Aug. 8, 1950 H. BEECHER 2,517,538

ELECTRONIC KEYING DEVICE

Filed May 3, 1946 4 Sheets-Sheet 1

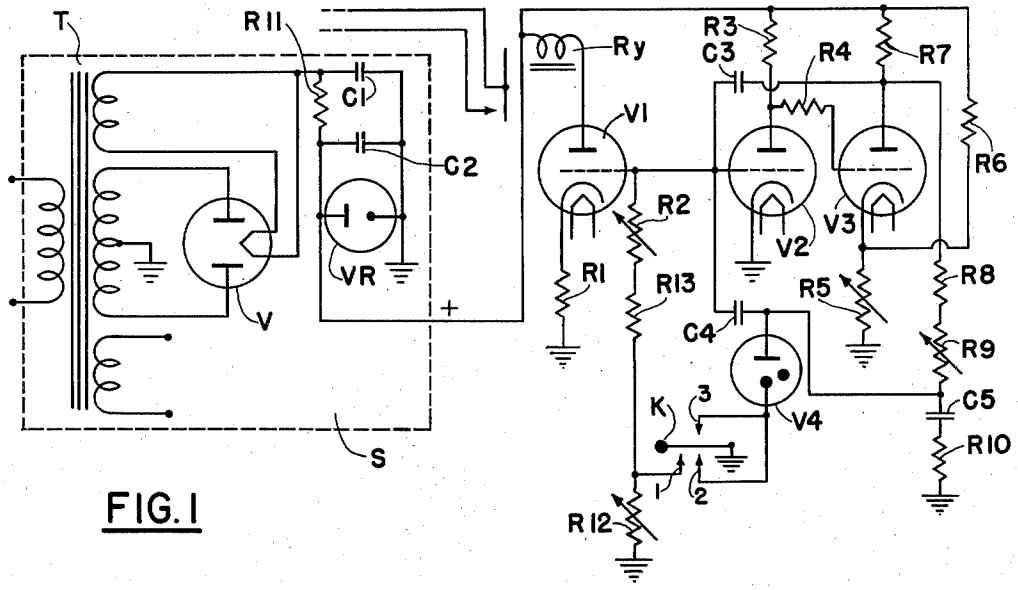


FIG. 1

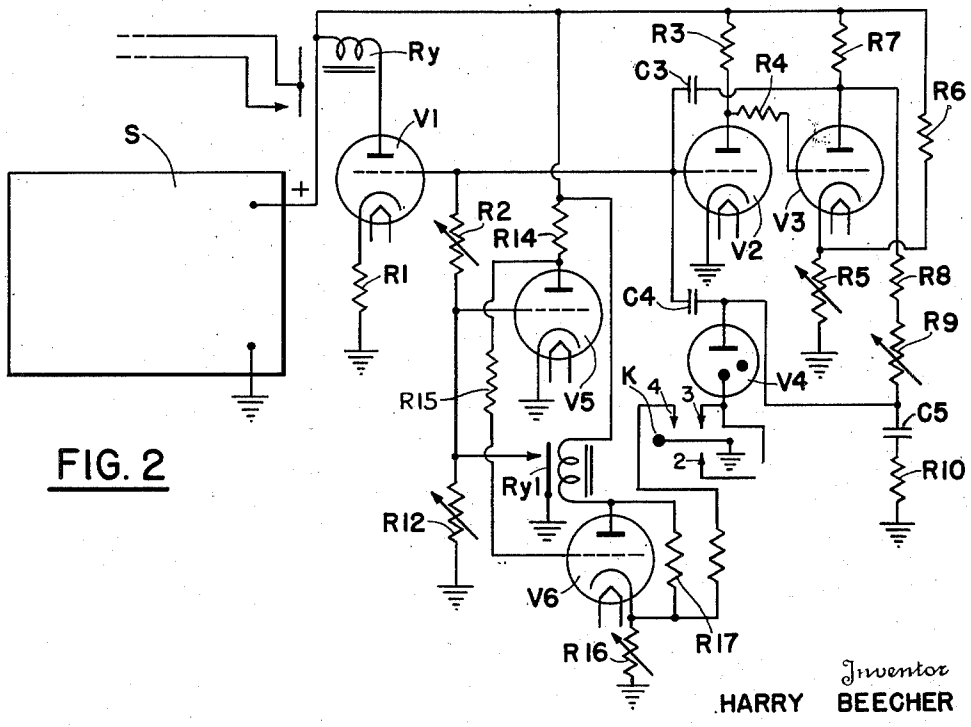


FIG. 2

Inventor
HARRY BEECHER

By

Attorney

Aug. 8, 1950 H. BEECHER 2,517,538

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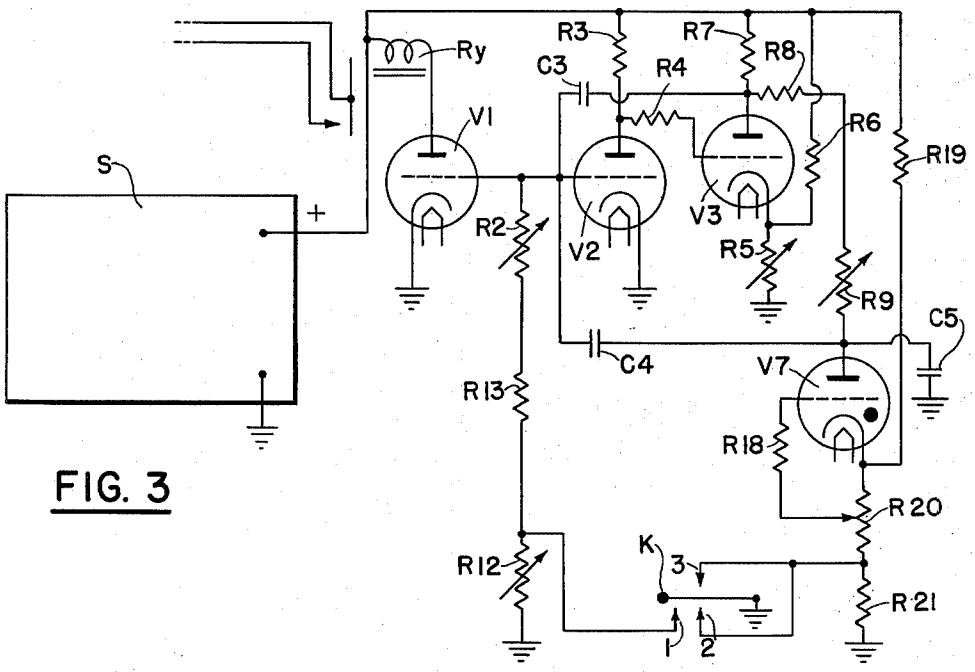


