any one of the modulators E, F, G, and H in keying position 2. The construction and operation of the modulators is not shown or described in detail since these form per se no part of this invention.

Modulators A, B, or C may be selected and put into operation by means of switches 37, 39, and 41 respectively in keying position 1 and any one of modulators E, F, and G may be selected and put into operation by switches 38, 40, and 42 in keying position 2 respectively. Modulator D in keying position 1 and modulator H in keying position 2 are not provided with a selecting switch since these send clearing signals at the completion of operation of any other modulator of the same keying position and are caused to operate by the circuits herein employed, as will be described.

Prevention of operation of a modulator of position 1 simultaneously with the modulator of position 2 is prevented by a pair of tubes which may be of the thyatron type 11 and 12, tube 11 having cathode 11c, control grid 11g, screen grid 11sg, and anode 11a. Similarly tube 12 may have cathode 12c, control grid 12g, screen grid 12sg, and anode 12a.

In the embodiment of the invention herein shown, the cathodes of these tubes are connected to ground through resistances 13 and 14, and the plate circuit of tube 11 is connected to one end of the actuating winding of relays 29, 31, 33, and 35 in keying position 1. The other end of the winding of relay 29 is connected to front contact 37f of switch 37, winding of relay 31 to front contact 39f of switch 39, and the other terminal of the winding of relay 33 to front contact 41f of switch 41. The other terminal of relay winding 35 is connected to back contact 41b of switch 41, the blade of switch 41 connected to back contact 39b of switch 39, and the blade of switch 39 connected to back contact 37b of switch 37 and through resistance 43 to the source of supply +B.

Switches 37, 39, and 41 are preferably spring-biased to back contact position, and they are of the type in which there is no wipe-over; that is to say, when they are moved from back contact to front contact position, there is an intermediate position in which the switch is open, relay 29 controls its contacts 29c, relay 31 its contacts 31c, relay 33 its contacts 33c, and relay 35 its contacts 35c, these contacts being normally biased to open position and closed by the flow of current through their respective windings.

Contacts 29c close the circuit controlling modulator A, contacts 31c modulator B, contacts 33c modulator C, and contacts 35c modulator D, in such a manner that when any one of these relays operates, its respective modulator is put in control of the transmitter and causes the transmission of the signal characteristic of such modulator. Keying position 2 is entirely similar to keying position 1.

Anode 12a of tube 12 is connected to one end of the actuating windings of relays 30, 32, 34, and 36, the other end of which may be connected to front contact 38f of switch 38, the other end of winding

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of relay 32 to front contact 40f of switch 40, the other end of the winding of relay 34 to front contact 42f of switch 42, and the other end of the winding of relay 36 to back contact 42b of switch 42.

Like switches 37, 39, and 41, switches 38, 40, and 42 may be biased to back contact position, and are arranged so that there is an interval of time when the circuit is open as the switch is moved from back contact to front contact. The blade of switch 42 is connected to the back contact of switch 40, the blade of switch 40 to the back contact of switch 38, and the blade of switch 38 through resistance 44 to the +B source.

Contacts 35c of relay 36 close the circuit to modulator E, contacts 32c to modulator F, contacts 34c to modulator G, and contacts 36c to modulator H. The +B source is connected through resistance 15 to the cathode of tube 11 and through resistance 16 to the cathode of tube 12.

For controlling tubes 11 and 12, we provide a multivibrator comprising tubes 21 and 22, the former having cathode 21c, control electrode 21g, and anode 21a, and the latter cathode 22c, control electrode 22g, and anode 22a.

The cathodes of tubes 21 and 22 are connected together and to ground, the grids through resistances 23 and 24 respectively to the +B supply, and resistance 23 is shunted by condenser 25 to resistance 27 in series, and resistance 24 shunted by condenser 26 and resistance 28 in series.

The intermediate point of resistance 27 and condenser 25 is connected through a differentiating network comprising condenser 19 and resistance 17 to grid 11g of tube 11, and the intermediate point of condenser 26 and resistance 28 similarly connected through a differentiating network comprising condenser 20 and resistance 18 to grid 12g of tube 12. Anode 21a of tube 21 is connected to the intermediate point between condenser 26 and resistance 28 and anode 22a of tube 22 to the intermediate point between condenser 25 and resistance 27.

The constants of this multivibrator circuit are preferably so chosen that the circuit delivers a square wave having a frequency of the order of 25 cycles per second. Consequently, there will be applied to grid 11g of tube 11 through the differentiating network condenser 19 and resistance 17 25 positive pulses per second and to grid 12g of tube 12 through differentiating network condenser 20 and resistance 18 25 positive pulses per second, and these will be delivered alternately, first to tube 11, then to tube 12, so that these grids electrically may be regarded as the opposite ends of a see-saw, never going positive at the same time.

Of course, negative pulses are also applied to said grids once per cycle, but since these negative pulses play no part in the operation of the circuit, they need not be considered.

The operation will now be described with reference to keying position 1, and it will be understood that the description as applied to keying position 1 applies equally to keying position 2. Under normal conditions; that is, when no signal is being transmitted, the relays and switches are in the position shown. Tube 11 is ionized and will remain ionized, the negative pulse which is periodically impressed upon this tube by the multivibrator being insufficient to deionize.

