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ELECTRONIC KEYING DEVICE

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Fig. 1.

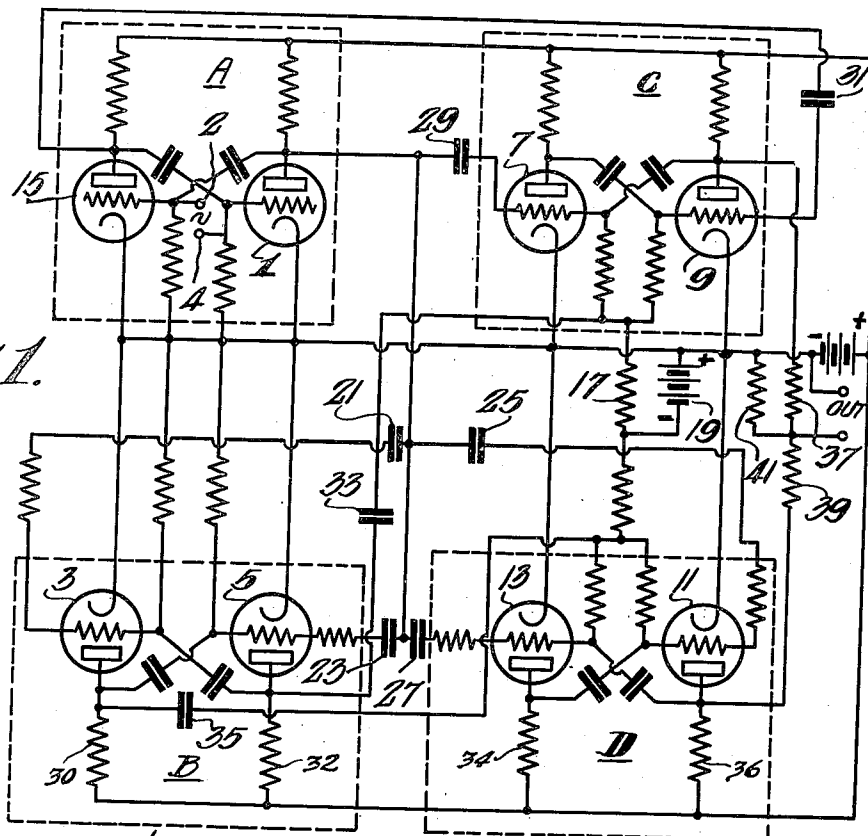
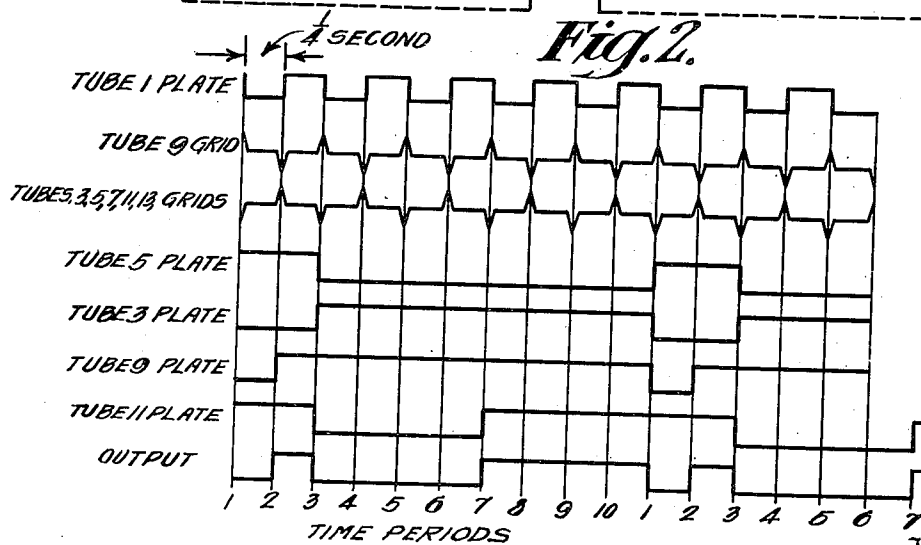


Fig. 2.



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ELECTRONIC KEYING DEVICE

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Application December 28, 1940, Serial No. 372,205

11 Claims. (Cl. 178—66)

This invention relates to electronic keying devices, and has for its principal object the provision of an improved vacuum tube circuit for keying a radio range of the A-N type. It is a further object of this invention to provide an electronic keying system which employs a minimum number of tubes. A still further object of this invention is to provide means for controlling the operation of a radio range by a keying system which requires no moving parts, and which is operated entirely by means of vacuum tubes.