FIG. 3

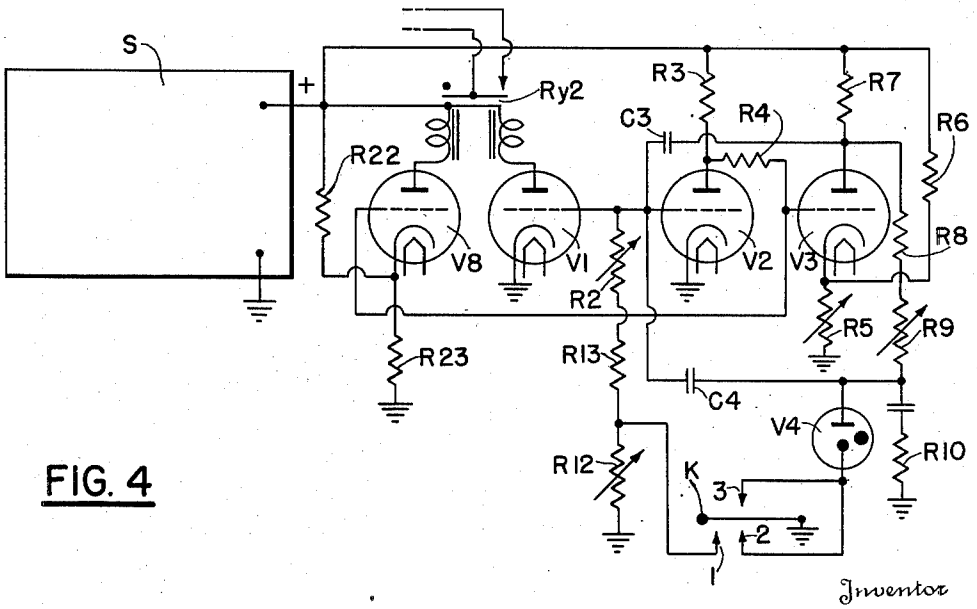


FIG. 4

Inventor
HARRY BEECHER

By M. O. Hayes

Attorney

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ELECTRONIC KEYING DEVICE

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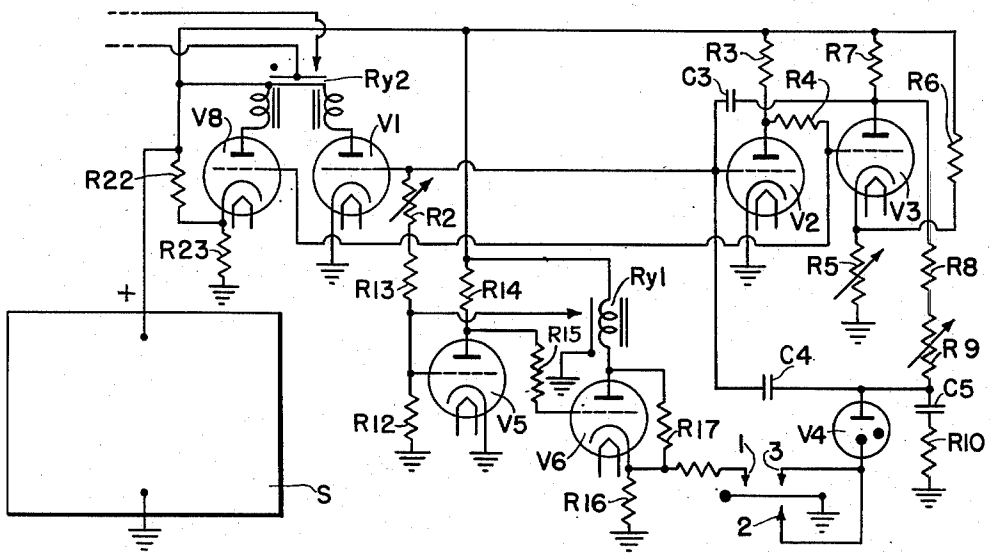