Plate current flows only through the winding of relay 35, and contacts 35c are closed. The contacts of the other relays, 29, 31, and 33, are

open, and the plate circuit of tube 11 is completed through back contact 41b, blade of switch 41, back contact 39b, blade of switch 39, back contact 37b, and blade of switch 37.

If now switch 41 be moved from back to front contact, the plate circuit of tube 11 is open during the interval when the blade of switch 41 moves off back contact 41b until it reaches front contact 41f. By opening the plate circuit, tube 31 is caused to deionize, this interrupting plate current through relay 35 and allowing relay contacts 35c to open.

When the blade of switch 41 reaches front contact, the plate circuit of tube 11 is completed through the winding of relay 33. The operating voltages on tube 11 are so chosen that the tube will not ionize until a positive pulse is impressed upon grid 11g from the multivibrator. Therefore, tube 11 will remain in deionized condition until a positive pulse reaches grid 11g. When this occurs, tube 11 ionizes and plate current begins to flow through winding of relay 33, thereby energizing the relay and causing closure of contacts 33c, and the closure of these contacts causes operation of modulator C, causing the transmitter to send the characteristic signal produced by modulator C.

Once the signal has been sent, no further action will occur so long as switch 41 is held on front contact 41f. When this switch is released, it is carried back to back contact, and in passing off front contact 41f opens the plate circuit of tube 11, which causes deionization of the tube. This interrupts the plate current flowing through the actuating winding of relay 33 and contacts 33c open. As soon as switch 41 closes on back contact, the plate circuit of the tube is again completed, but the tube does not reionize until the next positive pulse from the multivibrator is impressed upon its grid.

When this occurs, the tube fires and the plate current flowing through the winding of relay 35 closes contacts 35c, and modulator D is established as the controlling modulator, causing the transmitter to send the clearing signal. This completes the cycle of operation, and the apparatus is now ready for another closure of switches 37, 39, or 41 to front contact.

It will be understood that operation of the modulator in keying position 2 is the same as that already described except that they are controlled by tube 12 instead of tube 11 and that, as already stated, no modulator of keying position 1 can operate while any modulator of keying position 2 is operating, and vice versa.

Suppose, now, that switch 41 in keying position 1 and switch 42 in keying position 2 happen to be closed simultaneously. It cannot be predicted which tube, 11 or 12, will ionize first, this being dependent upon which first receives the positive pulse from the multivibrator. If it happens that tube 12 receives the positive pulse before tube 11, then tube 12 will first ionize and modulator G will be put in control, sending out its characteristic group of pulses.

If switch 41 is still closed after the signal is sent by modulator G, then the contacts of relay 33 will be closed, modulator C of position 1 will be placed in control, and its characteristic signal will be sent. Upon release of keys 41 and 42 modulators D and H will be successively established in control and both clearing signals sent, depending on which of tubes 11 and 12 first receives a positive pulse.

Thus, it will be seen that if a switch in keying

position 1 and a switch in keying position 2 are simultaneously closed for about $\frac{1}{25}$ second or longer, four signals will be sent; first, the operating signal from either keying position 1 or 2, depending upon which of tubes 11 and 12 is first ionized; second, the operating signal from the other keying position; third, the clearing signal from the one keying position; and finally, the clearing signal from the other keying position; and the entire sequence of operation will be completed in not more than a tenth of a second longer than the time during which the keys were held down.

While we have shown and described certain preferred embodiments of our invention, it will be understood that modifications and changes may be made without departing from the spirit and scope thereof, as will be clear to those skilled in the art.

In this application we have particularly pointed out and distinctly claimed the part, improvement, or combination which we claim as our invention or discovery, and we have explained the principles thereof and the best mode in which we have contemplated applying those principles so as to distinguish our invention from other inventions.

We claim:

1. The combination with a transmitter, of a plurality of banks of modulators, each bank comprising a plurality of modulators, each arranged to impress its characteristic modulation on the transmitter, a switch for controlling each modulator respectively, and means for causing sequential operation of the modulators when two switches controlling modulators in different banks are closed simultaneously.

2. The combination with a transmitter, of a plurality of banks of modulators, each bank comprising a plurality of modulators, each arranged to impress its characteristic modulation on the transmitter, a switch for controlling each modulator respectively, means for causing sequential operation of a modulator in each bank when their control switches are closed simultaneously, said last mentioned means including a pair of gas discharge tubes, and means for preventing simultaneous ionization of said tubes.

3. The combination with a transmitter, of a plurality of banks of modulators, each bank comprising a plurality of modulators, each arranged to impress its characteristic modulation on the transmitter, a switch for controlling each modulator respectively, means for causing sequential operation of a modulator in each of said banks when their controlling switches are closed simultaneously, said last mentioned means including a pair of gas discharge tubes, means for preventing simultaneous ionization of said tubes, and a relay for each modulator respectively operated by the space current of said gaseous discharge tubes.