In a copending application Serial No. 372,206, filed Dec. 28, 1940, I have described a thermionic keyer which may also be used for the above named purpose. In my copending application, I derive a series of timing impulses from synchronized multivibrators, and utilize the derived impulses to control an electronic toggle switch. In accordance with the present invention, however, the above objects are obtained by utilizing a pair of multivibrators to produce symmetrical square wave oscillations of different frequencies, and controlling the nonoperative and operative periods of oscillation of the two multivibrators by an unsymmetrical voltage derived from a third multivibrator, the entire system being synchronized by a timing voltage which may be derived from commercial power lines or other suitable source of constant frequency.

This invention will be better understood from the following description when considered in connection with the accompanying drawing in which Figure 1 is a schematic diagram of a preferred embodiment of my invention, and Figure 2 is a chart, the various curves of which represent the voltages at various parts of the circuit for explaining its operation.

Referring to Fig. 1, A, B, C and D are four conventional multivibrators, each of which employs a pair of triode vacuum tubes having their plate and grid electrodes cross-connected in the conventional manner.

Multivibrator A is the synchronizing multivibrator and its circuit constants are selected in the well known manner so that the output voltage on the plate of tube 1, for example, is a symmetrical square wave having a period of oscillation equal to one-half second. In order to insure the highest degree of accuracy, this multivibrator may be controlled by a square wave or sine wave voltage of corresponding frequency derived from a mechanical vibrator, or from a frequency divider coupled to the power line. The method of controlling the operation of a multi-

vibrator is well known to those skilled in the art and need not be described herein in detail. Terminals 2 and 4, connected to the grids of the multivibrators, respectively, are provided for applying such a synchronizing voltage. The voltage appearing on the plate of tube 1 is illustrated in the first curve of Fig. 2. It will be appreciated that the voltage appearing at the plate of the other multivibrator tube will be similar to this voltage but in phase opposition thereto.

Multivibrator B produces an unsymmetrical wave the period of which is equal to two and one-half seconds. The ratio of the time duration of the first portion of each cycle to the remaining portion, known as the dissymmetry ratio, is 1 to 4. By making plate resistor 30 slightly larger than plate resistor 32, upon the simultaneous application of equal negative impulses tube 3 will always become conductive before tube 5, thus assuring the proper phasing of the output voltages, and preventing the dissymmetry ratio from becoming reversed. The voltage produced at the plate of tube 3 of multivibrator B is shown in the fifth curve of Fig. 2, while the voltage appearing at the plate of tube 5 of the multivibrator B is shown in the fourth curve of Fig. 2. It will be observed that the output voltages of tubes 3 and 5 are of similar wave shape and time duration, but of opposite phase.

Multivibrator C is designed to operate at the same frequency as multivibrator A and produces a symmetrical output. The grid return of the two tubes 7 and 9 constituting this multivibrator is made through a resistor 17 and a battery 19 the polarity of which is such that an initial negative biasing potential is applied to the two tubes 7 and 9 which normally prevents their operation. These tubes therefore remain inactive until an unbiasing voltage is superimposed on their grid electrodes.

Multivibrator D is designed to produce a symmetrical square wave output whose period is two seconds but, like multivibrator C, battery 19 supplies an initial negative biasing potential to the grids of the tubes 11 and 13 which normally prevent their operation. As in the case of multivibrator B, proper phasing of the output voltages is assured by making plate resistor 36 slightly larger than plate resistor 34. Thus tube 11 always conducts first when simultaneous negative impulses are applied to the two tubes.

The grid electrodes of the two tubes of multivibrator B are coupled through differentiating capacitors 21 and 23 to the plate circuit of tube 1 of multivibrator A. The grid electrodes of the

tubes 11 and 13 of multivibrator D are also coupled through differentiating capacitors 25 and 27 to the plate electrode of tube 1. As a result, voltages are impressed on the grid electrodes of the four tubes which are represented by the third curve of Fig. 2, this voltage being derived from the first curve of Fig. 1 in the well known manner. The grid of tube 7 of multivibrator C is also coupled through a differentiating capacitor 29 to the plate of tube 1 but the grid of tube 9 is coupled through a differentiating capacitor 31 to the plate of the tube 13 of multivibrator A. The grid of tube 9 is therefore impressed with a voltage of the type illustrated in the second curve of Fig. 2, while the grid of tube 7 corresponds to the third curve since the voltages on the plates of the two tubes of multivibrator A are in phase opposition.

