

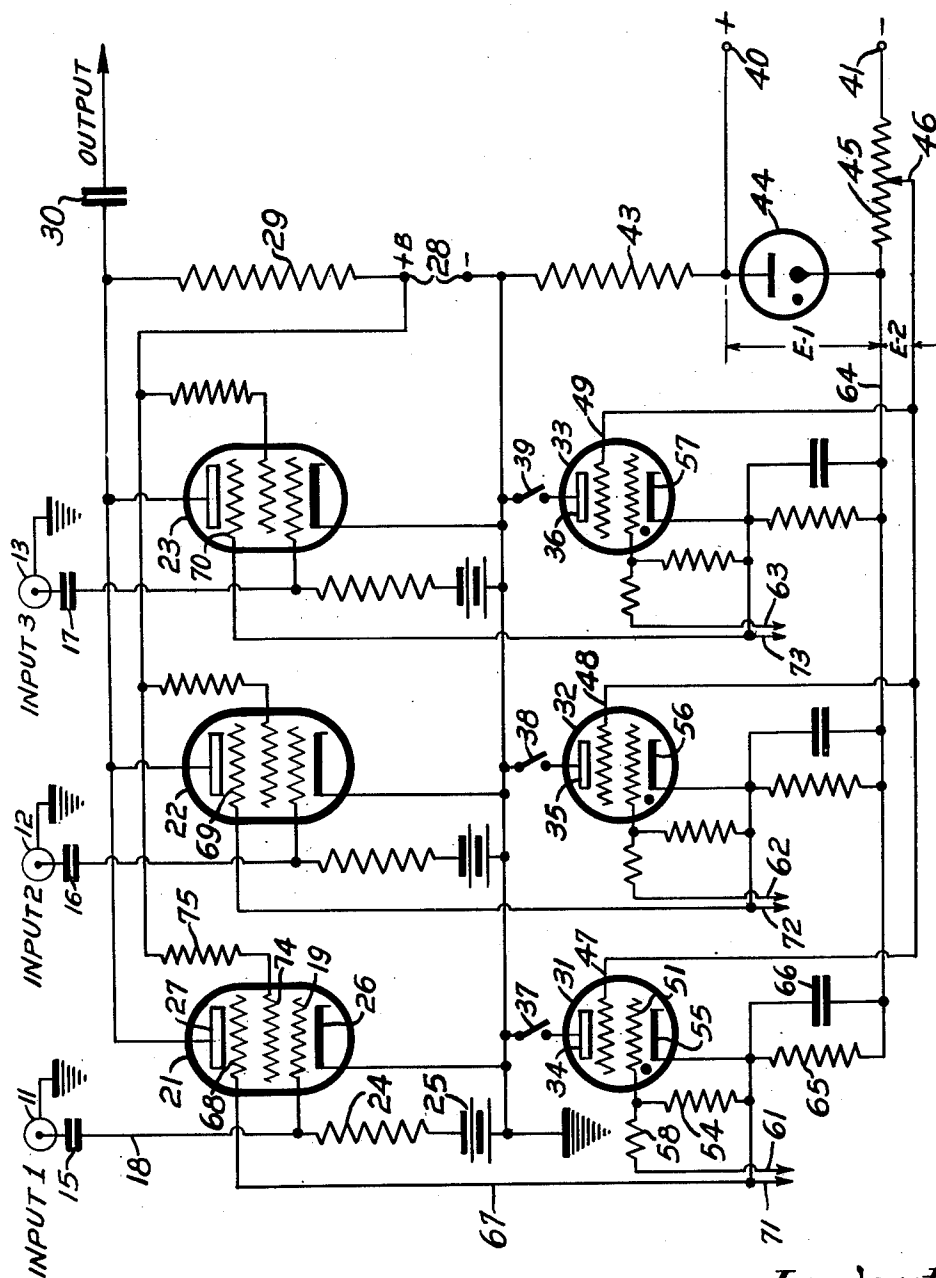
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ELECTRONIC SWITCHING

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ELECTRONIC SWITCHING

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The invention relates to electronic switching means and methods, and more particularly to switching from one circuit to another in a small fraction of a second, and at a particular time, as for instance, during the time of vertical retrace between successive frames or fields during the scanning of television images.

