Nov. 24, 1959 P. M. WRIGHT ET AL 2,914,669

ELECTRONIC SWITCHES

Filed Jan. 20, 1955 2 Sheets-Sheet 1

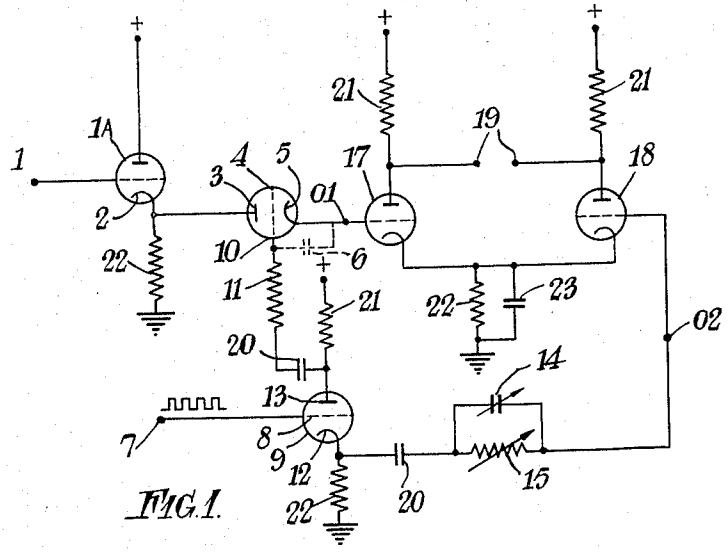


FIG. 1.

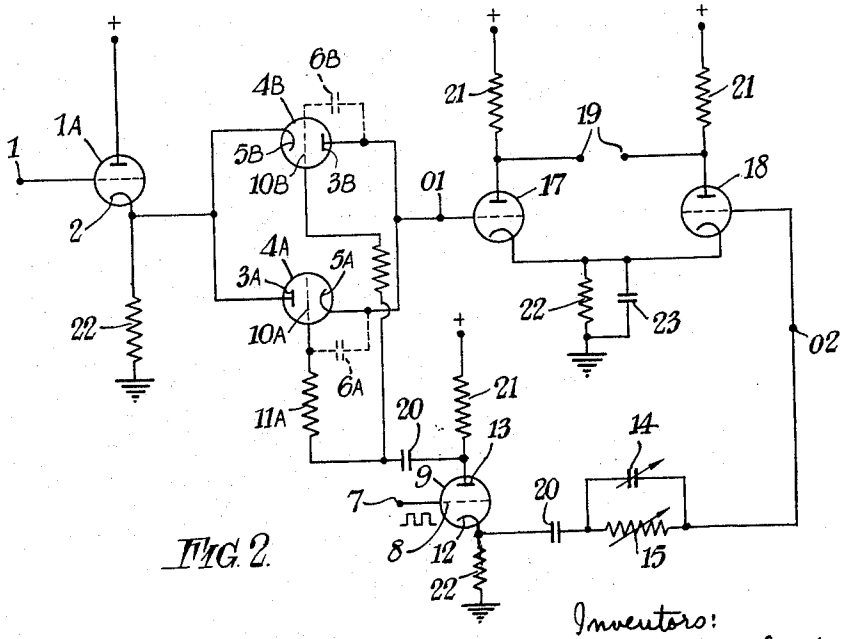


FIG. 2.

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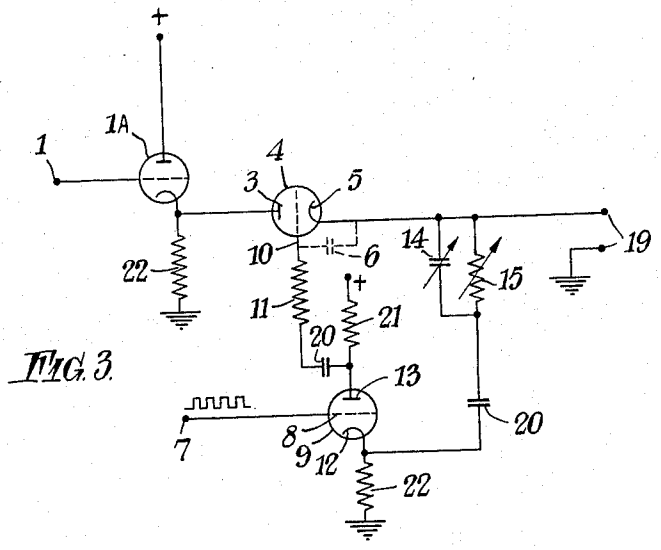


FIG. 3.

