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MULTICHANNEL ELECTRONIC SWITCH

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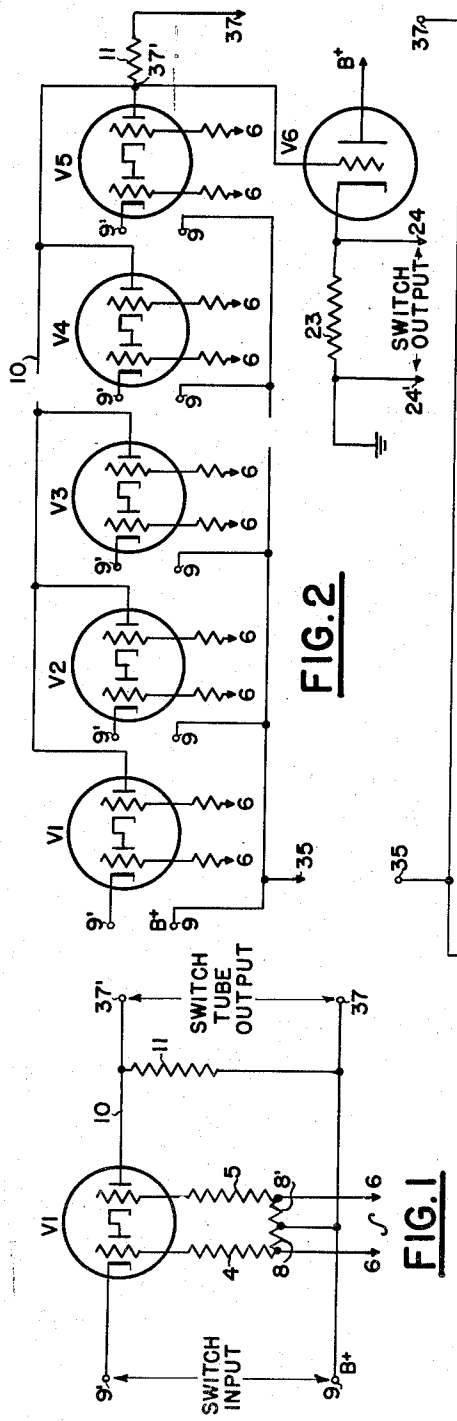


FIG. 2

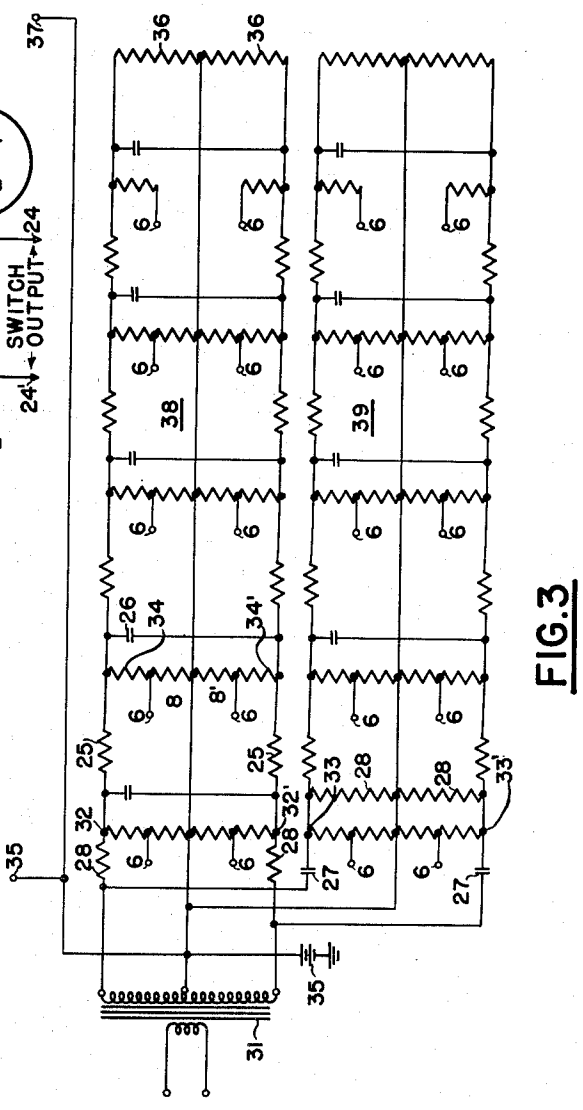


FIG. 3

FIG. 1

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MULTI-CHANNEL ELECTRONIC SWITCH

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5 Claims. (Cl. 250—27)

This invention relates to a multi-channel electronic switch.

