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H. GUILLON ET AL

2,939,002

TIME SELECTORS

Filed Sept. 26, 1956

5 Sheets-Sheet 1

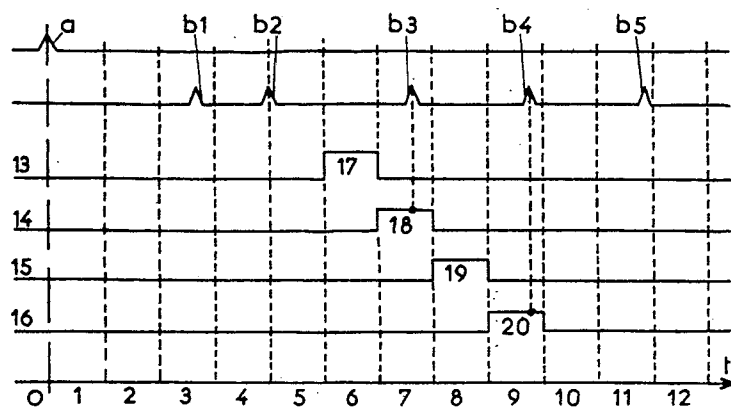


Fig. 1

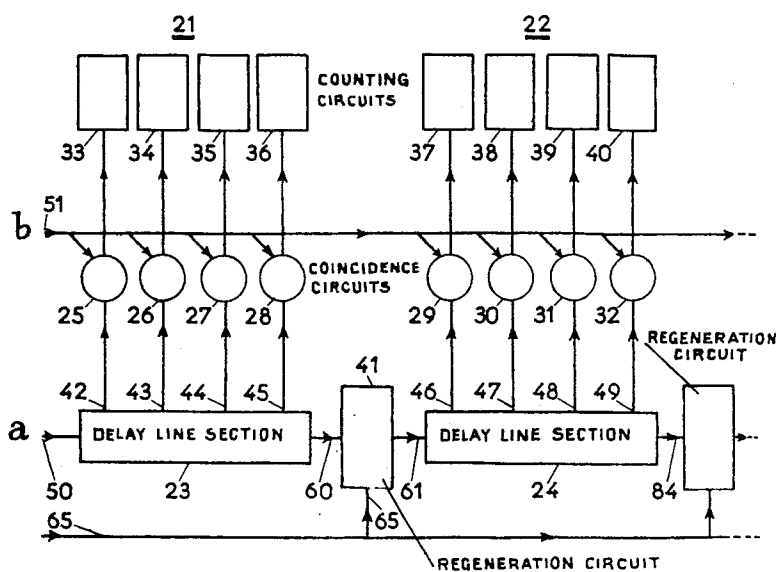


Fig. 2

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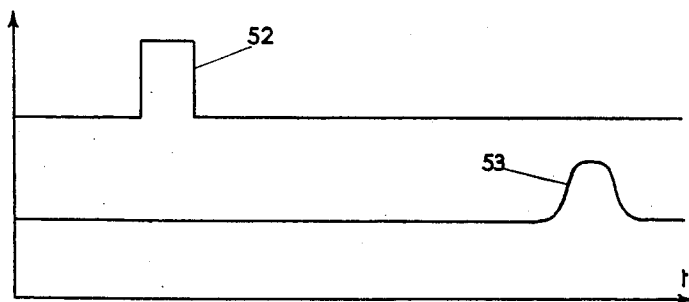