It often is desirable to perform such switching operations instantaneously and at a definite point in a cycle following an initiating operation by manual or automatic control; and also to repeat such switching operations alternately or sequentially at a rapid rate. It is obvious that mechanical switches or electrical relays having moving parts are not suitable for such purposes due to inertia, vibration, friction etc.

The primary object of this invention is to perform switching operations as above mentioned in a simple, reliable and effective manner.

A specific object is to switch from any one to any other one of a plurality of video circuits either by manual control as desired, or in automatic alternation or sequence, each switching operation being performed during a vertical blanking period.

Another object is to switch three or more devices cyclically, such as cameras or kinescopes used in color television.

A further object is to superimpose a plurality of signals for simultaneous observation or comparison.

Other objects and advantages of the invention will become apparent as the description proceeds.

Important features of the invention which lend themselves to accomplishment of the above objects are the use of grid-controlled gaseous discharge (trigger) tubes and an arrangement by which triggering of one tube automatically and instantaneously de-energizes a conducting trigger tube, thereby disconnecting the circuit controlled by the latter tube.

The invention will be understood more clearly by reference to the following detailed description of an illustrative embodiment, in connection with the accompanying drawing in which the single figure is a circuit diagram of a switching arrangement for three circuits or channels of video signals.

In the drawing, reference characters 11, 12 and 13 represent three concentric cables which may carry video or other signals, and may include sync and blanking impulses. The outer conductors of the cables may be grounded as indicated and the inner conductors provided with coupling condensers 15, 16 and 17. Each cable is an input for

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one circuit or channel, three of which are shown in the drawing but only one will be described in detail because the other channels are identical therewith. Relative to the left-hand channel, the signals are conducted from the condenser 15 through wire 18 to a control grid 19 of a vacuum tube 21. The usual grid leak 24 and grounded bias battery 25 complete the tube input circuit, the cathode 26 also being connected to ground. Input circuits for vacuum tubes 22 and 23 are arranged in like manner. A common grid bias may be used if desired. Anode 27 of tube 21 is connected in common with the anodes of tubes 22 and 23 to a supply 28 of B-potential through a common output impedance or resistor 29. One side of an output coupling condenser 30 is connected to the anode end of resistor 29, and the other side of condenser 30 is connected to an output lead for the switching arrangement shown.

With vacuum tubes 21, 22, 23 there are associated grid-controlled gaseous discharge tubes 31, 32, 33 respectively, which for brevity are called trigger tubes. The anodes 34, 35 and 36 thereof are connected through individual switches 37, 38 and 39 to ground and to the cathodes of their associated vacuum tubes. An anode supply has its positive terminal 40 connected through a common load resistance 43 to the above-mentioned ground which is also connected to the negative terminal of B-supply 28. For keeping the anode voltage supply constant, a voltage regulator 44 is provided having its anode connected to terminal 40 and its cathode connected through a ballast resistance 45 to the negative terminal 41 of said anode supply. An adjustable tap 46 on resistance 45 provides a negative potential E-2 for shield grids 47, 48, 49 of the trigger tubes for the purpose of setting the operating characteristics thereof.

Trigger tube 31 has a starting control grid 51 connected in the usual manner through a grid leak 54 to its cathode 55. Grid 51 is also connected through a current-limiting resistance 53 to a lead 61 by which starting pulses may be impressed upon said grid. Similar starting control circuits are provided for each of the other trigger tubes 32 and 33, input leads for the pulses being indicated at 62 and 63 respectively. The cathode 55 of tube 31 is connected through conductor 64 to the negative side of voltage regulator 44 and to one end of resistance 45. In series between cathode 55 and conductor 64 is connected an energy storage circuit or impedance which, in the example shown, comprises a resistance 65 and parallel-connected condenser 66. Similar energy

storage circuits are provided between cathodes 56 and 57 of tubes 32 and 33 and conductor 64 which provides a common return to the negative side of the anode supply.

The cathode 55 is connected, through a conductor 67, to a suppressor grid 68 of vacuum tube 21, and to a return lead 71 for the pulse circuit. Similar connections are made from cathodes 56, 57 of tubes 32, 33 to suppressor grids 69, 70 of their associated vacuum tubes 22 and 23, respectively, and to return leads 72, 73 for the pulse inputs 62 and 63, respectively.

