

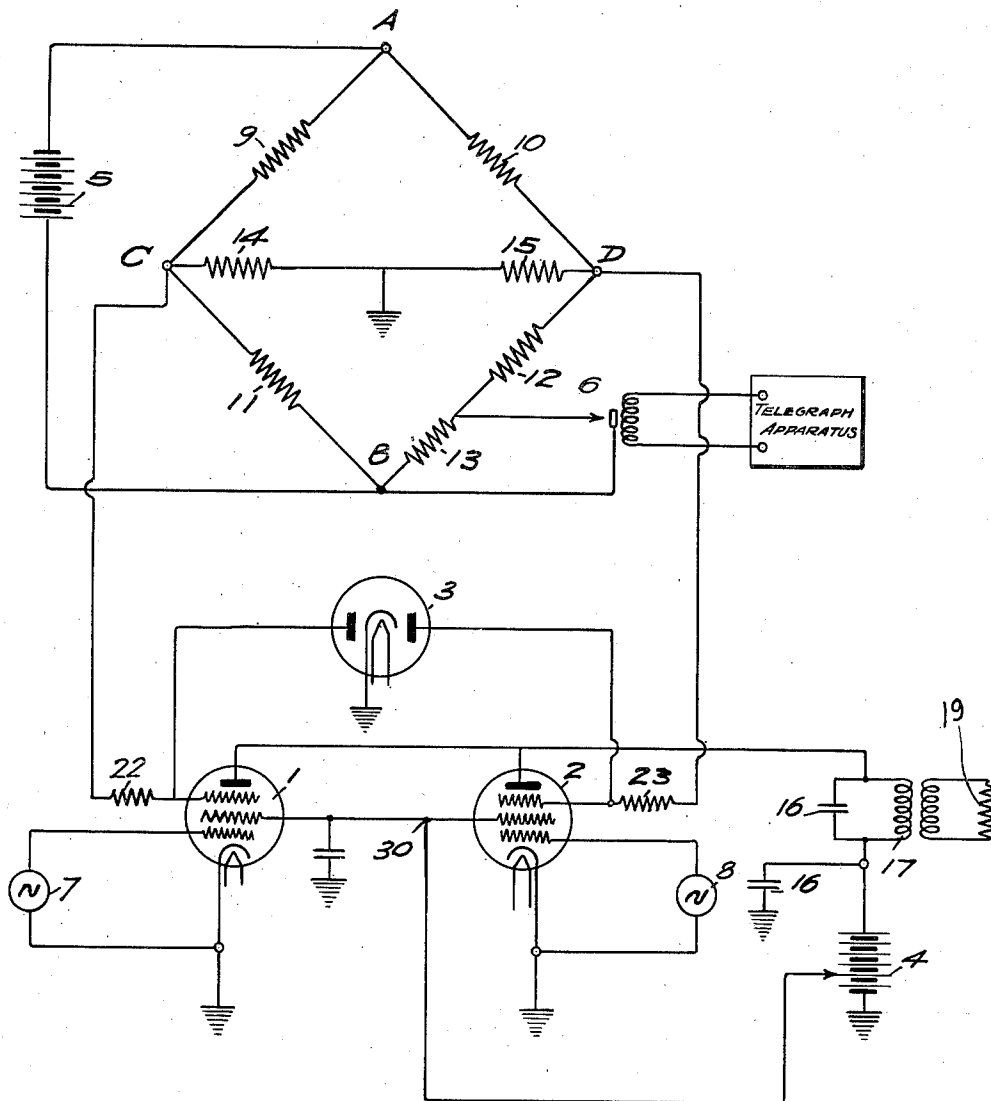
Jan. 29, 1946.

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2,393,645

SWITCHING SYSTEM

Filed Oct. 27, 1943



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2,393,645

SWITCHING SYSTEM

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Application October 27, 1943, Serial No. 507,802

7 Claims. (Cl. 178—66)

(Granted under the act of March 3, 1883, as
amended April 30, 1928; 370 O. G. 757)

The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

This invention relates to improvements in radio signalling devices adapted to be used in connection with telegraph, teletype, facsimile apparatus and the like.