FIG. 5

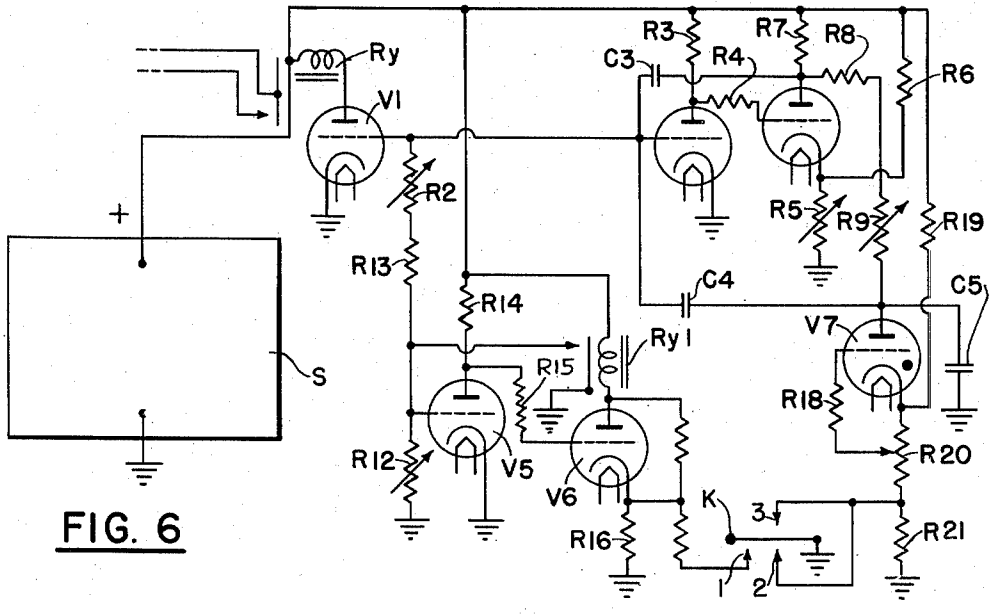


FIG. 6

Inventor
HARRY BEECHER

By M. A. Hayes

Attorney

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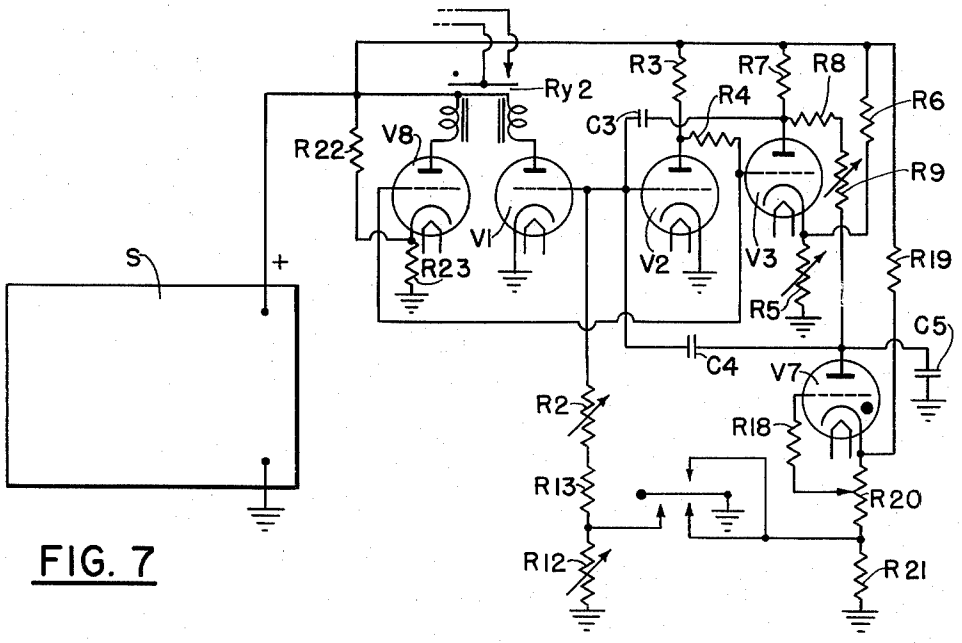


FIG. 7

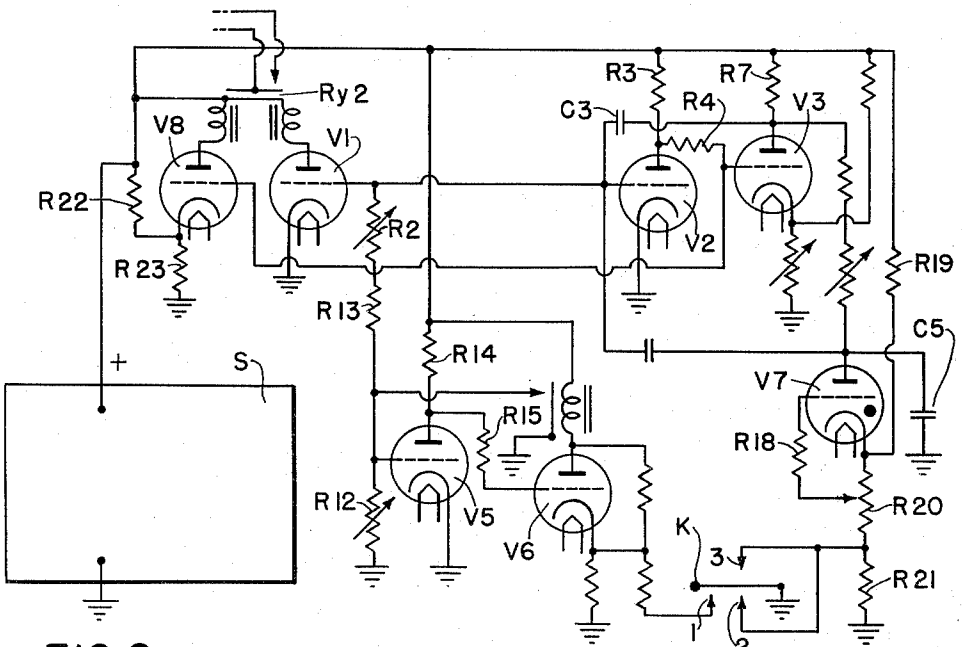


FIG. 8

Inventor
HARRY BEECHER

By

Attorney

Patented Aug. 8, 1950 2,517,538

UNITED STATES PATENT OFFICE

2,517,538

ELECTRONIC KEYING DEVICE

Harry Beecher, United States Coast Guard

Application May 3, 1946, Serial No. 666,946

14 Claims. (Cl. 178—82)

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

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My invention relates to keying systems and particularly to systems for automatically forming a dot, a dash or a succession of dots and dashes properly spaced in response to manipulation of a manually-operated key or equivalent.