The plate of tube 5 of the biasing multivibrator B is coupled through a large capacitor 33 to both grids of multivibrator C. The plate of tube 3 of the biasing multivibrator B is coupled through a large capacitor 35 to the grids of the tubes 11 and 13 of the multivibrator D. The time constants of the two last mentioned circuits are such that the voltages present on the plates of the multivibrator B are impressed on the grids of the corresponding multivibrators C and D.

The operation of this circuit will now be explained. It is a characteristic of all multivibrators that current can flow in only one of the two tubes at any given instant. That is, the voltage drop in the plate impedance of tube 3, for example, produced by a flow of current in the cathode-anode circuit of that tube applies a negative impulse to the grid of tube 5 which biases it beyond cut-off and prevents its operation. At a time later, determined by the time constant of the circuits, the negative charge on the grid of tube 5 leaks off, the tube begins to draw plate current, and the resultant drop in the potential of its plate in turn biases off tube 3.

Assuming, therefore, that at some instant, corresponding to a time just before time period 1 of curve, that tube 5 is conducting, and that its plate voltage, with respect to the cathode, is therefore a minimum, the first negative impulse applied to the grid of tube 5 at the time period 1 will bias off this tube, causing its plate voltage to approach the B battery potential. At the same time the plate voltage at tube 3 drops suddenly as this tube begins to conduct. These changes are illustrated in the curves corresponding to the grid and plate voltage of the tubes 3 and 5 of Fig. 2.

A quarter second later at time period 2 conditions are unchanged since the normal time period of this multivibrator is such that the negative charge applied to the grid of tube 5 has not yet leaked off. At time interval 3, however, a second negative impulse arrives at the grids of tubes 3 and 5. This impulse has no effect on tube 5 since its grid is already negative. The grid of tube 3, however, is driven negative causing its plate voltage to rise suddenly and also applying a positive impulse to the grid of tube 5 which makes the latter tube draw current and its plate voltage drop to a minimum value. As indicated above, the normal oscillatory period of multivibrator B is two and one-half seconds; and that it is normally unsymmetrical. Successive impulses from multivibrator A on the grids of multivibrator B

have no effect, therefore, until such time as the last applied potential is reduced to a value comparable to that of the control impulses reaching its grid. Thus at the next time interval 4 a negative impulse causes the tube 5 to go to cut-off, and the cycle is repeated.

The two out of phase voltages appearing on the plates of tubes 3 and 5 are applied to the grids of multivibrators C and D. The amplitudes of these voltages are such that the initial bias of the battery 19 is overcome sufficiently to permit the multivibrators C and D to operate when the control bias is of the proper polarity. Just prior to time interval 1, therefore, tube 3 of multivibrator C is biased to cut-off and its plate voltage is a maximum. As shown in the fourth and sixth curves of Fig. 2, at time interval 1, the plate voltage of tube 5 becomes positive, and since this voltage is applied to the grids of multivibrator C the initial negative bias of battery 19 is overcome. At the same instant a positive impulse from multivibrator A is applied to the grid of tube 9, see curve 2, so that the tube begins to draw plate current and its plate voltage approaches cathode potential. The normal time of oscillation of multivibrator C is a half second. Consequently, at time interval 2, a quarter second later, a negative impulse is applied to the grid of tube 9, and a corresponding positive impulse to the grid of tube 7, so that plate current stops in tube 9 and its voltage becomes more positive. At time interval 3 the normal oscillatory period of multivibrator would normally produce another reversal of plate current. However, at this instant the positive bias from the plate of tube 5 of multivibrator B is removed from the grid of tube 9 so that tube 9 can no longer oscillate and its plate voltage remains at its maximum positive potential. Since the biasing is not applied until the succeeding time interval 4 no further alternations take place until the cycle repeats itself in the same manner.

Multivibrator D is similarly controlled by a biasing potential derived from the plate of tube 3. At time interval 1 the positive bias from multivibrator is removed and the initial negative bias produced by battery 19 prevents oscillation so that the plate voltage of tube 11 is a maximum. This condition continues until time interval 3 at which time a positive voltage is applied from the plate of tube 3, the effect of which is to start multivibrator D oscillating at its natural period. Thus at time interval 4 a negative impulse on the grid of tube 11 causes an alternation to take place, tube 13 becoming conductive, and plate voltage of tube 11 going to its maximum value. At the next time interval 5 the tube would normally reverse again. However, at this instant the positive bias from the plate of tube 3 is removed thus stopping oscillation so that the plate voltage remains at its maximum value and the cycle is then repeated.