It is an object of this invention to provide a device for telegraphic signalling by using a radio frequency carrier. Intelligence is transmitted by causing the "mark" and "space" sense of signals so radiated to be slightly different in frequency, such as a difference of 850 cycles. That is, the "mark" (or the space) signal may have a radio frequency of 2,000,000 cycles per second, and the "space" (or mark) signal may have a frequency of 2,000,850 cycles per second. The received signal, when heterodyned in a suitable receiver, is caused to produce audio frequencies 850 cycles apart. These audio frequency signals can be readily separated by means of band pass filters.

The advantage of using two-frequency signalling occurs at the receiver. Noise frequencies are received and passed through the receiving system, including the selective band pass filters, with substantially equal facility. These noise voltages act with equal force upon the transducer, but in an opposite sense. This results in the cancellation of the effects of noise frequencies to a large extent. The heterodyne frequencies present in either the "mark" or "space" filter at any instant.

The above and other objects are attained by the novel circuit and arrangement of elements hereinafter described and illustrated in the accompanying drawing, forming a part hereof, and in which the figure shows a schematic diagram of a signalling system.

Referring to the drawing, the system is shown to include a pair of suitable generators 1 and 2 of radio frequency energy, their respective frequencies being nearly but not exactly the same. For example, the frequencies of the generators may differ by 850 cycles per second. However, it should be noted that the system is not restricted to such a difference. The choice of the difference in frequencies depends upon the extent of the radio spectrum to be employed, and also the capability of selective filters of practical design to distinguish between the two radio frequencies.

Generators 1 and 2 are caused to excite amplifier tubes 3 and 4, which are of the pentode type. The cathodes of these tubes are connected to "ground"; and the screen grids are connected

to a common point 36 on a battery 4 so as to provide a positive screen grid potential of suitable value with respect to the cathodes.

The plates of tubes 1 and 2 are connected together at a common point to a tuned circuit comprising a coil 17 and a condenser 16. The resonant frequency of this tuned circuit is midway between the frequencies of generators 1 and 2. Positive voltage from battery 4 is fed through coil 17 to the plates of tubes 1 and 2 to provide proper operation.

With fixed values of grid potential and plate potential, a characteristic of a pentode tube is that when the suppressor grid voltage is made negative with respect to the cathode, the space current will be reduced; and the space current may be reduced to zero by the application of sufficient negative potential on the suppressor grid. Likewise, a positive potential on the suppressor grid will cause the space current to increase and continue to do so until the point where saturation of emission is reached, when no further increase in current will occur. Pentode tubes are commonly operated with zero potential between suppressor grid and cathode.

In transmitting a signal, it is desired to select either generator 1 or 2, whichever produces the desired frequency; and to block out or prevent transmission of voltage through the tube connected to the generator producing the undesired frequency. The system depends upon its ability to transmit either frequency produced by the generators 1 and 2 at will, but never both frequencies simultaneously. To effect this function, the suppressor grid of tube 1 is connected through resistance 22 to junction C of a Wheatstone bridge, and suppressor grid of tube 2 is connected through resistance 23 to junction D of the bridge.

Arms 9, 10, and 11 have resistances of equal value. If the fourth arm of the bridge, composed of resistors 12 and 13, were the same as arms 9, 10, and 11, the battery 5 connected across the other junction points A and B would produce no potential difference across points C and D, since the bridge would be balanced. Common usage designates a condition of balance to exist when the potential across points C and D is zero. However, in this application of the bridge, an unbalanced condition is necessary; and this can be effected by causing resistors 12 and 13 to vary in value either greater or less than the values of arms 9, 10, and 11.

Assume point A to be negative and point B to be positive, with respect to each other. If resistors 12 and 13 are caused to be greater in value

than any one of the other three arms, point C will be positive and point D will be negative with respect to each other. If resistors 12 and 13 are caused to be less than any one of the other arms, point D will be positive and point C will be negative with respect to each other. Thus by varying the value of resistors 12 and 13 such that their sum is greater or less than any of the other arms, the potential difference between C and D can be caused to reverse. The current caused to flow due to this potential difference will flow from positive to negative in either case, but in one instance when C is positive the current will flow from C to D, and when D is positive, the current will flow from D to C.