Fig. 3

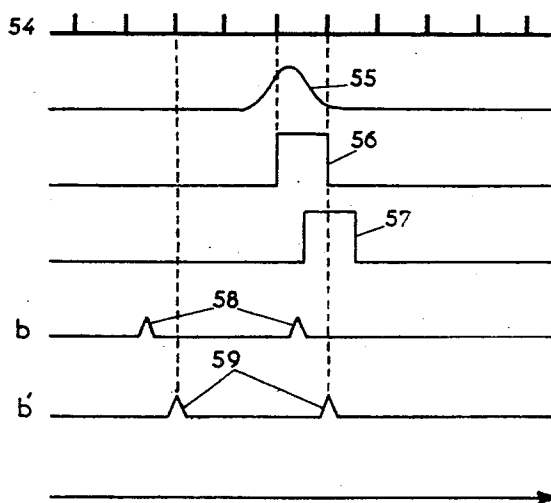


Fig. 4

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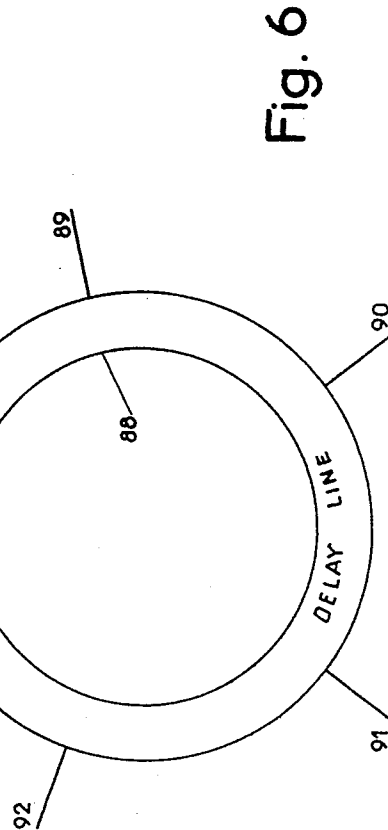
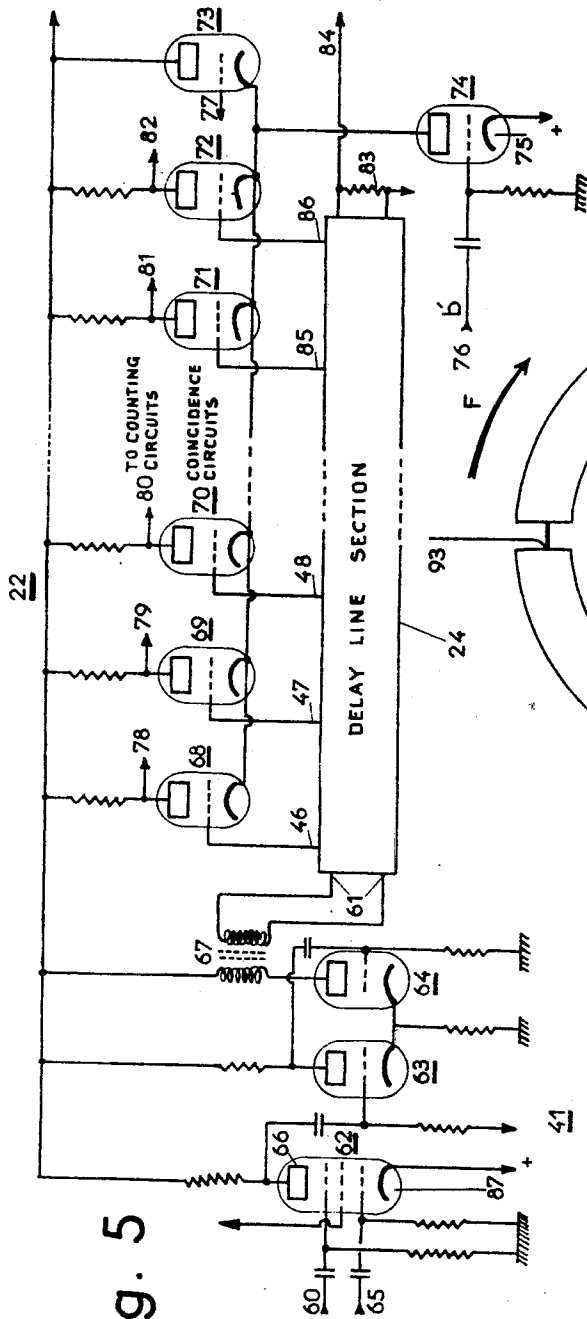
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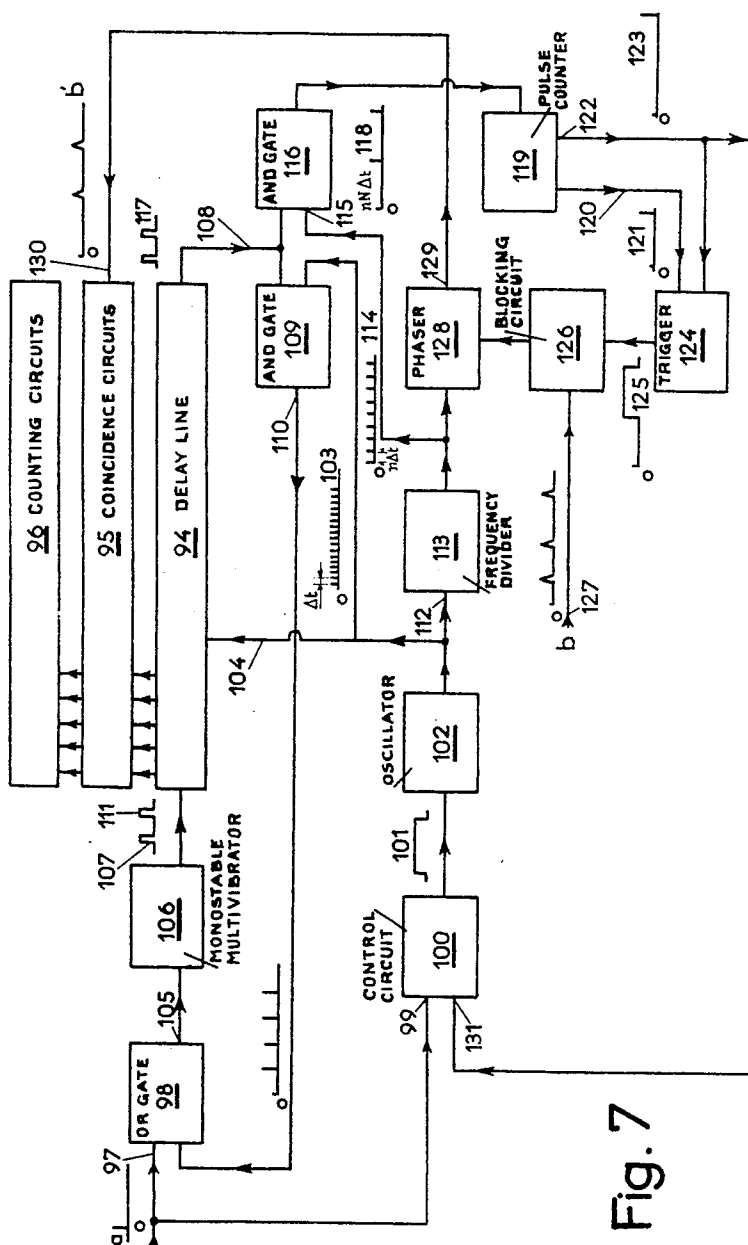
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TIME SELECTORS

