

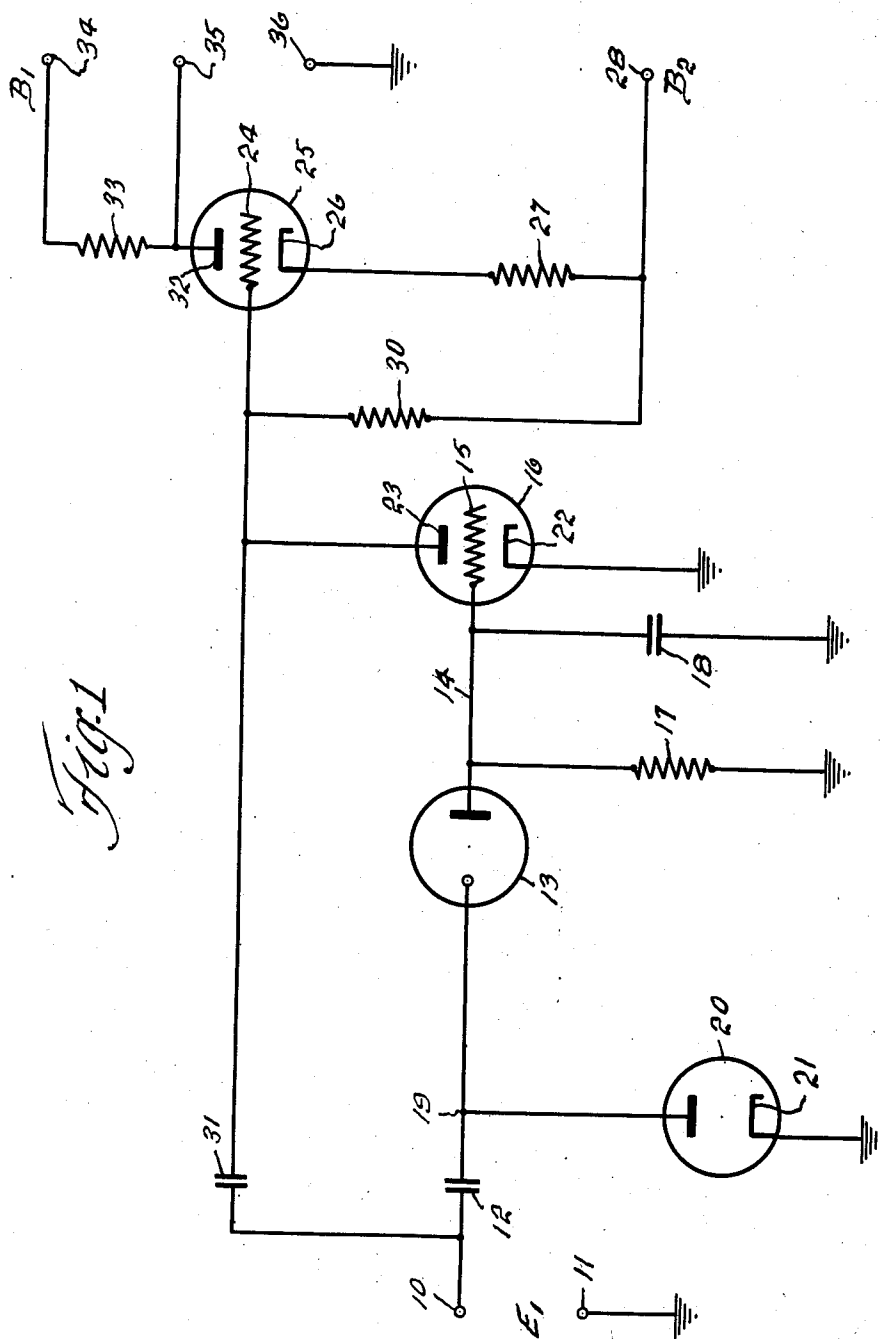
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R. S. NORTON
SWITCHING CIRCUIT