In accordance with my invention, the mark and space impulses utilized in keying are produced by a multivibrator which is triggered by an oscillation generator, preferably a relaxation oscillator, controlled by a manually-operated, or other type, key. More particularly in accordance with my invention, the time-constants of the multi-vibrator are selected to produce dots or dashes concurrently with movement of the key which initiates operation of the oscillator.

Further in accordance with my invention, the keying impulses are applied to a relay which is isolated from the multi-vibrator by an electronic tube or tubes directly coupled to the multi-vibrator: in some modifications particularly suited for high-speed keying, the relay is of polarized type having windings in the anode circuits of tubes respectively concurrently receiving both positive and negative pulses from the multi-vibrator.

Further in accordance with some forms of my invention, to ensure proper length of the mark impulses, there are provided electronic hold-in circuits whose operation is initiated by operation of the key and which are effective, despite subsequent change in position of the key, until the multi-vibrator has completed a mark impulse of predetermined duration.

My invention further resides in features of combination and arrangement hereinafter described and claimed.

For an understanding of my invention and for illustration of various embodiments thereof, reference is made to the accompanying drawing in which:

Fig. 1 is a circuit diagram of the basic system.

Figs. 2 to 8 inclusive are circuit diagrams each illustrating a modification of the system shown in Fig. 1.

Referring to Fig. 1, the relay R*y*, whose contacts effect keying of a radio transmitter or other signal source, is included in the anode circuit of the keying tube V1 whose control electrode or grid is connected to the control electrode of tube V2 which together with tube V3 is comprised in a multi-vibrator circuit triggered by a relaxation oscillator circuit comprising the gaseous discharge tube V4, the condenser C5 and resistance R10.

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Assuming the movable contact of key K has been in neutral position for appreciable time, the following conditions obtain: the anode current of tube V1, as determined by its grid bias derived from resistor R1, sufficiently energizes relay R*y* to hold its keying contacts open: tube V2 is also conductive since at this time no current is flowing through resistors R2, R12 and R13 in circuit between the control grid and cathode of that tube: tube V3 is not conductive because its negative grid-biasing potential, derived from resistor R5 of the voltage-divider network R5, R6, is sufficient to overcome the positive potential applied to the grid through resistor R4: and the condenser C5 is charged to a potential suitably above the ionization potential of the discharge tube V4 at this time in an open-circuit.

When the movable contact of key K is moved from neutral position to engage contact 2 or 3, the condenser C5 discharges practically instantaneously through tube V4 and resistance R10 which is included in the circuit to limit the peak discharge current to magnitude which does not damage tube V4. This sudden discharge of condenser C5 produces a brief pulse applied through condenser C4 to grids of tubes V1 and V2. The pulse is of negative polarity and therefore cuts off flow of anode current in tubes V1 and V2. Moreover tube V2 amplifies and inverts the pulse applying it as a larger positive pulse to the control grid of tube V3 which in turn reinverts the pulse and applies it through condenser C3 as a highly amplified negative pulse to the grids of tubes V1 and V2. In consequence of this regenerative action, the relay current is abruptly terminated or abruptly reduced well below contact-holding magnitude and the keying contacts of relay R*y* therefore sharply move to closed circuit position to start a "mark" period. By virtue of the highly positive bias now applied to its grid, the tube V3 passes maximum plate current.

The negative charge applied to the grids of tubes V1 and V2 leaks off through a path including resistors R2, R13 and R12 if the key is in "dash" position or through a path including resistors R2, R13 if the key is in "dot" position. In the latter position, the resistor R12 is shunted out of the leakage path through a circuit including contact 1 of the key.

The "mark" period, or period of closure of the relay contacts, continues until the negative charge of condenser C3 falls below cut-off at which time tube V2 starts to conduct current causing the grid of tube V3 to become less positive. The resulting amplified positive pulse is applied to the grids of tubes V1 and V2, and in

effect the remaining negative charge is practically instantaneously nullified with result the relay current is abruptly increased and the relay contacts sharply and cleanly separate to start a "space."

The tubes V1 and V2 are now conducting and tube V3 is cut off and the condenser C5 recharges through the resistors R7, R8 and R9.

If the key is held closed, the tube V4 fires when the condenser voltage rises to the ionization potential of the gas and another "mark" starts, the above sequence repeating so long as the key is held closed thus automatically to form a succession of dots or dashes of predetermined length and at regular intervals.