Output is derived by adding the voltage appearing on the plate of tube 9 and the voltage appearing on the plate of tube 11 through a pair of resistors 37 and 39 which are connected to the system through a low impedance resistor 41. The purpose of this is to prevent interaction between the circuits. The voltage appearing at the output terminals is therefore the sum of the voltages on the plates of tubes 9 and 11, illustrated in the sixth and seventh curves of Fig. 2, respectively, and is indicated in the eighth curve

of the figure. It will be observed that the output voltage is a D. C. voltage upon which is superimposed a square wave dash-dot corresponding to the letter N of the international code. In reverse polarity this output voltage also produces the letter A of the international code. It will be observed that the length of the dash is four times the length of the dot, that the spacing between the dash and the dot is equal to the length of the dot, and that the spacing between successive groups is equal to the length of the dash. The keying signal is therefore in strict accordance with the conventional practice.

While this invention has been described in an embodiment suitable for keying radio ranges in A-N sequence, it is to be understood that the system is also applicable to E-T keying or for the production of any other code letters which may be desired. Various modifications of the particular circuit will occur to those skilled in the art, and the present invention is not limited to the particular circuit shown but only by the prior art and the scope of the appended claims.

I claim as my invention:

1. An electronic keying device comprising means for producing high and low frequency symmetrical square waves, means for producing unsymmetrical square waves, means for applying said unsymmetrical square waves to control the inoperative and operative periods of said symmetrical wave producing means, means for deriving output voltages from said symmetrical wave producing means, and means for combining said derived output voltages.

2. An electronic keying device comprising means for producing high and low frequency symmetrical square waves whose periods are related in a ratio of 1:4, means for producing a first unsymmetrical square wave whose period is 5 times that of said high frequency wave, and having dissymmetry ratio of 1:4, means for producing a second unsymmetrical square wave in phase opposition thereto, respectively, means for applying said unsymmetrical square waves to control the inoperative and operative periods of said symmetrical wave producing means, means for deriving output voltages from said symmetrical wave producing means, and means for combining said derived output voltages to produce a resultant voltage equal to their sum.

3. A device of the character described in claim 1 which includes, in addition, means for synchronizing said symmetrical and said unsymmetrical square waves.

4. An electronic keying device comprising first square wave generating means, second square wave generating means, means for applying

initial biasing voltages to said generating means, means for applying opposing biasing voltages alternately to said generating means whereby square wave oscillations are produced by said generating means alternately, and means for combining said alternately generated wave oscillations to produce a keying signal.

5. An electronic keying device comprising a pair of multivibrators, means for initially biasing said multivibrators, means for producing biasing voltages of opposite polarity, means for applying said biasing voltages to said multivibrators so as to oppose said initial bias and control the operating periods of said multivibrators, and means for producing an output voltage determined by the sum of the voltages produced by said multivibrators.

6. A device of the character described in claim 5 which includes means for synchronizing said multivibrators and said bias producing means.

7. An electronic device comprising first generating means for producing rectangular waves of different frequencies, biasing means normally maintaining said generating means in an inoperative condition, other generating means for producing controlling voltages which oppose said biasing means and control the off-and-on periods of said first generating means, and means for producing output voltages from said first generating means, and means for producing a resultant voltage equal to the sum of said output voltages.

8. An electronic device for producing complementary A-N keying signals comprising separate square wave generating means, biasing means for normally maintaining said generating means in an inoperative condition, a source of separate voltages which oppose said biasing means and control the off-and-on periods of said generating means, and means for combining the output voltages of said generating means to produce a resultant equal to their sum.

9. A device of the character described in claim 7 in which said first generating means comprises two multivibrators whose frequencies are related in the ratio of 4:1.

10. A device of the character described in claim 7 in which said other generating means includes a multivibrator for producing unsymmetrical output voltages whose dissymmetry ratio is 1:4.

11. A device of the character described in claim 7 in which said first generating means comprises two multivibrators whose frequencies are related in the ratio of 4:1, and in which said other generating means includes a multivibrator for producing unsymmetrical output voltages whose dissymmetry ratio is 1:4.

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