2,671,169

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2 Sheets-Sheet 1



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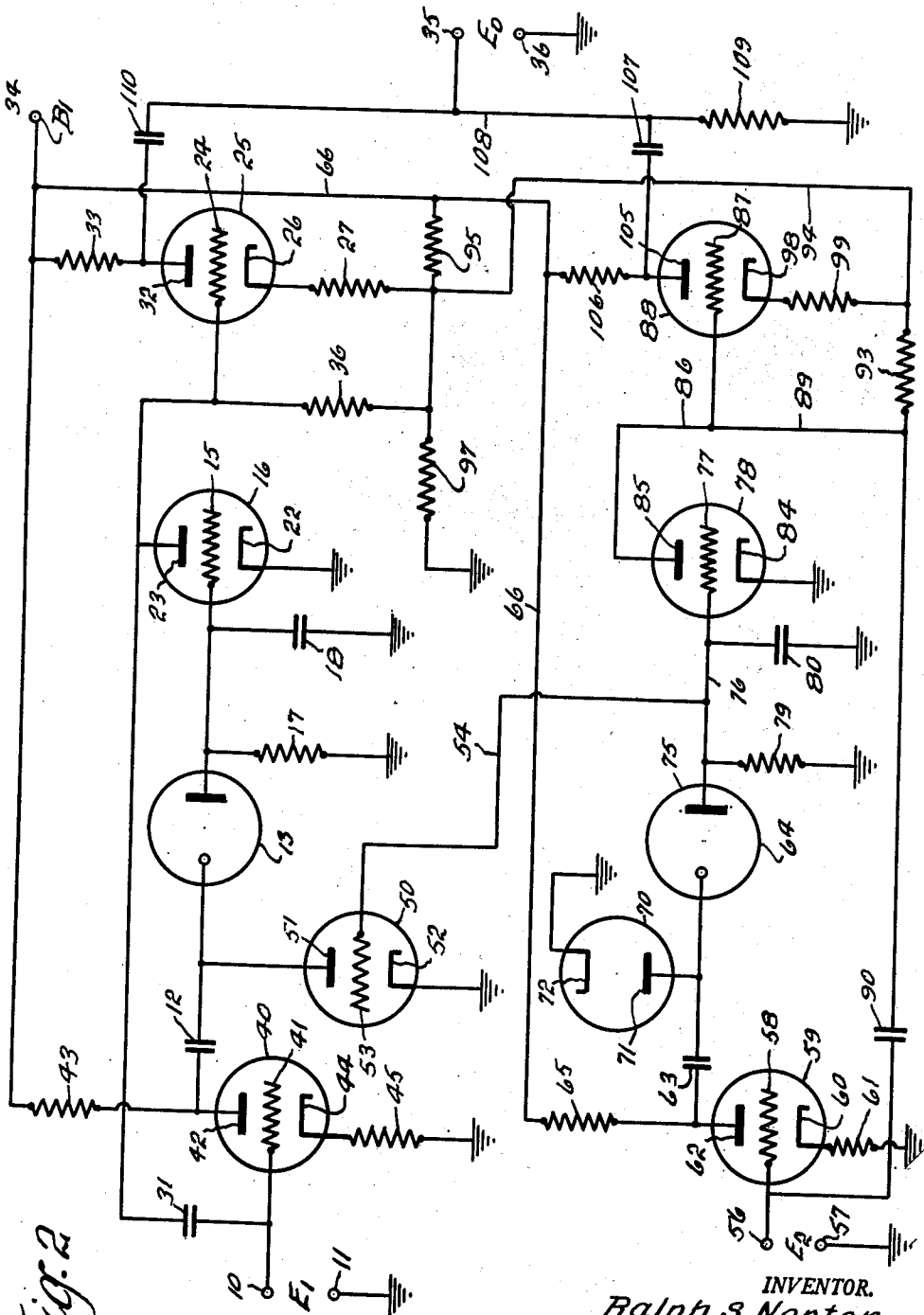


Fig. 2

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SWITCHING CIRCUIT

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5 Claims. (Cl. 250-27)

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This invention relates to an electronic switching circuit and more particularly to a switching circuit for use in a multiple speed servo mechanism in which a plurality of signals are to be applied selectively to actuate the mechanism.

In one embodiment the invention may be applied to a servo mechanism in which the primary control is from a fine control signal, a secondary control is exerted by a coarse control signal which is superimposed on the fine control signal when the coarse control signal exceeds a predetermined value, and a tertiary control is effected by a second coarse control signal which is connected to remove the first coarse control signal and to be superimposed on the fine control signal in lieu thereof.

An object of the invention is to provide a novel and improved system of the above type.

Another object is to provide a system which operates with a low noise level.

Another object is to provide a system of the above type which is accurate and dependable in operation.