The proper or desired length of the "space" intervals for a given speed of transmission may be attained by variation of resistance R9 which jointly with resistance R7, R8 and capacitance C5 determine the charging time required to restore the potential applied to tube V4 to magnitude effecting ionization. With the key closed on the "dot" side, resistor R2 may be varied to attain the desired length of the dots and with the key closed on the "dash" side, resistor R12 may be varied to attain the desired length of the dashes.

With the usual straight or "bug" keys, most operators have difficulty in holding the dashes for like, precise lengths. With the keying system above described, a complete dot or dash may be made by merely hitting the key lever to make momentary contact on the dot or dash side. Moreover, improperly shortened spacing between the dots or dashes of a character cannot be made because another "mark" cannot be started until there has intervened a "space" corresponding with the charging time of condenser C5.

The keying system described may be supplied from any source of suitably constant voltage; for example, the output voltage of a conventional filter-rectifier system S may be stabilized by a regulator tube VR. Because of low current demand, the filter system may be a simple resistance-capacity filter comprising condensers C1, C2 and resistor R11.

By way of example, there are given below circuit constants and components which have been successfully used:

V1—6SN7GT tube (one section)
V2—6SN7GT tube
V3—6SN7GT
V4—991 midget neon voltage-regulator tube
VR—VR-105 tube
R1—1000 ohms
R2—75,000 ohms
R3—150,000 ohms
R4—250,000 ohms
R5—20,000 ohms
R6—15,000 ohms
R7—20,000 ohms
R8—50,000 ohms
R9—250,000 ohms
R10—100 ohms
R12—500,000 ohms
R13—30,000 ohms
Ry—Ward Leonard relay type 507-543.

The modification shown in Fig. 2 is the same as that of Fig. 1 with addition of tubes V5, V6, relay Ry 1 and associated components hereinafter listed. Except for features hereinafter described, the operation of this keying system is essentially the same as that of Fig. 1.

With the key in either neutral or dot position,

the tube V5 is fully conducting, tube V6 is substantially non-conducting and the contacts of relay Ry 1 are held closed as by a biasing spring. Current through tube V6 is cut off because the positive biasing voltage applied to its control grid through resistance R15 is, under the stated circumstances, nullified by the negative bias derived from the resistor R16 in the divider network including it and the resistor R17.

When the key is moved to the "dash" side, the contact 4 is engaged to reduce the negative bias of tube V6 and so permit flow of current through relay Ry 1 of magnitude sufficient to open its contacts and so open the short circuit across resistance R12. When as previously described, there is, during the mark period, flow of current through resistor R12, the resulting voltage drop applied as negative bias to the control grid of tube V5 cuts off the anode current resulting in increase of the positive bias applied through resistors R14 and R15 to the grid of tube V6 thus ensuring the contacts of relay Ry 1 remain open for the dash period even though the key is prematurely moved away from the dash position. At conclusion of the dash period, if the key is then away from the dash position, all circuits return to their original condition.

It is characteristic of the modification shown in Fig. 2 that both dots and dashes continue for proper length even though the key is merely hit momentarily to close the dot or dash contacts and that there is no dependence upon the mechanical sluggishness of a spring contact (contact 1 of Fig. 1) during the dot period.

By way of example, there are listed below additional circuit constants and components used in this modification:

V5—6SF5 tube
V6—6SN7GT (one section)
R14—250,000 ohms
R15—250,000 ohms
R16—75,000 ohms
R17—15,000 ohms

The keying system of Fig. 3 is generally the same as that of Fig. 1 except that the relaxation oscillator utilizes a thyratron instead of two element gaseous discharge tube.

The voltage divider network R19, R20 and R21 provides sufficient negative bias for the control grid of thyratron tube V7 to cut off the anode current at the peak charging voltage of condenser C5. The resistor R18 for substantially eliminating grid emission may be omitted when the peak anode voltage is sufficiently low.

With the key in dot or dash position, the resistor R21 is shunted out through a circuit including the key contacts 2 or 3. Accordingly the grid-biasing voltage is reduced to such extent that the tube V7 momentarily conducts or fires to discharge the condenser C5. From this point on, the automatic action of the keying system is the same as described in connection with Fig. 1.

An advantage of this modification is that higher values of anode supply voltage may be used so permitting use of less sensitive relays.

By way of example, there are listed below circuit constants and components added in Fig. 3.

R18—50,000 ohms
R19—15,000 ohms
R20—2,000 ohms
R21—200 ohms
V7—844 or similar thyratron tube.

Except for particular features herein specifically discussed, the keying system shown in Fig.