In the past, many methods of switching multi-channel devices have been suggested but they have, in general, been rather complicated and inflexible. When it is desired to scan the outputs of a plurality of channels (or conversely, distribute the output of a signal channel) at relatively high frequencies, my invention provides an excellent means for doing so.

One of the outstanding advantages offered by my invention is the manner and ease with which the switching sequence is obtained. It differs from many prior switches in that no oscillating circuit is built into it, the switching signal being obtained from an external sinusoidal source. A phase-shifting network is utilized to produce the switching sequence so that each switch element receives a switching signal displaced in phase by an amount corresponding to its position in the switching cycle.

Another advantage of my invention is that the various switch elements are inherently independent of one another; with interaction between switch elements made negligible.

A further advantage of my invention is that the basic switch element is very simple and contains but one tube.

A still further object is an electronic switch composed of a simple basic element to which additional identical elements may be easily added for any desired number of channels.

A yet further object of my invention is a multiple electronic switch containing no thyratron tubes and which is relatively free from noise.

And yet another object of my invention is an electronic switch which may be utilized for a variety of purposes, including distribution, wave analysis, monitoring, multiplex signalling, and secret communications, etc.

In the drawings:

Figure 1 is a schematic diagram of the basic switch element.

Figure 2 is a schematic diagram of a multi-channel switch, with certain of the channels omitted.

Figure 3 is a schematic diagram of one type of phase-shifting network designed for use with the multi-channel switch of Figure 2.

The invention disclosed herein is an improvement over the switch described in my copending application for patent entitled, "Multi-Channel Electronic Switch," Serial No. 532,915, filed April 26, 1944, now U. S. Pat. No. 2,594,535. The same phase-shifting network utilized with the switch described therein is also used with the present invention. However, the present switch operates effectively inversely, as compared with the one just referred to, it necessitates the use of only one, rather than two, electronic tubes per channel, and is considerably simpler in construction and operation.

The basic element of the switch is shown in Fig. 1. For every channel controlled, there is an identical such unit and all are controlled by the phase-shifting network. A dual triode tube V1, such as a 6SN7, is employed as a switching tube, with one of its plates connected to the other of the cathodes.

The switch input is applied at terminals 9', and the switch output is taken off across load resistor 11 at the terminals 37 and 37'. The two grids of the tube V1 are connected to a switching signal input terminals 6, 6 through high resistors 4, 5. The grids are returned to the B+ of a plate supply through equal resistors 8 and 8' which provides an electrical center for the signal input.

It is thus seen that for the input signal to reach the switch output, it must pass through the cascaded triodes of the tube V1. When both grids of the tube V1 are positive or zero with respect to their cathodes, the tube appears as a comparatively low resistance; and the voltage appearing across the switch input terminals 9, 9' will be transmitted to the switch output terminals 37 and 37'. On the other hand, if either of the grids is sufficiently negative with respect to its cathode to cut off the triode, the circuit is effectively opened and the input is disconnected from the output, thereby preventing the signal across the terminals 9 and 9' from appearing across the terminals 37 and 37'.

The "on"-time of the switch tube V1 may be controlled by a large push-pull sinusoidal voltage applied across the terminals 6, 6. When this voltage across the terminals 6, 6 goes through zero, both cascaded triodes of the tube V1 conduct, and the switching tube is "on"; before and after going through zero, the switching tube is "off," as one or other of the triode sections is cut off.

As has been stated, a plurality of switch elements, as described above, is used in a complete switch; and such a circuit is illustrated in Fig. 2. The broken circuit shows the use of a plurality of such switch elements and their association with the phase-shifting network of Figure 3. It is noted that the output of each of the respective switching tubes V1, V2, V3, V4 and V5 is fed into a common lead 10 for developing the output voltage of each of these respective tubes across the common load resistor 11. These respective voltages, as they appear across this resistor 11, are applied to the grid of a cathode follower tube V6, the output of which is taken off across resistor 23 at the terminals 24 and 24' which in turn feed into a suitable indicating device, not shown.