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5 Sheets-Sheet 4



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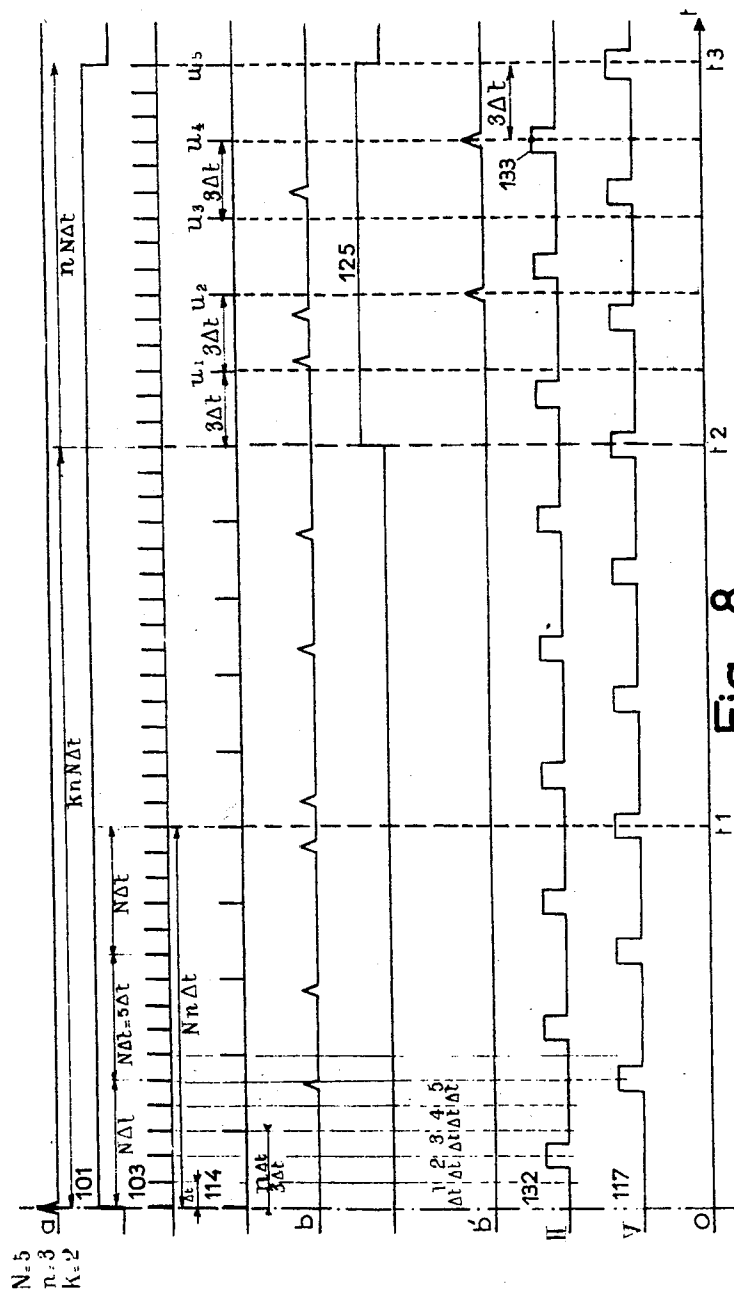