4 is similar to that of Fig. 1. The principal difference is the substitution of a polarized relay R*y*2 for the relay R*y* and the addition of tube V8 whose control grid is connected to the control grid of tube V3 of the multivibrator and in whose anode circuit is included one of the windings of the relay R*y*2. The other relay winding is included in the anode circuit of tube V1 as in Fig. 1.

With the key open and during space periods with the key closed in either position, the tube V1 is conducting and tube V8 non-conducting. Under these circumstances, the relay contacts are in open-circuit position. During mark periods, the negative control-grid bias of tube V8, derived from resistors R22 and R23 is nullified by the positive potential appearing at the control grid of tube V3. At the same time, tube V1 becomes non-conducting due to the negative potential then existing on its grid. Accordingly, the relay coils in circuit with V8 and V1 become energized and de-energized respectively jointly to effect circuit-closing movement of the relay contacts.

This system is particularly suited for high speeds of transmission because of the positive action of the relay contacts.

The keying system shown in Fig. 5 is generically the same as that shown in Fig. 1 modified to include the features of the keying systems of both Figs. 2 and 4 and its operation need not therefore be specifically described.

The keying system shown in Fig. 6 is generically the same as that shown in Fig. 1 modified to include the features discussed in connection with Figs. 2 and 3. Its operation therefore need not be specifically described.

The keying system shown in Fig. 7 is generically the same as that shown in Fig. 1 modified to include the features discussed in connection with Figs. 3 and 4. Reference is made to description of the operation of those systems for understanding of the operation of Fig. 7.

The keying system shown in Fig. 8 is generically the same as that shown in Fig. 1 modified to include features discussed in connection with Figs. 2, 3 and 4. Consequently, it is not necessary here to describe the operation of Fig. 8.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

What is claimed is:

1. An electronic keying system comprising a keying tube having a control electrode, a multivibrator directly coupled to said control electrode, an oscillator, said oscillator being adapted to trigger said multivibrator and said keying tube, and keying means for initiating said oscillator whereby mark and space impulses are applied to said control electrode.

2. An electronic keying system comprising a keying tube having a control electrode, a multivibrator directly coupled to said control electrode, an oscillator, said oscillator being adapted to trigger said multivibrator thereby applying mark and space impulses to said control electrode, said multivibrator including impedances selectively to afford mark impulses of different predetermined length, and keying means for said oscillator operable concurrently to initiate operation thereof and to select the multivibrator impedance affording desired length of mark impulse.

3. An electronic keying system comprising a keying tube having a control electrode, means for producing mark and space impulses applied to said control electrode comprising a multivibrator directly coupled to said control electrode and an oscillator directly coupled to said multivibrator, and keying means for initiating said oscillator and selectively determining the length of the mark impulses.

4. An electronic keying system comprising a keying tube having a control electrode, and means for providing mark and space impulses applied to said control electrode comprising a multivibrator and a relaxation oscillator coupled thereto, said multivibrator being directly coupled to said control electrode and adapted to be triggered by said relaxation oscillator, and keying means for said oscillator.

5. An electronic keying system comprising a keying tube having a control electrode, a multivibrator directly coupled to said control electrode, an oscillator, said oscillator adapted for triggering said multivibrator thereby applying mark and space impulses to said control electrode, a keying means for initiating said oscillator and selecting mark impulses when said keying means is operable from neutral position to dot or dash position, a multivibrator impedance for determining the duration of the mark impulses, a first tube having a shorting relay in its output circuit to short out said multivibrator impedance when said relay is deenergized, said first tube having a control electrode whose bias is changed by the actuation of said keying means to dash position thereby effecting energization of said relay to remove the short circuit of said multivibrator impedance, and a second tube responsive to completion of a dash impulse for varying the bias on said first tube to effect deenergization of said relay provided said keying means is away from the dash position.

6. An electronic keying system comprising a keying tube having a control electrode, a multivibrator directly coupled to said control electrode, a gaseous discharge tube and reactance-resistance network, said discharge tube generating triggering impulses for said multivibrator for producing mark and space impulses applied to said control electrode, and a keying means for initiating said discharge tube and operable to one position completing a circuit including said discharge tube for generation of mark impulses of dash length and operable to another position for completing a circuit including said discharge tube and in addition to modify the circuit constants of said multivibrator for generation of mark impulses of dot length.