The switching signal at each pair of input terminals 6, 6 for each of the respective tubes V1, V2, V3, V4 and V5 is supplied from one section of a phase-shifting network, shown in Fig. 3, which may be identical with that shown in Fig. 4 of my copending application, identified above. As is described therein, this network comprises a series of conventional π-sections composed of resistors 25 and condensers 26.

As shown in Fig. 3, the phase-shifting network is fed from a suitable source, such as a transformer 31. The network is divided into two parts, 38 and 39, at the input; condensers 27 feeding one part 39, resistors 28 feeding the other part 38. The voltage, therefore, across points 32, 32' leads the voltage across the points 33, 33', that is, the voltage across points 32, 32' is in phase with that across the transformer whereas that across the points 33, 33' lags such voltage. Each section of each part 38 and 39 is identical to give an equal phase shift per section. The voltage across one section follows the voltage across progressive sections of each part 38 or 39 in a definite sequence and the voltage of the last section of each part is followed by that of the first section of the other part so that both parts 38 and 39 form a continuous and sequential phase shift, each section differing from its adjacent sections by a definite phase angle.

As the phase-shifting network contains dissipative elements, it is subjected to attenuation. Thus, the voltage across 32, 32' is approximately equal to or is slightly less than the supply voltage from 31 but higher than the voltage across the resistors 36, 36'. For this reason a bleeder, formed by the resistors 34, 8, 8' and 34', is used in each section and the voltage for terminals 6, 6 for the grids of the switching tubes is taken from these bleeders at points between a resistor 34 and 8, and 8' and 34', to equalize the voltages applied to the switching tubes. Each bleeder is of high impedance and, in conjunction with resistors 4 and 5, limits the grid current taken by the switching tubes.

By dividing the phase-shifting network into two parts the attenuation is thus reduced and the use of a lower voltage transformer becomes feasible.

The switching signal input terminals 6, 6 of each of said respective switching tubes are directly connected to one pair of terminals 6, 6 (Fig. 3) on the phase-shifting network.

Resistors 28, 36 and condensers 27 serve the same

functions as were performed by them in the application identified above. In Fig. 2, the B+ terminal is supplied from a convenient source of voltage such as a battery **35** (Fig. 3) and terminal **37** may be connected directly to it or be tapped off of a bleeder on the B+ supply at some lower value.

The operation of the device can be best understood by considering a single switch tube, such as for example **V1** of Figure 1. The cathode of the first triode section of the tube **V1** is adapted to be connected to the output of a signal channel such as, for example, a radio receiver. The plate of the first triode section connects to the cathode of the second triode section. The plate of the second triode section of tube **V1**, as well as corresponding plates of the remaining switch tubes **V2**, **V3**, **V4** and **V5**, is joined to a common lead **10** which connects with the common load resistor **11** and to the grid of the cathode follower **V6**. If both triode sections of each tube are conducting, then a signal voltage fed by the signal channel or the receiver will be passed to the cathode follower **V6**. If on the other hand either triode section of the tube is cut-off, nothing is passed by it and the signal channel (at terminals **9'**, **9**) disconnected from the output. The two grids of each tube are connected to the balanced A. C. source available at terminals **6**, **6**. Hence when the A. C. voltage at transformer **31** goes through its zero value the grids of both sections of each triode will be at zero voltage and both will be conducting; at any other time one or the other of the grids of each triode will have a large negative voltage and thus block the tube. The switching tube **V1** is consequently "closed" (passes signal) twice for every cycle of the line voltage, as the line voltage goes through its zero value.

The switching sequence for each tube is established by the phase shifting network so that the phase of the sinusoidal signal applied to successive switching tubes differs by a phase angle relationship determined by the voltage across points **6**, **6** for each respective switching tube.

Thus, the successive tubes **V1** to **V5** form a synchronized switch system with, for example, **V1** closed first, then **V1** opening and **V2** closing, next **V2** opening and **V3** closing, etc., until all switch tubes have been closed after which the cycle is repeated. Thus, the signals applied to the various input terminals **9**, **9'** of the respective switching tubes will be supplied in sequence, to output terminals **24** and **24'**. Thus, the input of each channel is supplied at the output of the circuit once during each cycle of the switching voltage and at the same time in each such cycle.