Various other objects and advantages will be apparent as the nature of the invention is more fully disclosed.

The invention will be better understood by referring to the following description, taken in connection with the accompanying drawings in which certain specific embodiments thereof have been set forth for purposes of illustration.

In the drawings:

Fig. 1 is a schematic diagram of an electronic switching system embodying the present invention; and

Fig. 2 is a similar schematic diagram illustrating a further embodiment of the invention.

Referring to the drawings more in detail, Fig. 1 shows a system in which the input signal E_1 is applied to input terminals 10 and 11, the latter being grounded. Terminal 10 is connected through a condenser 12 to the negative terminal of a gas tube 13, the positive terminal of which is connected by a lead 14 to the control grid 15 of a triode 16. The lead 14 is grounded through a resistor 17 and condenser 18 in parallel. The negative terminal of the gas tube 13 is connected to the anode of a rectifier diode 20, the cathode 21 of which is grounded. The cathode 22 of the triode 16 is grounded and its anode 23 is connected to the control grid 24 of a triode 25 having a cathode 26 connected through a resistor 27 to a terminal 28 which is connected to a source of positive potential B_2 . The control grid 24 of the triode 25 is also connected through a resistor

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30 with the terminal 28 and through a condenser 31 to the input terminal 10. The anode 32 of the triode 25 is connected through a resistor 33 to a terminal 34 which is supplied with a source of positive plate potential B_1 . The anode 32 is also connected to an output terminal 35, the other output terminal 36 being grounded.

In the operation of this device an alternating input signal E_1 is supplied to the input terminals 10 and 11. When the voltage on the terminal 10 swings positive the tube 20 conducts current. If this voltage is less than the breakdown voltage of the gas tube 13 when a positive voltage is applied to a negative terminal, the gas tube 13 will not conduct. Therefore capacitor 12 will store a charge during this half cycle with the voltage at point 19 going negative. During the next half cycle of the input signal, as the input terminal 10 goes negative the rectifier 20 will not conduct. Consequently the point 19 is now negative by an amount approximately twice the peak value of the input signal. If the voltage at the point 19 is now less than the breakdown voltage of the gas tube 13 when a negative voltage is applied to its negative terminal, the gas tube will not break down. During the next half cycle in the positive direction, since the point 19 is already positive by an amount equal to the peak value of the input signal no current will flow through the rectifier 20 except that necessary to compensate for any charge that may have leaked off of the condenser 12. Similarly, the gas tube 13 cannot break down. As long as the point 19 is at a voltage less than the breakdown voltage of the gas tube 13 the grid 15 of the triode 16 is near ground potential. Since the cathode 22 of the tube 16 is grounded, the tube 16 tends to draw a large plate current. If the resistor 30 is large the plate potential of the tube 16, which is also the control grid potential of the tube 25, is at a potential very near ground. Since the cathode 26 of the tube 25 is above ground by the voltage B_2 , the tube 25 is effectively cut off and the output voltage applied across the terminals 35 and 36 is zero.

The potential of the point 19, if different from zero, will be negative with respect to ground because of the diode 20. Consequently the gas tube 13 will only break down when the voltage at the point 19 becomes equal to its breakdown voltage. When breakdown occurs the gas tube 13 conducts and a negative bias is applied to the grid 15 of the tube 16. The plate current of the tube 16 is thus cut off and allows the plate voltage of the tube 16, and the grid voltage on the control grid

of the tube 25, to return to a value of B_2 . The tube 25 then conducts since B_1 is greater than B_2 , and the input signal applied through the condenser 31 to the grid 24 of the tube 25 is amplified and appears at the output terminal 35 as an amplified output voltage. The time constants of the resistor 17 and condenser 18 must be large compared to the period of the input voltage so that the grid potential of the triode 13 never rises above its cut-off value while the gas tube 13 is conducting. The time constant must also be small enough to have little effect on the servo mechanism response characteristic.

It is evident from the above that the output signal across the terminals 35 and 36 is a function of the input signal across the terminals 10 and 11 when the input signal exceeds a predetermined value, but is cut off sharply when the input signal falls below said predetermined value. Hence if the terminals 35 and 36 are connected to a servo control mechanism which is supplied with a fine control signal and the coarse control signal is applied across the terminals 10 and 11, then the coarse signal is effectively cut off from the output terminals 35 and 36 when it is below its predetermined value. Above this value the coarse control signal appears at the output terminals and is superimposed on the fine control signal of the servo mechanism. Below the cut-off point the system operates with an extremely small noise level.

