

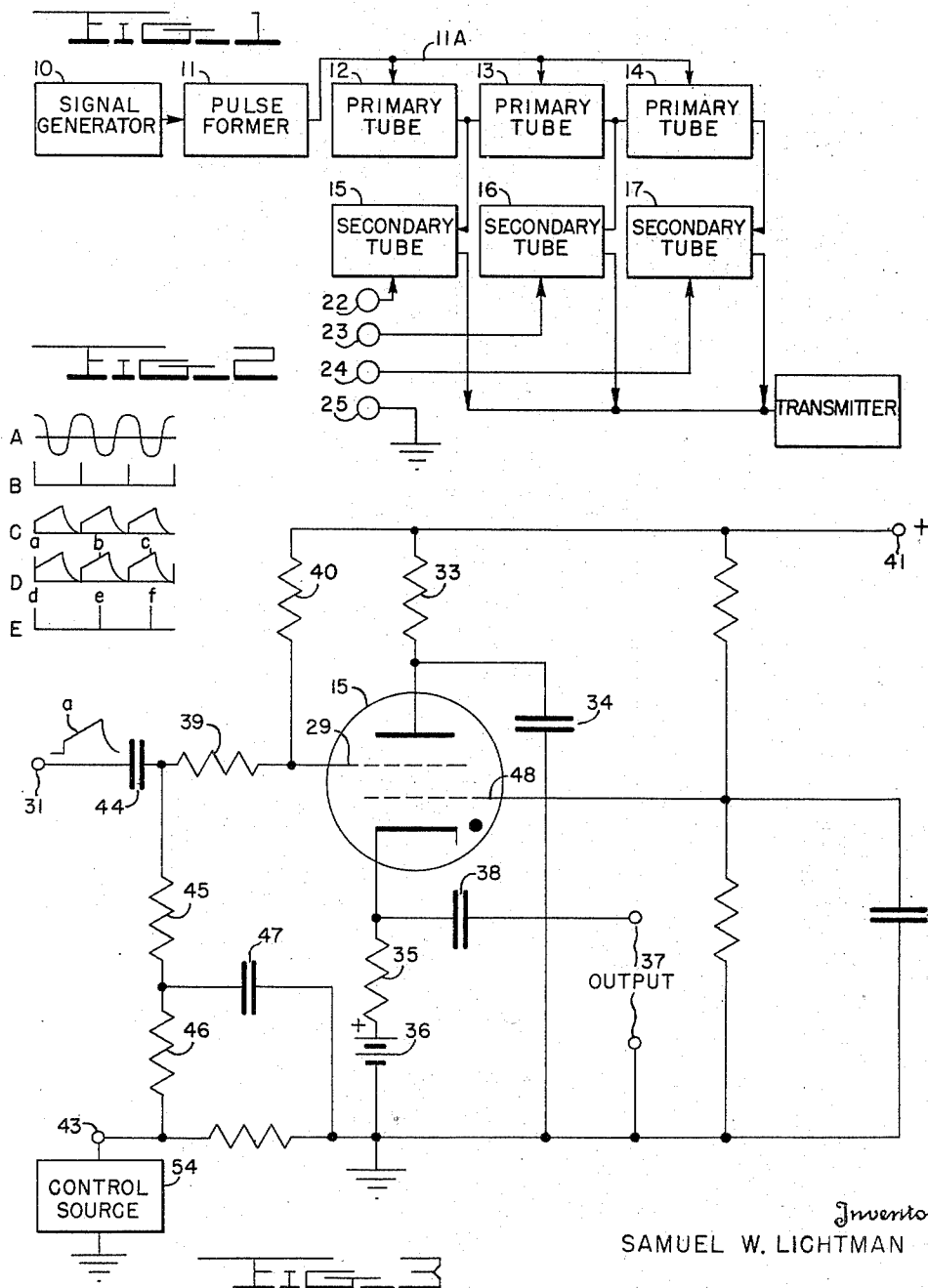
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ERROR ELIMINATION IN THYRATRON PICK-OFF CIRCUITS

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ERROR ELIMINATION IN THYRATRON
PICK-OFF CIRCUITS

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This invention relates in general to pulse time modulation systems such as disclosed by C. H. Hoeppner, Serial No. 708,857, filed November 14, 1946, now Patent No. 2,457,819, and in particular to improvements in time occurrence stabilization of the pulses generated thereby.

In the aforementioned patent there is disclosed a signal generator comprising a cascaded chain of saw-tooth generating primary electron tubes driven from a stable oscillation generator. The primary tubes of the chain are sequentially rendered operative upon the joint application thereto of a timing pulse from the oscillation generator and a saw-tooth voltage wave from the preceding primary tube. Coupled to each of the primary tubes is a corresponding secondary tube operative responsive to the output of the primary tube to produce a time modulated output pulse. The time occurrence of the time modulated pulse outputs from each secondary tube is in turn controlled by an intelligence voltage applied thereto.