It is to be noted that the B+ is connected to the center tap of the phase-shifting network and thence through the equal resistors **8** and **8'** to the double grids of each switching tube. The sinusoidal switching voltage at terminals **6**, **6** is made substantially larger than the voltage of any signal to be applied across points **9** and **9'** for each respective switching tube. However, the switching voltage is so adjusted that with no signal across terminals **9** and **9'**, the plate and the cathode of each switching tube are at the same potential, as may be more clearly gathered from Figure 1. When a signal, however, is across the terminals **9**, **9'**, it will be added to the sinusoidal switching voltage across the grids of each section of the switching tube. The effect of such signal voltage across the terminals **9**, **9'** is to make the cathode more or less negative relative to the grids and the total potential on the grids will exceed or fall short of the peak sinusoidal switching voltage across the terminals **6**, **6**. Hence, with a signal across the terminals **9**, **9'**, it will cause the switching voltage to reach its zero value sooner in time than with no signal voltage present across terminals **9**, **9'**. In effect, therefore, the mean of the grid voltage becomes positive as the cathode goes negative due to the signal voltage, thereby controlling the time that the tube **V1** is conducting. Thus, weak signals are conducted across for only a very short time interval while strong signals are conducted across for a longer interval.

The terminals **24**, **24'** may be fed into a cathode-ray oscilloscope, controlled by a sweep circuit disclosed in my copending application, entitled "Sweep Circuit," Serial No. 549,876, filed August 17, 1944, now U. S. Pat. No. 2,660,691.

Having described my invention, I claim:

1. A multiple-channel electronic switch comprising: a

plurality of pairs of cascaded triodes; each comprising a cathode, a grid and an anode; a separate input terminal for each of said pairs connected across a cathode of one triode of each pair and the grids of both triodes thereof; a common output terminal for all of said pairs connected across the anode of one triode of each pair and said grids of both triodes thereof; control means for applying an alternating switching signal to the grids of both triodes of each of said pairs at differing phase angles whereby the various input signals applied to said pairs are supplied to said output terminal in sequence.

2. In the device described in claim 1, wherein the control means comprises a phase-shifting network.

3. In a multiple-channel switch, the combination of a plurality of independent and discrete signal input circuits, a plurality of electron tubes for each of said signal input circuits, respectively, each said electron tube comprising a pair of cathodes, a pair of grids and a pair of anodes with one of said anodes connected to one of said cathodes, means connecting each of said signal input circuits across the remaining said cathode and said pair of grids of each electron tube, respectively, a common circuit connected between each said pair of grids and the remaining plate of each of said electron tubes, respectively, said electron tubes being normally inoperative to transfer a signal from its respective signal input circuit to said common output circuit, a sinusoidal voltage source, a phase-shifting network connected to said voltage source for converting same into a series of discrete potentials equally and progressively displaced in phase relative to each other and means applying the discrete potentials across each pair of grids of said respective tubes thereby rendering the same progressively operative for equal time intervals for independently and sequentially transmitting the signal from the signal input circuit of the respective electron tube to said common output.

4. In an electronic switch, the combination of a first electron tube having at least anode, cathode and grid electrodes, a second electron tube having at least anode, cathode and grid electrodes, means connecting the cathode of the first tube to the anode of the second tube, means impressing cyclically-variable voltages of opposing polarity to the grid electrodes, an input circuit connected across the cathode of the second tube and the grid electrodes and an output circuit connected across the anode of the first tube and the pair of grid electrodes.

5. In an apparatus, the combination of a plurality of independent and discrete signal input circuits, electron tubes for said signal input circuits, respectively, each said electron tube comprising a pair of cathodes, a pair of anodes and a pair of grid electrodes, one of said cathodes being connected to one of said anodes, means connecting each said signal input circuit across the remaining cathode and both grid electrodes of each tube, respectively, a cyclically-variable voltage source, a plurality of resistance-capacitance voltage phase-shifting means, each said phase-shifting means being across each pair of grid electrodes of each tube, respectively, said phase-shifting means being progressively arranged with each said phase-shifting means, except the first, being connected to the output of the preceding phase-shifting means and said first phase-shifting means being connected across said voltage source, whereby the phase relationship of the voltage across each pair of grid electrodes of each tube, respectively, differing sequentially by a predetermined phase angle during each voltage cycle of said voltage source for independently and sequentially connecting the signal input circuits across the common output in succession during the passage of the voltage source through the zero voltage cycle portion thereof.

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