It is seen that potentials developed across resistances 14 and 15 due to current flow from C to D, or vice versa, are impressed upon suppressor grids of tubes 1 and 2. For example, assume current to be flowing from C to D. Point C, therefore, is positive with respect to ground, causing suppressor grid of tube 1 to be positive with respect to ground which in turn enables tube 1 to function. While current continues to flow from C to D, point D is negative with respect to ground, causing suppressor grid of tube 2 to be negative with respect to the cathode of tube 2, the cathode being connected to ground, and preventing the functioning of tube 2. With suitable choice of battery voltage 5 and resistors 14 and 15, this negative potential can be made to block or prevent transmission of voltage developed by generator 8 through tube 2. Likewise, the reverse situation obtains when resistors 12 and 13 are less than any of the other arms, causing D to be positive and C to be negative with respect to each other.

In practice, resistor 12 is made as near to zero as practicable by making a direct connection and not inserting any resistance. Resistor 13 is made as near infinity as possible by omitting any connection. Contacts of a relay 6 connect across resistor 13, the relay being actuated by impulses created by a telegraph apparatus or the like. When contacts of relay 6 are closed, the resistance of arm BD is less than AD or BC. When contacts of relay 6 are open, arm BD has a greater resistance than that of any of the other arms of the bridge.

It will be noted that the transition time between reversals of current through CD by virtue of operation of relay 6 is substantially zero. Either one or the other situation exists, but not both or neither at any given instant.

As mentioned above, pentode tubes are usually operated with suppressor potential positive with respect to the cathode. To limit the positive potential to a small value, rectifier tube 3 is connected so that one of each of the plates of tube 3 is connected to a suppressor grid. When point C is positive with respect to ground, tube 3 conducts current through the plate connected to suppressor grid of tube 1. The current thus caused to flow develops a voltage drop across 22. The greater portion of the potential across 14 thus appears across 22 and only a small portion appears across tube 3 connected to suppressor grid of tube 1. On the other hand, tube 3 does not conduct when D is negative with respect to ground, because current can only flow through the tube when the plate is positive with respect to the cathode. As no current is flowing through resistance 23, no voltage drop is developed across it. The full voltage developed across resistance 15 therefore is impressed on suppressor grid of

tube 2 with proper choice in the voltage of battery 4 and resistors 14 and 15, and this potential can be caused to block off tube 2. The reverse situation exists when point D is positive with respect to ground.

The principal advantage of this system is a zero transition time between selection of generators 7 and 8, resulting in no interruption of the radiated radio frequency carrier, but merely a shift in its frequency. Since there is no carrier interruption while signalling, the carrier can be modulated by the amplitude method. The depth of modulation may not be completed, however, as some carrier must be radiated to effect the signalling described herein.

The speed of signalling is limited only by the external means such as the operation of the apparatus controlling relay 6, the transitions following the operation of the contacts of relay 6. However, the system is not restricted to a mechanical device such as relay 6, but there may be substituted for the relay any electronic device capable of changing the resistance due to signalling impulses being impressed thereon.

The system is adaptable to any signalling system employing block or square wave signal units, such as Morse telegraph, teletype, or facsimile transmission.

The current delivered by battery 4 is constant and has no component of signalling frequency due to the fact that at every instant either tube 1 or tube 2 is functioning, but never both tubes together or neither. Space currents of tubes 1 and 2 are adjusted to be equal, and also is the value of voltages delivered by generators 7 and 8. Properly tuned and adjusted, current in the load 19 is the same for either frequency. The plate voltage to each oscillator tube must be the same.

It will be seen that there has been provided a simple and effective system for providing instantaneous switching between two signals of different radio frequencies, and especially adapted for use in connection with telegraph, teletype and facsimile apparatus.

The above description is to be considered as descriptive and not limitative of the invention of which modifications may be made without departing from the spirit and scope of the invention as set forth in the appended claims.

The invention having been described, what is claimed is:

1. In a device for telegraphic signalling by using a radio frequency carrier, a first electron tube connected to a generator of a radio frequency, a second electron tube connected to a generator of a slightly different radio frequency, a Wheatstone bridge connected to the tubes to control the operation thereof, said bridge having one arm of variable resistance, and means controlled by the opening or closing of a switch for changing the resistance of said arm to change the grid bias of said tubes so that one tube will be in operation and the other tube inoperative.