It has been found that under normal circuitry operation and due to variations in the source impedance of the circuit connecting the intelligence voltage input to the secondary tubes, that the output pulses therefrom will shift in time occurrence as much as 20% from their proper positions. To properly convey intelligence, with time modulated pulses, it is necessary that this error be corrected as the position of the time modulated pulses is determinative of its intelligence.

It is accordingly an object of the present invention to provide, in a modulator system for producing time sharing signals containing information relative to a plurality of variable quantities, a method and means for stabilizing in time occurrence said time sharing signal in accordance with the intelligence to be conveyed.

Other and further objects and attainments of the present invention will become apparent from the following detailed description when taken in conjunction with a careful consideration of the following drawings, in which:

Fig. 1 is a block diagram of a suitable pulse transmitter useable by the the present invention;

Fig. 2 shows a series of wave forms added for purposes of illustrating the operation of the generating system, and

Fig. 3 is a schematic diagram of the improved type secondary tube circuit developed by the present invention.

To better illustrate and to more fully understand the purpose and function of the present invention it may best be described in conjunction

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with the system set forth in the aforementioned Hoeppner patent. It is to be understood, however, that the present invention is not to be limited to the transmitter system referred to, moreover the present invention may be employed in conjunction with any pulse time modulated system wherein there is employed an electron tube for combining intelligence voltages with that of a particular wave form for determining information relative to a plurality of variable quantities.

With reference to Fig. 1 an intelligence pulse time modulation transmitting system such as disclosed by Hoeppner, is shown in block with a series of explanatory wave forms shown in Fig. 2. The system is timed in operation by a sinusoidal oscillation signal generator 10. From the sinusoidal output of generator 10, illustrated at A of Fig. 2, a series of pulse type time reference signals of short duration are derived by pulse former 11.

The time reference pulses thus produced, and illustrated at B in Fig. 2 are applied via lead 11a simultaneously to a series of gas filled primary electron tubes 12, 13 and so on, in accordance with the number of channels employed. Each of these primary tubes corresponds to a different intelligence conveying pulse channel from which the successive pulses are transmitted. The number of primary tubes, of course, correspond to the number of intelligence channels desired. The first of the primary tubes 12 may be self-starting and is made conductive by the injection thereto of the first oscillator pulse from pulse former 11. The first primary tube generates upon conduction a saw-tooth wave form of the type as illustrated at C in Fig. 2. This wave form is coupled to the second primary tube 13 to render it conductive upon reception of the second oscillator pulse from pulse former 11. This same action continues with the third primary tube in series and so on until there is completed a cycle of operation through each primary tube employed in the series whereby there is thus generated a sequential series of saw-tooth voltages as illustrated by wave form C in Fig. 2. The circuit is so designed that no primary tube except the first in the series can be made conductive unless the voltage from the previous primary tube and the oscillator pulse from pulse former 11 are simultaneously impressed thereon. This requirement produces sequential operation of the primary tube chain.

The output of each primary tube, as typified at 12, is further supplied to a corresponding secondary gas filled electron pick-off tube, typified

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at 15. Each of the pick-off tubes is normally biased to nonconduction with the bias so arranged in the preferred embodiment that each pick-off tube conducts, in the absence of an intelligence signal applied thereto as later described, at the initial vertical slope of the saw-tooth wave form applied thereto. This action causes a narrow time modulated pulse to be developed from the pick-off tube as illustrated by wave form E of Fig. 2.

The exact point on the saw-tooth wave form, at which the pick-off tubes become conductive, is varied by the amplitude of a respective negative intelligence control voltage applied to each of the pick-off tubes. The intelligence voltage is preferably in the form of a negative control potential applied to the appropriate control terminals 22, 23, 24, and ground 25. The more negative the control potential the longer the delay between the start of the saw-tooth voltage and the initiation of conduction in the pick-off tube. The time occurrence of the output voltage pulses of wave form E with respect to the time reference markers of wave form B is therefore governed in each channel by the instantaneous amplitude of the corresponding intelligence voltage applied to the same channel via input terminals 22, 23 and 24. The sharp output pulses of the pick-off tubes are illustrated at E of Fig. 2. Pulses e and f being displaced in time from their corresponding time reference markers in wave form B in accordance with the amplitude of the intelligence voltage, applied to terminals 23 and 24 with d being representative of the first pick-off tube output wherein no intelligence voltage is applied to terminal 22.

With particular reference to Fig. 3 there is illustrated a practical operative schematic diagram of a secondary gaseous pick-off electron tube circuit constructed as taught by the present invention. In operation of the pick-off tube circuit 15 the varying signal from the cathode of primary tube 12 is supplied to the grid 29 of a gaseous type secondary pick-off electron tube 15 which may be a triode as disclosed by C. H. Hoepfner or of a multiple grid type. Tube 15 is normally maintained nonconductive by virtue of a cathode biasing voltage supplied at 36. The saw-tooth signal voltage a applied to grid 29 from connection 31 is in opposition to the average biasing voltage with respect to the cathode. The exact point in the cycle of the saw-tooth voltage a at which tube 15 becomes conductive is varied by varying the magnitude of the intelligence voltage impressed at terminal 43 by source 45. The latter voltage, which is negative in sense, is applied to the grid 29 through a suitable smoothing filter comprising resistances 45 and 46 and capacitor 47 connected between the juncture of the resistors and ground.