In Fig. 2 the invention is shown as applied to a switching arrangement for selectively applying either of two input signals to the output terminals. For convenience and to simplify the description the parts of Fig. 2 corresponding to the above described parts of Fig. 1 have been given the same reference characters and operate in the same manner.

In Fig. 2 an amplifier tube 40 has been connected between the input terminal 10 and the condenser 12 so as to make the system responsive to smaller input signals.

The amplifier tube 40 is provided with a control grid 41 connected to the input terminal 10 and with an anode 42 which is connected to the condenser 12 and also through a resistor 43 to the E_1 terminal 34. The cathode 44 of the amplifier tube 40 is grounded through resistor 45.

In Fig. 2 the diode 20 in Fig. 1 has been replaced by a triode 50. The triode 50 has an anode 51 connected to the negative terminal of gas tube 13, and a grounded cathode 52.

The second input signal E_2 is applied across terminals 56 and 57, the latter being grounded. The terminal 56 is connected to the control grid 53 of a triode 59 having a cathode 60 grounded through a resistor 61, and an anode 62 connected through a condenser 63 to the negative terminal of a gas tube 64, and connected through a resistor 65 and lead 66 to the B_1 terminal 34.

A diode 70 is provided with an anode 71 which is connected to the negative terminal of gas tube 64 and a grounded cathode 72.

The positive terminal 75 of gas tube 64 is connected by a lead 76 to the control grid 77 of a triode 78. The lead 76 is grounded through a resistor 79 and condenser 80 in parallel. The triode 78 has a grounded cathode 84 and an anode 85 connected by a lead 86 to the control grid 87 of a triode 88, and also through a lead 89 and condenser 90 to the input terminal 56. The lead 76 is also connected by a lead 54 to the control grid 53 of the triode 50. The control grid 87 of the triode 88 is also connected through

a resistor 93, lead 94 and resistor 95 to the lead 66. The lead 94 is also grounded through a resistor 97. The cathode 98 of the triode 88 is connected through a resistor 99 to the lead 94.

The anode 105 of the triode 88 is connected through a resistor 106 to the lead 66 and through a condenser 107 and lead 108 to the output terminal 35, also through a resistor 109 to ground. The anode 32 of the triode 25 is connected through a condenser 110 to the lead 108.

When the voltage on the grid 53 of the triode 50 is at ground potential the triode 50 acts in a manner similar to the diode 20 of Fig. 1 and the triode 25 passes the input signal E_1 supplied from the input terminal 10, provided this signal exceeds the value necessary to unblock the triode 25 as described in connection with Fig. 1. The amplifier tube 40 serves to amplify the input signal at the terminals 10 and 11 so that control may take place at a much lower value of signal than could be obtained by the circuit of Fig. 1. The amplifier tube 40 is also designed so that its amplified signal does not exceed a predetermined value of swing because of saturation and cutoff.

The peak value of the voltage on plate 42 is limited by this means to approximately three-quarters of the breakdown voltage of gas tube 13. When triode 50 is cut off by the voltage on its grid 53 going sufficiently negative, the voltage on plate 51 cannot exceed three-quarters of the breakdown voltage of tube 13. Therefore the gas tube 13 cannot be made to conduct or sustain conduction. Consequently the circuit has been disabled.

The second channel carrying the second input signal E_2 across the terminals 56 and 57 is similar to the first channel above mentioned and operates in a similar way. The signal is amplified by the amplifier tube 59, is applied across the condenser 63 to the gas tube 64 and, due to the diode 70 which corresponds to the diode 20 of Fig. 1, causes the gas tube 64 to conduct when the signal reaches a predetermined value. With the gas tube 64 non-conducting the grid 77 of the triode 78 is of the same potential as its cathode 84 and the tube 78 draws current, thereby making the control grid 87 of the triode 88 sufficiently negative to cut off triode 88.