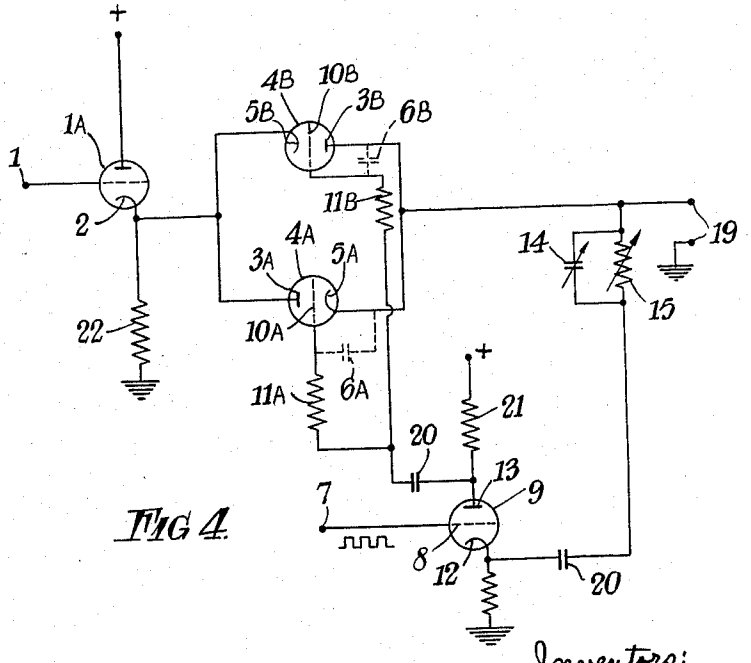


FIG 4.

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ELECTRONIC SWITCHES

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Application January 20, 1955, Serial No. 483,054

Claims priority, application Great Britain January 21, 1954

5 Claims. (Cl. 250—27)

This invention relates to electronic switches. A requirement which frequently arises in radar and other very high frequency techniques is that of providing a high speed switch capable of being actuated by a wave form of relatively high frequency and of such shape as to contain components of much higher frequency and which shall be such that, in all circumstances, the actuating circuit is substantially fully isolated from the switched circuit, the switch, when closed, being of low impedance and, when open, of very high impedance approximating to infinity. Thus, for example, it may be required to switch an ultra-high frequency circuit by means of an actuating rectangular wave form of, say 2.5 kc./s. By reason of the rectangular shape such a wave form will contain component frequencies of the order of 250 kc./s. The problem is then to provide a reasonably simple, cheap and reliable low impedance electronic switch capable of being actuated at 2.5 kc./s by this wave and which shall nevertheless be such that substantially no energy at any frequency comprised in the actuating wave form shall appear at any time in the switched circuit. In spite of the pressing need for such a switch there has been, so far as is known, no satisfactory solution yet of this problem.

According to the present invention there is provided a high speed low impedance electronic switch comprising a valve, means for applying an actuating voltage wave to said valve to render it alternately conductive and non-conductive, a switched circuit including the discharge space of said valve, means for producing a second voltage wave at substantially 180° phase relation to the actuating voltage wave, a balancing circuit fed with said second voltage wave, and means for combining voltage derived from said balancing circuit with voltage fed through said discharge space, said balancing circuit being so dimensioned that the voltage derived therefrom is substantially equal in amplitude to, and in phase opposition to, any components of actuating voltage wave fed through said discharge space, means being provided for taking off useful switched output from the switched circuit.

Preferably, the balancing circuit is of adjustable impedance and, in the simplest case, consists of an adjustable condenser.

For a better understanding of the invention and to show how the same may be carried into effect reference will now be made to the accompanying drawings, in which:

Fig. 1 shows an embodiment which will switch a wave of one sign only;

Fig. 2 shows an embodiment which will switch a wave of either sign; and

Figs. 3 and 4 show preferred simplified circuits which are modifications of the circuits of Figs. 1 and 2 respectively.