7. An electronic keying system comprising a keying tube having a control electrode, a multivibrator directly coupled to said control electrode for producing mark and space impulses applied to said control electrode, means for generating triggering impulses for said multivibrator comprising a resistance-reactance network and a discharge circuit therefore including a tube having a control electrode, and a key operable to one position for varying the potential of said last-named control electrode for generation of mark impulses of dash length and to another position in addition to modify the circuit constants of said multivibrator for generation of mark impulses of dot length.

8. A keying system comprising a keying relay, means for producing mark and space impulses, said means comprising a multi-vibrator and an oscillator coupled thereto, a keying tube having a control electrode to which said impulses are applied, said multivibrator being directly coupled

to said control electrode, and said keying tube having an output circuit including said relay, and keying means for controlling said oscillator and for selecting circuit constants of the multivibrator to determine the length of the mark impulses.

9. A keying system comprising a differential keying-relay, means for producing mark and space impulses, said means comprising a multivibrator and an oscillator coupled thereto, two keying tubes having windings of said relay in their respective output circuits and having control electrodes to which said impulses are applied in opposite polarities, each portion of said multivibrator being directly coupled to a different one of said control electrodes, and keying means for initiating said oscillator and for selecting circuit constants of the multivibrator to determine the length of the mark impulses.

10. A keying system comprising a differential keying-relay, means for producing mark and space impulses comprising a multi-vibrator and an oscillator coupled thereto, two keying tubes having windings of said relay in their respective output circuits and having control electrodes to which said impulses are applied in opposite polarities, each portion of said multivibrator being directly coupled to a different one of said control electrodes, and means for keying said oscillator and determining the length of the mark impulses comprising a key operable from neutral position to dot or dash position, a relay operable to change circuit constants of the multi-vibrator, a first tube having said relay in its output circuit and a control electrode whose bias is changed by actuation of said key to dash position to effect actuation of said relay in one sense, and another tube responsive to completion of a dash impulse for varying said first tube bias to effect actuation of said relay in reverse sense provided said key is away from dash position.

11. A keying system comprising a differential keying-relay, means for producing mark and space impulses comprising a multi-vibrator and an oscillator coupled thereto, said oscillator including a resistance-reactance network and an oscillator tube having a control electrode, two keying tubes having windings of said relay in their respective output circuits and having control electrodes to which said impulses are applied in opposite polarities, each portion of said multivibrator being directly coupled to a different one of said keying tube control electrodes, and keying means actuatable to dot or dash position to vary the potential of the control grid of said oscillator tube and concurrently to select circuit constants of the vibrator determining the length of the mark impulses.

12. A keying system comprising a differential keying-relay, means for producing mark and space impulses comprising a multi-vibrator and an oscillator coupled thereto, said oscillator including a resistance-reactance network and an oscillator tube having a control electrode, two keying tubes having windings of said relay in their respective output circuits and having control electrodes to which said impulses are applied in opposite polarities, each portion of said mulivibrator being directly coupled to a different one of said keying tube control electrodes, a relay operable to select circuit constants of the multivibrator determinative of the length of the mark impulses, a relay-control tube having said relay in its output circuit and a control electrode; said relay acting to short circuit the above mentioned circuit constant when the relay is deenergized, a key actuatable to dot position to vary the control-grid potential of the oscillator tube and actuatable to dash position to vary said control grid potential of the oscillator tube and also that of control-grid of the relay-control tube, and another tube responsive to completion of a dash impulse for varying in reverse sense the potential of the control grid of the relay-control tube provided said key is away from dash position.

13. An electronic keying system comprising keying means, a keying tube having a control electrode, a multivibrator directly coupled to said control electrode, an oscillator for triggering said mulivibrator, said keying means operating to initiate said oscillator to thereby apply mark and space impulses to said control electrode, and an oscillator for triggering said multi-vibrator, said oscillator including a capacitor charged through an impedance, said impedance determining the duration of the space impulse, and a gas-filled tube for discharging said capacitor through said keying means to initiate the mark impulse.

14. An electronic keying system comprising a keying tube having a control electrode, means for producing mark and space impulses applied to said control electrode comprising a multivibrator, said multivibrator being directly coupled to said control electrode, means for generating triggering impulses for said multi-vibrator comprising a gaseous discharge tube and a reactance-resistance network, and a key operable to either of two positions for adjusting the circuit constants of said multi-vibrator and completing circuits including said discharge tube for generating mark impulses of dash length and dot length respectively.

HARRY BEECHER.

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