Termination of conduction in tube 15 is provided by the resistance-capacitance networks 33-34 placed in the anode circuit thereof. Conduction by tube 15 removes more charge from capacitance 34 than can be supplied by resistance 33 permitting the capacitance to discharge, thereby lowering the voltage impressed across the tube. Eventually this voltage falls to a level at which conduction by tube 15 cannot be maintained. Conduction then ceases and the tube becomes inoperative.

Upon the initiation of conduction in tube 15, a sharp voltage change occurs across the cathode resistance 35. This voltage change is applied

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through the coupling capacitance 38 to an output terminal 37.

As described above, the exact point on the saw-tooth a at which the thyatron pick-off tube 15 becomes conducting is controlled by the source 54. In practice this source may be a simple thermo-couple, a resistance bridge, or any one of a number of devices whose impedance is subject to wide variations during the course of operation. This variable impedance characteristic of the source 54 gives rise to a timing error in the firing of the pick-off tube 15. That is, the point on saw-tooth voltage a at which tube 15 fires is not only a function of the magnitude of the voltage from control source 54 but is also a function of the instantaneous impedance thereof. As noted above this impedance is variable almost without regard to the nature of the source and the degree of error is accordingly unpredictable and cannot be calculated.

The reason that the impedance of source 54 effects the firing time of tube 15 is not fully understood but the solution is found to reside in the application of a small positive compensating voltage on the control element 29. In practice, this voltage need not be any greater than $\frac{1}{2}$ volt and in general can be obtained from a small biasing battery, or any other means well known in the art, inserted in the grid return path of the grid 29. The most expeditious way, however, of obtaining this voltage is shown in the preferred embodiment as being obtained from the point of positive potential 41 through a dropping resistor 40.

Referring again to Fig. 1 and the operation of the system, the saw-tooth signal voltage from the cathode of tube 12 is also supplied to the next primary tube in series, tube 13. The pulse signal from pulse former 11 applied to tube 13 is not of sufficient amplitude to, alone, cause the initiation of conduction therein, however, when supplemented by the saw-tooth voltage from the cathode of tube 13 a pulse signal from former 11 can cause the initiation of conduction. Tube 13 may then be employed to permit the subsequent initiation of conduction in tube 16 in accordance with the description of tube 15. The initiation of conduction in tube 14 is in accordance with that of the tube 13 upon the application thereto of the saw-tooth voltage from tube 13 and a subsequent signal from pulse former 11. The operation of secondary tubes 16 and 17 being similar to that of tube 15 with each circuit having a positive potential applied to the input grid, for stabilizing the output pulses therefrom.

It is apparent that any desired number of primary tubes may be inserted between the tubes 12 and 14 for the transmission of any number of variable quantities. In such case a corresponding number of secondary tubes 15, 16, 17, etc. would be required, and which corresponding tubes would further incorporate the present invention.

Although I have shown only certain and specific embodiments of the present invention, it is to be expressly understood that many modifications are possible thereof without departing from the true spirit of the invention.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

What is claimed is:

1. In a thyatron pick-off circuit, the combina-

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tion of a gas tube component having a grid element therein, means for producing a timing wave of substantially uniformly varying amplitude and for applying said timing wave to said tube to produce conduction therein, a variable impedance control source connected to said grid element to control the amplitude on said timing wave at which said tube component conducts, and a compensating voltage circuit means connected to said grid element to compensate for the firing time error of said tube introduced by the impedance variations in said control source.

2. In a thyatron pick-off circuit, the combination of a gas tube component having a grid element therein, means for producing a timing wave of substantially uniformly varying amplitude and for applying said timing wave to said tube to produce conduction therein, a variable impedance control source connected to said grid element to control the amplitude on said timing wave at which said tube component conducts, and a compensating positive voltage circuit means connected to said grid element to compensate for the firing time error of said tube introduced by the impedance variations in said control source.

3. In a thyatron pick-off circuit, the combination of a gas tube component having at least a

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cathode, an anode and a grid element therein, means for cathode biasing said gas tube to maintain the same non-conductive, means for producing a timing wave of substantially uniformly varying amplitude and for applying said timing wave to said grid element to produce conduction therein, a variable impedance control source also connected to said grid element to control the amplitude on said timing wave at which said tube component conducts and a compensating positive voltage circuit means in comparison to said cathode biasing potential connected to said grid element to compensate for the firing time error of said tube introduced by the impedance variations in said control source.

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