

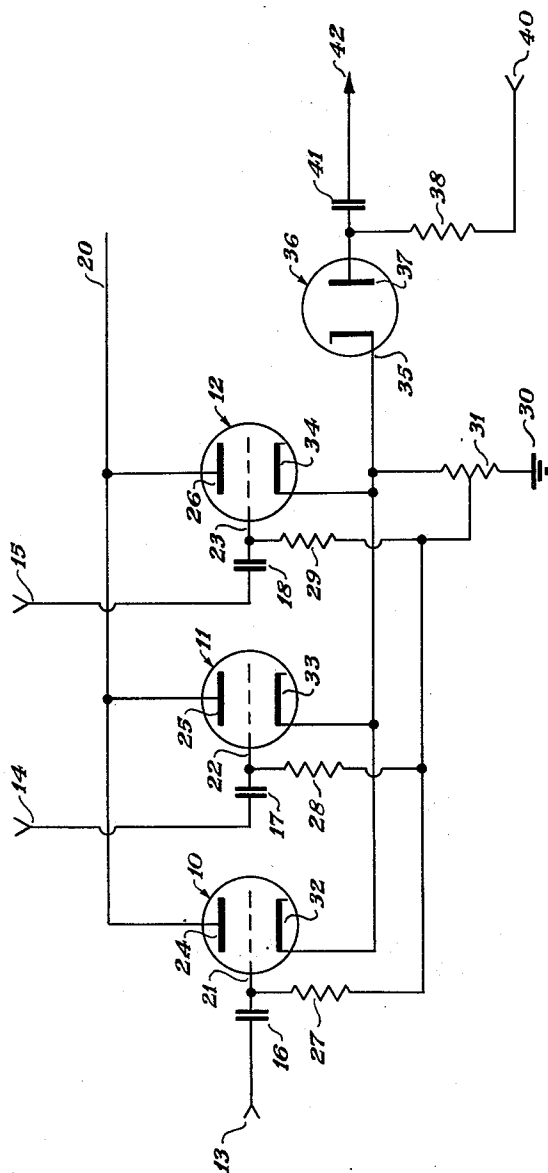
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COINCIDENCE CIRCUIT

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WITNESSES

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COINCIDENCE CIRCUIT

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This invention relates to a coincidence circuit and more particularly, to a multiple coincidence circuit.

Prior to this invention, circuits for the determination of the coincident occurrence of a plurality of pulses have been generally so arranged that two or more externally impressed simultaneous pulses produce a signal larger in magnitude in the output than that produced by a lesser number of simultaneous pulses. A description of such circuits of the prior art is incorporated herein by reference to "Electrical Counting" by W. B. Lewis, published in 1943 by the MacMillan Company, New York city, New York. Circuits of the type described have the limitation that their resolution, which is determined by their high frequency response, is limited by the input admittances of the various tubes.

Coincidence circuits described in the prior art are also deficient in operation under the influence of fast pulses due to plate load impedance for the reason that if the plate load impedance is great enough to produce appreciable amplification, the input admittances will so vary as to by-pass high frequency components of the fast input pulses.

An object of this invention is to provide a coincidence indicating device having an improved high frequency response.

A further object of this invention is to provide a mixing circuit responsive only to pulses from various sources coincident in time.

A still further object of this invention is the ease with which the output of this circuit may be limited to networks having low time constants without undue loading effects and the consequent increase of resolution time.

Other objects and advantages of the present invention will become apparent to persons skilled in the art upon examination of the drawing, description, and appended claims.

In general, the above objects are attained by the provision of input means to a plurality of thermionic tubes which are cathode coupled to succeeding indicating circuits. This arrangement, i. e., the use of cathode followers, results in an increased input impedance and thus extends the upper frequency limit of the circuit thereby improving the resolution thereof.

The resolution of coincidence is defined as that time interval within which a series of events are registered as simultaneous events. A higher frequency response is obtained by virtue of the higher input impedance of the instant circuit. With such higher input impedance, the resolution time is decreased since it is proportional

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to the time constant of the input resistance coupled network in shunt with the input impedance of the tubes.

This invention will be described by referring to the drawing made part of this specification in which the single figure is a schematic circuit diagram of an embodiment of this invention.

Referring to the drawing, a coincidence circuit is shown provided with a plurality of input circuits, for example, three for purposes of explanation. Three tubes 10, 11 and 12 are provided with inputs 13, 14 and 15 respectively. The grids of the tubes are coupled to the individual inputs by coupling condensers 16, 17 and 18. Anodes 24, 25 and 26 are connected in parallel with each other and are connected directly to a suitable positive potential source indicated by conductor 20. Control grids 21, 22 and 23 are returned to ground 30 through their respective grid resistors 27, 28 and 29 respectively, and to a tap on the common cathode resistor 31. Cathodes 32, 33 and 34 are connected together and to ground 30 through cathode load resistor 31.

To the end that an indication can be obtained from pulses applied to the circuit thus far described, the diode 35 is provided. Cathode 35 of the diode is directly connected to cathodes 32, 33 and 34 of the respective input tubes.

In order that a suitable response may be obtained even in the cases of pulses having a steep wave front, i. e., pulses including high frequency components, the circuit input admittance must be minimized.