In Fig. 1, the input to be switched is applied at input terminal 1 to a valve 1A connected as a cathode follower and having its cathode 2 connected to the anode 3 of a valve 4 which acts as the switch proper. The cathode of this valve is connected to a point O1. The effective grid-cathode capacity of valve 4 is represented in broken lines

by the condenser 6. A switching voltage having a frequency of say 2.5 kc./s. and being of rectangular shape, is applied at input 7 to the grid 8 of a valve 9 and from the anode 13 thereof to the control grid 10 of the valve 4 to render the same alternately conductive and non-conductive. The lead to the grid of the valve 4 contains a suitable resistance 11. The voltage at the anode 13 of valve 9 will be at substantially 180° phase relation to that at the cathode 12 and the latter voltage is applied through a balancing circuit comprising condenser 14 and resistance 15 in parallel, both of which are preferably adjustable, to a second point O2. In practice resistance 15 is adjusted to balance resistance 11 (plus any conductive leakage there may be through the valve 9) and balancing condenser 14 to balance the condenser 6. The voltage between the output terminals is applied through an output stage comprising the two valves 17 and 18, to final output terminals 19. The condensers 20 are blocking condensers, the resistances 21 are anode load resistances, the resistances 22 are cathode return resistances and condenser 23 is a by-pass condenser. Properly adjusted and with a suitable low impedance valve for valve 4 this electronic switch gives excellent results operating as a high speed, high frequency low impedance switch with substantially no frequency components of the actuating wave present at any time in the output even for actuating frequencies as high as, and of the wave for, stated. The switch will obviously only "open" on alternate half waves of the switching frequency.

Referring to Fig. 2 which shows a modification which will allow the switched wave form to be of either sign, i.e., either positive or negative going, like references denote like parts in Figs. 1 and 2. The difference between the two figures is that the single valve 4 of Fig. 1 is replaced by two parallel connected, oppositely directed valves 4A, 4B. 6A is the grid cathode capacity of valve 4A and 6B is the grid-anode capacity of valve 4B. In this embodiment the balancing condenser 14 is adjusted to balance the sum of the capacities 6A and 6B and each grid 10A, 10B is fed through its own resistance 11A or 11B. The valves 1 and 17 are provided with conventional bias potentials to insure the correct operation thereof.

Figs. 3 and 4 are simplified modifications of Figs. 1 and 2 respectively the main difference being the omission of the valves 17, 18 and their associated circuits. As will be seen the far end of the balancing circuit 14, 15 is taken direct to one of the output terminals 19 and is fed from the cathode instead of from the anode of valve 9.

We claim:

1. A high-speed low impedance electronic switching arrangement comprising an input circuit and a switched circuit, a switched electronic valve having at least a cathode, a control electrode and an anode, connected with its cathode to anode discharge space in series between the input circuit and the switched circuit, a control valve having at least a cathode, a control electrode and an anode for controlling said valve, means for applying an actuating voltage wave to the control valve, a resistance connected between the anode of the control valve and the control electrode of the switched valve whereby the output from the control valve is applied to the switched valve to render it alternately conductive and non-conductive, means for producing from the output of said control valve a second voltage wave at substantially 180° phase relation to the actuating voltage wave, a balancing circuit fed with said second voltage wave, and means for combining the voltage derived from said balancing circuit with voltage fed through said discharge space, said balancing circuit being so dimensioned that the voltage derived therefrom is substantially equal in amplitude to, and in phase opposition to, any components of actuating voltage wave fed through said discharge

space, an output stage comprising two valves each having a cathode, control grid and anode, means to apply the output from said switched valve to the control grid of one output valve, means to apply said derived voltage from the balancing circuit to the control grid of the other output valve, and means for taking off useful switched output from the circuit of said two output valves.

2. A high-speed low impedance electronic switching arrangement as set forth in claim 1 wherein said balancing circuit includes a network comprising a condenser and resistance connected in parallel, said condenser being adapted to balance out the stray capacitance in the switched valve and means for adjusting the impedance of said balancing circuit.

3. A switching arrangement as claimed in claim 1 wherein the actuating voltage is applied to the control valve, the output from which is fed to the switched valve, the voltage for the balancing circuit being derived from the cathode electrode of the control valve.

4. A high-speed low impedance electronic switch as set forth in claim 1, wherein in order to allow a switched wave form to be of either sign, a second switched valve is connected with the first switched valve the anode of the second switched valve being connected to the cathode of the first and the cathode of the second switched valve being connected to the anode of the first, whereby when said voltage to be switched is of one sign, said first switched valve is conductive, whilst the second switched valve is non-conductive, and when the voltage to be switched is of the opposite sign, the state of conductivity of the switched valves is reversed.

5. A high-speed low impedance electronic switch as set forth in claim 1, wherein the means for combining voltage derived from said balancing circuit with voltage fed through said discharge space includes a pair of valves having their cathodes commoned, and wherein the voltage fed through said discharge space is arranged to be applied to a control grid of a first valve of the pair of valves, and the voltage derived from said balancing circuit is applied to a control grid of the other valve of the pair of valves, and the switched output is derived from the anodes of said pair of valves.

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