Fig. 8

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2,939,002

TIME SELECTORS

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Claims priority, application France Oct. 5, 1955

3 Claims. (Cl. 250—27)

The present invention relates to time selectors, i.e. apparatus for counting and sorting the time intervals separating events A of a first kind from events B of a second kind which are related with said events of the first kind.

In order to obtain this result, these events are transformed into corresponding electrical pulses *a* and *b*. Pulse *a* being taken as origin, time is divided into consecutive short intervals Δt which constitute time bands, and the number of pulses *b* occurring in every time band Δt is counted. Generally, a selector is capable of working with several time band widths. In some apparatus, events B are recorded only after a given time has elapsed since the corresponding event A.

For the sake of clarity, Fig. 1 of the appended drawings illustrates the principle of operation of such time selectors. Time intervals Δt are plotted in abscissas, limiting time bands 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12. An accurate division of time into such bands is obtained in known apparatus, by means of a sinusoidal oscillator which supplies a wave train of period Δt operating a system called "ring system" or "stepping circuit."

This system transmits a series of successive rectangular signals corresponding respectively to the time bands 1, 2, 3, 4, etc.

During each of these time bands, a gate signal is transmitted through an electrical circuit or "channel" corresponding thereto. Fig. 1 shows, at 13, 14, 15 and 16, the curves representing the electric state of the channels through which the gates 17, 18, 19 and 20 are transmitted during the time bands (or time intervals) 6, 7, 8 and 9 respectively. Every channel is associated with a counting circuit (not shown). When a pulse *b* occurs, the gate that is being transmitted at this time causes the counting circuit associated with the channel in which said gate is transmitted to operate.

For instance, in the example illustrated by Fig. 1 (which shows pulses b_1, b_2, b_3, b_4 and b_5), pulse b_3 , which coincides, in time, with the transmission of gate 18, causes one unit to be added to the count registered by the counting circuit associated with the channel (indicated by 14) in which said gate 18 is transmitted. This means that the time interval between pulse *a* (of the first kind) and pulse b_3 (of the second kind) has a value between $6\Delta t$ and $7\Delta t$.

When there is a great number of channels (one hundred for instance) use is made of two "ring systems" instead of a single one. One of these systems supplies ten short gate signals, of a duration equal to Δt . The other supplies ten long gate signals, of a duration equal to $10\Delta t$, obtained from said first gate signals. Control of the counting circuits is achieved by one hundred triple coincidence circuits (a triple coincidence is a coincidence of three signals whereas it is customary to call simple coincidence a coincidence of two signals). Unfortunately, the simplification obtained in the ring systems is balanced by the complication of the triple coincidence systems.