4. The combination with a transmitter, of a plurality of banks of modulators, each bank comprising a plurality of modulators, each arranged to impress its characteristic modulation on the transmitter, a switch for controlling each of said modulators respectively, means for causing sequential operation of one modulator in each bank when their control switches are closed simultaneously, said last mentioned means including a pair of gas discharge tubes each having a control electrode, a substantially square wave generator, means for impressing alternately upon said con-

trol electrodes positive pulses derived from the output of said square wave generator.

5. The combination with a transmitter, of a plurality of banks of modulators, each bank comprising a plurality of modulators, each arranged to impress its characteristic modulation on the transmitter, a switch for controlling each modulator respectively, means for causing sequential operation of one modulator in each bank when their control switches are closed simultaneously, said last mentioned means including a pair of gas discharge tubes each having a control electrode, a generator of substantially square waves, and a pair of differentiating net works connected to said electrodes respectively and to points of 180 degrees phase opposition in said square wave generator.

6. The combination with a transmitter, of a plurality of banks of modulators, each bank comprising a plurality of modulators, each arranged to impress its characteristic modulation on the transmitter, switches for controlling said modulators respectively, means for causing sequential operation of one modulator in each bank when their controlling switches are closed simultaneously, said last mentioned means including a pair of gas discharge tubes each having a pair of control electrodes, a generator of substantial square waves, means for applying alternately positive pulses from said square wave generator to one of said control electrodes in each tube, the other of said control electrodes being normally biased with respect to the cathode of its respective tube so as to prevent ionization thereof, said switches being arranged to alter the bias on said last mentioned control electrode in the respective tubes to a valve such that the tube will ionize when a positive pulse applied to the other control electrode of said tube.

7. In a signaling system, in combination, a transmitter, a plurality of modulators, each impressing a predetermined characteristic upon the transmitted signal, and a switch for selectively operating each of said modulators, said switches having front and back contact positions, and being interconnected in a manner such that when all of said switches are on back contact position a control circuit is established.

8. In a signaling system, in combination, a transmitter, a plurality of working signal modulators and a clearing signal modulator and a switch for controlling each of said working modulators, said switches having front and back contact positions and being so connected that when all of said switches are on back contact position the control circuit is closed for operating said clearing modulator.

9. In a signaling system, in combination, a transmitter, a plurality of working signal modulators, and a clearing signal modulator, a thyatron, a relay for each modulator having one terminal of its energizing winding connected in the anode circuit of said thyatron, and a switch for each of said working signal modulators for completing the circuit through the respective energizing winding, said switches having front and back contacts and being so interconnected that when the said switches are on back contact position the circuit through the energizing winding of the clearing signal modulator relay is completed.

10. In a signaling system, in combination, a transmitter, a plurality of working signal modulators, and a clearing signal modulator, each impressing a predetermined characteristic upon

the transmitted signal, means for selectively causing operation of any one of said working signal modulators, and means for energizing the clearing signal modulator at the completion of the working modulator signal.

11. In a signaling system, in combination, a transmitter, a plurality of working signal modulators, and a clearing signal modulator, means for selectively energizing any one of said working signal modulators, said means operating to interrupt the control circuit of said clearing signal modulator whenever the control circuit of any working modulator is established.

12. In a signaling system, in combination, a transmitter, a plurality of working signal modulators, and a clearing signal modulator, and means for selectively operating any one of said working signal modulators, said means operating, when actuated, to interrupt the control circuit of said clearing signal modulator and establishing the control circuit of said clearing signal modulator when returned to initial position.

13. The combination with a transmitter, of a plurality of banks of modulators, each bank comprising a plurality of working signal modulators and a clearing signal modulator, each arranged to impress its characteristic modulation on the transmitter, a switch for controlling each working signal modulator respectively, means for causing sequential operation of one working signal modulator of each bank when two working modulator signal switches in different banks are closed simultaneously, the switches in each bank being so interconnected that the closure of a working signal modulator control switch in either bank interrupts the control circuit to the clearing modulator of said bank.

14. The combination with a transmitter, of a plurality of banks of modulators, each bank comprising a plurality of working signal modulators and a clearing signal modulator, each arranged to impress its characteristic modulation on the transmitter, a switch for controlling each working signal modulator respectively, means for causing sequential operation of a working signal modulator in each bank when their control switches are closed simultaneously, said last mentioned means including a pair of gas discharge tubes, and means for preventing simultaneous ionization of said tubes, the switches of each bank being interconnected so that when all of the switches of either bank are in bank contact position the control circuit to the clearing modulator of said bank is established.

15. The combination with a transmitter, of a plurality of banks of modulators, each bank comprising a plurality of working signal modulators and a clearing signal modulator, each arranged to impress its characteristic modulation on the transmitter, a switch for controlling each working signal modulator respectively, means for causing sequential operation of a modulator in each of said banks when their respective controlling circuits are closed simultaneously, said last mentioned means including a pair of gas discharge tubes, means for preventing simultaneous ionization of said tubes, and a relay for each modulator respectively, operated by the space current of said gaseous discharge tubes, the switches of each bank being interconnected in a manner to establish the control circuit to the clearing signal modulator of said bank when all of the switches in said bank are on back contact.

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