2. In a device for telegraphic signalling by using a radio frequency carrier, two generators of different radio frequencies, each of said generators having an electron tube connected thereto, a Wheatstone bridge having three arms of equal resistance and a fourth arm having a portion of very high resistance in series with a very low resistance, a relay controlled by a telegraph apparatus, said relay when closed being connected to the bridge to short circuit the very high resistance and when open to connect the

very high resistance and very low resistance in series, a pair of spaced resistances connected in series between diagonal junction points of the bridge, a connection to ground between the pair of spaced resistances, one of the junction points being connected to one of the electron tubes and the other junction point connected to the other electron tube, and means to regulate the voltages applied to the electron tubes.

3. In a device for telegraphic signalling by using a radio frequency carrier, two generators of different radio frequencies, each of said generators having an electron tube connected thereto, each of said electron tubes having a suppressor grid, a Wheatstone bridge having three arms of equal resistance and a fourth arm having a portion of very high resistance in series with a very low resistance, a relay controlled by a telegraph apparatus, said relay when closed being connected to the bridge to short circuit the very high resistance, and when open to connect the very high resistance and the very low resistance in series, a pair of spaced resistances connected in series between diagonal junction points of the bridge, a connection to ground between the pair of spaced resistances, one of said junction points being connected to the suppressor grid of one of the electron tubes and the other junction point connected to the suppressor grid of the other electron tube, and a rectifier tube associated with the bridge to regulate the voltages applied to the suppressor grids.

4. In a device for telegraphic signalling by using a radio frequency carrier, two generators of different radio frequencies, a first electron tube connected to one of the generators and having a suppressor grid, a second electron tube connected to the other generator and having a suppressor grid, a Wheatstone bridge having three arms of equal resistance and a fourth arm having a portion of very high resistance in series with a portion of very low resistance, a relay controlled by a telegraph apparatus, said relay being connected to the bridge to short circuit the very high resistance when closed and placing said very high resistance and very low resistance in series when open, a line having spaced resistances in series connected between diagonal junction points of the bridge, the line being grounded at a point between said resistances, one end of the line being connected to the suppressor grid of the first tube and the other end of the line being connected to the suppressor grid of the other tube, and a rectifier tube associated with the bridge to regulate the voltages applied to the suppressor grids.

5. In a device for telegraphic signalling by using a radio frequency carrier, two generators

of different radio frequencies, each of said generators having an electron tube connected thereto, a Wheatstone bridge having three arms of equal resistance and a fourth arm having a portion of very high resistance in series with a very low resistance, a relay controlled by a telegraph apparatus, said relay when closed being connected to the bridge to short circuit the very high resistance and when open to connect the very high resistance and the very low resistance in series, and connections from points on the bridge to said tubes so that when one tube is operating the other tube is inoperative.

6. A device for continuous wave signalling, comprising: first frequency generator means including a tube having cathode, grid and plate elements; second frequency generator means including a tube having cathode, grid and plate elements, the frequencies of said generator means being different but not substantially so; a Wheatstone bridge having three arms of fixed impedance and a fourth arm of variable impedance; control means for varying said variable impedance; a direct current source connected to two opposite corners of said bridge to energize it; a connection between the third corner of said bridge and an element of said first generator means tube; and a connection between the fourth corner of said bridge and an element of said second generator means tube, so that when one tube is operating the other tube is inoperative.

7. A device for continuous wave signalling, comprising: first frequency generator means including a tube having cathode, grid and plate elements; second frequency generator means including a tube having cathode, grid and plate elements, the frequencies of said generator means being different but not substantially so; a Wheatstone bridge having three arms of fixed resistance and a fourth arm having a resistance higher than that of its associated arm; switch means adapted to be closed to short at least sufficient of the resistance of the fourth arm to reduce the resistance of that arm below that of its associated arm; a direct current source connected to two opposite corners of said bridge to energize it; resistance means connected between the other two opposite corners of said bridge; a connection between one of said other two opposite corners and an element of said first generator means tube; a connection between the other of said other two opposite corners and an element of said second generator means tube; and a common return from the cathodes of both of said tubes to an intermediate point on said resistance means, so that when one tube is operating the other tube is inoperative.

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