The input admittance is the ratio of control grid current to the voltage applied between the control grid and the cathode. Because the potential on the control grid is affected by all electric factors in its environment, the input admittance takes into account the capacitance between the input and output circuits through inter-electrode coupling, and the interaction between the control grid and the electron stream.

The input admittance of a triode is mostly determined by the displacement currents flowing between the control grid and cathode and between the control grid and anode through the respective capacitance. The current flow through the grid-anode capacitance is dependent on the nature of the load impedance in the anode circuit for the reason that the A. C. voltage between the anode and grid is equal to the amplified voltage across the load minus the signal voltage between the cathode and grid. The A. C. potential difference between the grid and anode will be very large compared to the signal voltage with the result that a large displacement current will flow between the grid and anode thereby

making this part of the input admittance important. Not only is the magnitude of the input admittance a function of the grid-anode coupling and the size of the anode load, but also the input phase angle is a function of the reactive character of the anode load impedance. This last mentioned consideration is very important from the viewpoint of stability.

In accordance with the above discussion, anode load impedance is deleterious where fast pulses are to be processed. The circuit of this invention avoids the use of anode load impedance by placing the load impedance in the cathode circuits.

The static operating currents derived from the three triodes 10, 11 and 12 traverse cathode resistor 31 thereby generating a potential drop and consequently establishing the bias potential on all three control grids 21, 22 and 23. With no signal applied on input terminals 13, 14 and 15 the currents in the respective tubes 10, 11 and 12 are substantially equal and the total current is sufficient to produce a potential difference between the upper or cathode terminal of resistor 31 and its tap which is proper for biasing the individual tubes low on the linear portion of their grid potential-anode current characteristic.

Under the influence of a negative pulse impressed on input terminal 13, the pulse is fed through coupling condenser 16 to control grid 21 of tube 10 driving it toward cutoff and thereby tending to decrease the total current through common cathode resistor 31. Simultaneously with this decrease, the bias on the control grids 22 and 23 of tubes 11 and 12 is decreased allowing tubes 11 and 12 to conduct more current. The sum of the currents of tubes 11 and 12 under this condition very nearly approaches the sum of all three tubes 10, 11 and 12 in the quiescent stage. Therefore, the resultant signal appearing on the cathode 35 of tube 36 is an insignificantly small negative pulse.

When two simultaneous negative pulses are applied to input terminals 13 and 14, they are fed through respective coupling condensers 16 and 17 to control grids 21 and 22 respectively, of tubes 10 and 11. These negative pulses simultaneously impressed on control grids 21 and 22 of tubes 10 and 11 produce a drop across resistor 31 in the same manner as a single pulse. The potential difference across resistor 31 is maintained substantially constant by an increase in current through tube 12, thus the output for a double coincidence may be slightly larger than that registered for a single input pulse, but still is insignificantly small and not sufficient to render tube 36 conducting.

Under the influence of negative pulses simultaneously applied at input terminals 13, 14 and 15 and fed through respective coupling condensers 16, 17 and 18 to control grids 21, 22 and 23 respectively, of tubes 10, 11 and 12 respectively, all three said tubes cease conducting and the potential drop across resistor 31 is sharply reduced to zero and, as a consequence, the positive potential impressed on cathode 35 of diode 36 is abruptly removed.

Anode 37 of tube 36 is maintained at a positive potential by a connection through load resistor 38 to conductor 40 upon which is impressed a positive potential. This anode potential is of a selected value less than the lowest potential that will appear at cathode 35 as a result of two simultaneous input pulses on any two input terminals of the circuit. Upon the impression of three input pulses the potential on

cathode 35 of diode 36 is depressed to a negative potential with respect to the anode 37. As a consequence, a negative pulse is created across load resistor 38 which is transmitted through condenser 41 to the output terminal 42.

The potential applied to anode 37 of diode 36 is preferably adjustable whereby the relation between the potential on the anode with respect to the cathode of diode 36 can be so selected that the coincidence system herein described is reliably operative independently of the magnitude within wide limits of the input pulses.

With the above described apparatus in mind, other modifications of the invention will become apparent to persons skilled in the art without departing from the spirit and scope of the invention, as defined with particularity in the following claims.

What is claimed is:

1. A multiple coincidence circuit for receiving signals coincident in time and for producing a large single signal, comprising at least two electron discharge devices each including an anode, cathode and control electrode, said cathodes being connected to each other and to a common cathode resistive load, said cathode resistive load being divided to furnish bias potential for said control electrodes, means for impressing said bias potential on said control electrodes, input means applied to each of said control electrodes, output means including a diode having an anode and a cathode, said cathode being connected to said first mentioned cathodes; a positive potential source connected to said diode anode whereby the simultaneous impression of negative pulses on all of said input means decreases the positive potential on said cathode and thereby results in the creation of an output pulse.

2. A multiple coincidence circuit for receiving signals coincident in time and for producing in its output a large single signal, comprising at least two electron discharge devices each including an anode, cathode and control electrode, said cathodes being connected together and to a common cathode resistive load, said cathode resistive load being provided with a tap; a grid leak resistor connected to each control electrode and to said tap to furnish bias potential for each of said control electrodes, input means coupled to each of said control electrodes, output means including a diode having an anode and a cathode, said diode cathode being connected to said first mentioned cathodes, said diode being biased at a value at which only the creation of a potential by the simultaneous application of pulses to all of said input means is sufficient to exceed said bias and render said diode conducting.

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