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When the duration of pulses *b* is not very small as compared with that of the gates, the errors which are introduced as a consequence of the fact that some pulses, such for instance as pulse b_2 on Fig. 1, occur just at the limit between two time bands are not negligible. It is then necessary to bring these pulses "into phase," this operation consisting, as known, in delaying pulses *b* by a variable amount, ranging from zero to Δt , so that they coincide with the respective centers of the gate signals.

As a consequence, it is impossible to register more than one event B in every channel, after an event A. In the field of nuclear physics, this does not constitute a major drawback, because the rates of counting that are used are so low that there is very little probability of two *b* pulses occurring simultaneously in the same band.

But the main drawbacks of apparatus as above referred to are as follows:

a. It is necessary to provide for a number of triple coincidences equal to that of channels;

b. Electronic ring systems are to be used. Adjustment and operation of these circuits are delicate. Furthermore they are not of a nature to achieve quick action; with ordinary electronic tubes, the width of the time bands might be made as low as one half of a microsecond, but it is preferable, for practical purposes, to use one microsecond as lower limit.

The object of our invention is to provide a time selector which is free from said drawbacks.

For this purpose, according to our invention, we make use, to transmit, at time intervals equal to Δt , the gate signals to the counting and other circuits, of a delay line along which each gate signal is made to travel at a speed in accordance with the value of Δt .

Regeneration means are provided to make it possible, at the output of the delay line, or of a section thereof, to regenerate the gate signal which has become more or less deformed and the speed of propagation of which through the line is not very accurately determined, said means synchronizing the gate signal with the pulses of the main oscillator so as to obtain a piloting of the gate signals over the whole of the delay line.

With such an arrangement, it becomes possible to simplify the construction of time selectors. As the construction of a delay line is the easier as the desired delay is shorter, its use will consequently be all the more advantageous as the desired time bands are narrower.

Preferred embodiments of our invention will be hereinafter described with reference to the accompanying drawings, given merely by way of example and in which:

Fig. 1, as already referred to, illustrates the principle of known selectors.

Fig. 2 is a lay-out of a portion of a time selector apparatus made according to our invention.

Figs. 3 and 4 show curves illustrating the principle of the operation of our apparatus.

Fig. 5 shows in a more detailed fashion a section of the apparatus of Fig. 2.

Fig. 6 shows a delay line closed upon itself according to our invention.

Fig. 7 shows a complete apparatus according to our invention combining the features illustrated by Figs. 2 and 6.

Fig. 8 shows curves illustrating the operation of the apparatus of Fig. 7.

We will now describe, with reference to Fig. 2, the principle of a time selector made according to our invention.

This selector includes several identical units and Fig. 2 shows two of them, 21 and 22. Unit 21 includes a delay line section 23, coincidence circuits 25, 26, 27 and 28, and corresponding counting circuits 33, 34, 35 and 36.

The other unit 22 includes a delay line section 24, coincidence circuits 29, 30, 31 and 32 and the corresponding counting circuits 37, 38, 39 and 40. Between the two delay line sections there is provided a regeneration circuit 41 which will be more explicitly referred to herein-after. Each delay line section includes a number M of taps, M being equal in this case to four. Delay line section 23 includes taps 42, 43, 44 and 45. Delay line section 24 includes taps 46, 47, 48 and 49.

The taps are placed at equal distances from one another so that the gate signal travelling along the delay line passes from one tap to the next one in a time interval equal to Δt . Each tap is connected with a simple coincidence circuit and a counting circuit, these circuits being arranged in the known fashion. The gate signal which is travelling along the delay line has itself, at any point of said line, a duration equal to Δt . Therefore, there is always one gate signal on one tap, and only one tap, for a time interval equal to Δt , until said signal has reached the end of the line.

The principle of operation is as follows.

Simultaneously with an event A of the first kind, a gate signal is delivered at 50 on the delay line and its propagation through said line is suitably delayed. Some time after this and simultaneously with an event B of the second kind, a pulse is transmitted through line 51 along which it is propagated instantaneously. Thus, it can overcome the gate signal at a given point of the delay line. At this point, the coincidence circuit corresponding to the tap on which the gate signal is then passing is energized and causes the counting of one unit in the counting circuit corresponding with said tap.

However, this operation is based upon the assumption that the delay line is perfect, that is to say, capable of delivering at its output a signal identical to the input signal after an exactly predetermined time interval. Now, a delay line always has a non negligible frequency band-pass width and therefore deforms the signals travelling thereon.