The vacuum tube 21, which in the illustrated example is a pentode, may have a shield or screen grid 74 connected through usual resistance 75 to the positive terminal of B-supply 28. Similar connections are provided for shield grids of vacuum tubes 22 and 23.

The pulses to be applied to leads 61—71, 62—72 and 63—73 may be derived from, and/or synchronized with, the vertical blanking impulse included in the signals supplied through cables 11, 12 and 13. Pulses may be applied individually to the trigger tubes by manual control, or in cyclic rotation from successive blanking impulses obtained from video cameras or kinescopes, or they may be applied simultaneously to two of the trigger tubes, depending upon what mode of operation is desired.

The operation of the switching arrangement illustrated is as follows. Assuming switches 37, 38, 39 are closed and if none of the trigger tubes 31, 32 or 33 is conducting, the grids 68, 69, 70 will be negative with respect to their cathodes by the potential E-1 across voltage regulator 44. With such negative potential on their suppressor grids, vacuum tubes 21, 22 and 23 will keep open the circuits from the cables 11, 12, 13 to the output condenser 30.

Assuming now a pulse of voltage is applied to leads 61—71, the lead 61 being positive, trigger tube 31 will be made conductive and the negative potential on grid 68 will be reduced to equal the voltage drop across the anode 34 and the cathode 55 of tube 31, which ordinarily is about 8 volts. This low voltage on grid 68 permits the vacuum tube 21 to conduct and pass signals impressed upon its grid 19 or, in other words, it closes the circuit between cable 11 and output 30. The other circuits remain open because the potential on their grids 69 and 70 is reduced only by the voltage drop through resistance 43 due to the anode current of tube 31. In the example shown, such voltage drop may be about 25 volts. Assuming that voltage regulator 44 is of the type which provides a constant potential E-1 of 150 volts, there will remain on grids 69 and 70 a negative potential with respect to their cathodes of about 125 volts which blocks tubes 22 and 23 and keeps their respective circuits open.

If it is desired to switch the input from cable 11 to cable 12, a pulse is applied to leads 62—72, lead 62 being positive, thereby making trigger tube 32 conductive. Immediately before applying this pulse there was no current through tube 32 and, therefore, its cathode 56 was negative with respect to its anode 35 by the voltage E-1 minus the voltage drop in resistance 43 which, as previously mentioned, are 150 and 25 volts respectively. Hence, immediately before tube 32 starts, there is a potential of about 125 volts across its anode and cathode. Inasmuch as tube 31 is conducting as previously mentioned, its cathode is only 8 volts negative with respect to its anode, and about 117 volts appear across

impedance 65—66. These respective voltages will tend to be held for an instant following the starting of tube 32 due to the series impedances. Thus tube 32 upon starting will draw a heavy current momentarily which increases the voltage drop through resistance 43 and thereby reduces the anode potential of tube 31 to such an extent that ionization cannot be maintained and tube 31 ceases to be conductive. Preferably the said voltage drop should be sufficient to make anode 34 momentarily negative with respect to cathode 55.

Hence, the starting of tube 32 automatically de-energizes tube 31, thereby restoring the high negative potential on grid 68 of tube 21 and causing said tube to open the circuit from cable 11 to output 30. Simultaneously therewith the potential of grid 69 of vacuum tube 22 is reduced to 8 volts negative with respect to its cathode, and, the circuit from cable 12 to output 30 is closed.

A pulse applied to the leads 63—73 of the third channel comprising tubes 23 and 33 will function in like manner to open the circuit 12 to 30 and close the circuit 13 to 30. More channels can be added if desired.

In order to de-energize any trigger tube (other than by initiating another of the trigger tubes), its anode switch 37, 38, or 39 may be opened thereby making the corresponding channel inoperative.

The switching operations described above can be performed slowly or very rapidly, as desired, and either by manual or automatic application of pulses. For instance, if a series of pulses are applied to tubes 31 and 32 simultaneously, either tube will start depending upon slight differences in their characteristics. If tube 31 starts it will prevent tube 32 from starting, but the next pulse, if a series of pulses are applied, will start tube 32 and automatically de-energize tube 31 as above explained. The next pulse will reverse the process and so on, resulting in alternate conductivity of tube 31 and 32 on successive pulses. This mode of operation is useful for passing video signals alternately from two sources to one output so that a superimposition can be obtained by alternately reproducing the picture from one source and then the other. Another use for such alternate operation is the simultaneous observation or comparison of two signals on an oscilloscope by synchronizing the pulses with the oscilloscope sweep.