Now when the second input voltage E_2 reaches a sufficient value to cause the gas tube 64 to become conducting a negative voltage is applied to the line 76, thence to the grid 77 of the triode 78, cutting off the tube 78. This negative voltage is also applied through the lead 54 to the grid 53 of the triode 50, thereby rendering the tube 50 non-conducting and cutting off the control signal E_1 from the first channel as above pointed out. When the tube 73 is cut off the voltage on the grid 87 of the triode 88 becomes positive and the triode 88 becomes conductive and amplifies the second input signal which is supplied thereto from the output circuit of the amplifier tube 59. This signal is accordingly applied to the output terminals 35 and 36 in place of the amplified signal from the input terminals 10 and 11.

It is evident from the above that if a first coarse control signal is applied to the input terminals 10 and 11 and a second coarse control signal is applied to the input terminals 56 and 57, and the output terminals 35 and 36 are connected to a servo mechanism normally responsive to a fine control signal, then no voltage will be applied across the output terminals as long as

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both coarse input signals are below a predetermined value. However, as soon as the first input signal E_1 across the terminals 10 and 11 exceeds this minimum value the first channel is rendered operative and the amplified input signal from the triode 25 is applied across the output terminals 35 and 36 and is superimposed on the fine control signal of the servo mechanism. During this time the second channel is inoperative because the second coarse control signal is not sufficient to cause the gas tube 64 to conduct. As soon as the second coarse input signal E_2 across the terminals 56 and 57 becomes sufficient to cause breakdown of the gas tube 64, the first channel is blocked by reason of the blocking of the tube 50 and the second channel is made operative to amplify the second coarse input signal and apply the same to the terminals 35 and 36 to be superimposed on the fine control signal of the servo mechanism.

While the above system has been shown as applied to control of a multi-speed servo, the system may be used for various purposes wherein the output signal is to be made responsive to one of two input signals depending upon the values thereof. Hence various changes and modifications may be made in the specific circuit disclosed as will be readily apparent to a person skilled in the art.

What is claimed is:

1. An electronic control circuit comprising a pair of channels, each of said channels containing an amplifier tube, an input circuit carrying a control signal connected to the input of said first amplifier tube, a second input circuit carrying a second control signal connected to the input of said second amplifier tube, means in each of said channels normally blocking the respective amplifier tubes, means in each of said channels responsive to the respective input signals and connected to unblock the respective tubes when the respective input signals exceed predetermined values, and means in said second channel to block said first channel when said second amplifier tube becomes unblocked, and a single output circuit connected to the output of both of said amplifier tubes.

2. An electronic control circuit comprising a pair of channels, each of said channels containing an amplifier tube, an input circuit carrying a control signal connected to the input of said first amplifier tube, a second input circuit carrying a second control signal connected to the input of said second amplifier tube, each of said input circuits including a normally conducting triode connected to apply a blocking bias to the respective amplifier tube, and also a rectifier circuit including a rectifier tube and a gas tube connected to apply a blocking bias to the respective

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triode when the rectified input voltage is sufficient to cause the respective gas tube to conduct, and a connection from said rectifier circuit of said second input circuit to apply a blocking bias to the rectifier tube of said first input circuit when the gas tube of said second input circuit becomes conducting.

3. An electronic control circuit comprising a pair of channels, each of said channels containing an amplifier tube, an input circuit carrying a control signal connected to the input of said first amplifier tube, a second input circuit carrying a second control signal connected to the input of said second amplifier tube, each of said input circuits including a normally conducting triode connected to apply a blocking bias to the respective amplifier tube, and also a rectifier circuit including a rectifier tube and a gas tube connected to apply a blocking bias to the respective triode when the rectified input voltage is sufficient to cause the respective gas tube to conduct, a connection from said rectifier circuit of said second input circuit to apply a blocking bias to the rectifier tube of said first input circuit when the gas tube of said second input circuit becomes conducting, and a single output circuit connected to the output of both of said amplifier tubes.

4. A circuit as set forth in claim 2 in which the rectifier tube of said first input circuit is a triode and said connection supplies a blocking bias to the control grid thereof.

5. An electronic control circuit comprising an amplifier tube having a control grid, means supplying an input signal to said control grid for amplification by said tube, an output circuit connected to said tube to receive said amplified signal, a triode connected to be normally conducting and having an output circuit connected to apply a negative bias to said control grid of said amplifier tube for blocking the same, a rectifier circuit including a gas tube, a series condenser and a shunt rectifier connected to apply a blocking bias to said triode when the rectified signal is sufficient to cause said gas tube to conduct, means applying said input signal to said rectifier circuit, and an output circuit connected to the output of said amplifier tube.

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