Such superimposition or simultaneous observation can be carried further by employing more than two channels if the pulses are applied to the respective channels in succession rather than simultaneously.

In the case of cameras or kinescopes used in color television, pulses which rotate cyclically with respect to three of such devices are frequently available (especially in sequential color systems) and if such cyclic pulses are applied in rotation to the leads 61, 62, and 63, switching operations in cyclic order can be obtained. For the switching operations above mentioned, the time between starts of any one trigger tube should be greater than the de-ionization time of the gas or vapor in said tube.

The time constant of the series impedances, such as the resistor-condenser combination 65, 66, should be less than the interval during which the switching operation is to be performed. For instance, according to present television technique, the interval for vertical blanking is about

$\frac{1}{860}$ of a second. In such case the impedance time constant preferably should be about $\frac{1}{2000}$ of a second, which allows a margin for any transients to be dissipated before the start of a new frame or field.

In the foregoing description particular parts are mentioned for specific functions. However, it should be understood that other parts which can perform substantially the same functions may be substituted.

What is claimed is:

1. Electronic switching means comprising a plurality of circuits each circuit containing a vacuum tube adapted to pass or not pass signals in accordance with a potential applied thereto, a trigger tube associated with each said vacuum tube and connections therebetween whereby each vacuum tube passes signals only when its associated trigger tube is conductive, means for applying pulses to any one of the respective trigger tubes at random to make them individually conductive, and means interconnecting said trigger tubes whereby the starting of one such tube causes any other conducting trigger tube to become non-conductive.

2. Electronic switching means as defined by claim 1 wherein the last mentioned means comprises a resistance common to the said trigger tubes.

3. Electronic switching means as defined by claim 1 wherein the last mentioned means comprises an energy storage circuit in series with each trigger tube, and a common connection for the ends of said energy storage circuits remote from said trigger tubes.

4. Electronic switching means for a plurality of video circuits comprising a vacuum tube in each circuit adapted to open and close the same, a grid and cathode in each vacuum tube, the potential therebetween controlling said opening and closing; a common output circuit for said vacuum tubes; a trigger tube for each vacuum tube having cathode, anode, and starting control electrodes; a connection between each vacuum tube cathode and the anode of its associated trigger tube, a connection between each said grid and the cathode of the associated trigger tube, a common anode supply for said trigger tubes including a resistance therein, an impedance in series with the cathode of each trigger tube, a common connection for the ends of said impedances remote from said cathodes, and individual means for applying pulses to the starting control electrodes of said trigger tubes.

5. Electronic switching means comprising a plurality of circuits, a first means for individually opening and closing said circuits, a second means capable of conducting current associated with

each of said first means, means for causing the first mentioned means to close its associated circuit when its associated second means is conducting current, a third means for causing any of second means to conduct current when desired, and means for causing all the other of said second means to cease conducting when one of second means is caused to conduct by the third means.

6. Electronic switching means comprising a circuit, a first vacuum tube having at least a grid, said grid being connected to said circuit, a first trigger tube having at least a plate, a grid and a cathode, means for biasing said vacuum tube into conduction when said trigger tube conducts, a second vacuum tube, a second trigger tube having at least a plate, a grid and a cathode, a common load impedance connected to the plates of said first and second trigger tubes, and energy storage circuits connected in the cathode circuits of said trigger tubes so that when one trigger tube is caused to conduct the other trigger tube is cut off.

7. An electron switching means comprising a plurality of circuits, a plurality of vacuum tubes having at least a plate, two grids and a cathode, means for individually connecting each one of said circuits with one of said grids, a plurality of gaseous tubes having at least a plate, a grid and a cathode, the cathodes of said vacuum tubes and the plates of said gaseous tubes being connected to a common source of fixed potential, means for storing energy connected between the cathodes of said gaseous tubes to the other side of said source of fixed potential, individual connections between each of the cathodes of the gaseous tubes and one of the other of said grids in said vacuum tubes, and means for supplying pulses in any desired order to the grids of said gaseous tubes.

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