Fig. 3 shows, at 52, a signal applied to the input of a line in the form of a rectangular pulse and, at 53, the deformed shape of this signal at the output of the same line. Furthermore, various losses reduce the amplitude of the signal.

When it is desired to transmit a signal in good condition and with a high delay, it is therefore necessary to insert in the line, either repeater circuits intended to compensate for the losses, or regeneration circuits which restore the initial shape of the signal.

On the other hand, the accuracy of the delay supplied by a line is relatively low. As a matter of fact, due to the deformation of the signal (Fig. 3), the notion of delay introduced by the line cannot be defined in a very accurate manner.

The delay also depends upon the temperature, unless particular care is taken to compensate the temperature coefficient of the elements of the line.

Finally, it is difficult to obtain, on lines of identical manufacture, delays which differ from one another by less than 1% in relative value.

Therefore, in order to obtain the propagation of a signal on a delay line in such manner that said signal keeps its initial shape and travels at a predetermined constant speed, it is necessary to provide special means for this purpose.

Advantageously, such means consist, in a time selector according to our invention, in "piloting" the gate signal along the line. For instance, said line is constituted, as illustrated by Fig. 2, by several sections such as 23 and 24 between which are inserted regeneration circuits such as 41. Each of these circuits automatically performs a regeneration of the output gate signal and further synchronizes this signal by means of pilot pulses supplied at 65 and transmitted from the main oscillator (not shown). On Fig. 4 we have illustrated by means of curves, in

which time is plotted in abscissas, the deformed signal 55 supplied at the output 60 (Fig. 2), of line section 23. Fig. 4 shows at 56 the same signal after it has been given back its initial shape and has been reset in synchronism with the pulse train 54 supplied by said main oscillator. It is in this form that the gate signal is introduced as 61 (Fig. 2) in the next line section 24. We have shown at 57 on Fig. 4 the gate signal when it passes on tap 46, the time of travel between the input end 61 on the line and the first tap 46 being equal to Δ_2/t . The period of the oscillator is made as close as possible to the time of propagation of the gate signal between two consecutive taps.

Owing to the provision of such gate signal regenerating and synchronizing circuits, the delay line may be considered as theoretically perfect.

In actual practice, due to the deformations of the delay line and to possible defects in the regeneration circuits, it is not possible to be sure that the gate signal is always of a width exactly equal to Δt . Therefore it might happen that a signal located too close to the limit between two time bands is not counted or is counted twice (i.e. once in each of said bands). In order to obviate this drawback, we set pulses b in phase according to a known method. Thus the signals b shown at 58, Fig. 4, are replaced by signals b' delayed with respect to signal b by time intervals suitable for locating each of said signals b' in the middle part of a gate signal as shown at 59.

Among the main advantages obtained with time selectors according to our invention and based upon the use of delay lines, we will cite the following ones:

(a) A satisfactory operation for small band widths; thus, we can use band widths lower than one micro-second;

(b) An apparatus the cost of which is lower than that of the conventional time selectors.

It suffices, in order to perform time selection, to effect a simple coincidence between each of the taps of the delay line and the conductor 51 (Fig. 2) on which are transmitted the pulses b' of the second kind. This constitutes an essential advantage, since every triple coincidence is replaced by a simple coincidence, which permits of reducing the material used for effecting their coincidences.

The advantages which may be obtained concerning the apparatus depend upon the performance to be obtained, to wit width and number of the bands. The most economical field of utilization is between 20 and more than 100 taps for small band widths.

Our invention does not exclude the possibility of making use partly of the conventional arrangements. For instance, if it is desired to obtain a 1000 band selector, we may use a 100 tap selector according to our invention in combination with a 10 ring system whereby 1000 simple coincidences are effected in supplement.

Anyway we obtain a high safety of operation. The number of tubes are reduced in a ratio which may be as high as two or three to one. The circuits are simpler and their operation is much less critical than that of ring systems.

These time selectors permit as a rule of establishing statistics of short time intervals. They are very useful, in the field of nuclear physics for the measurement of the periods of radioactive elements and of the time of flight of particles.

We will now describe with more detail, with reference to Fig. 5, a section of the apparatus of Fig. 2.

The selector section of Fig. 5 includes a unit 22 and a regeneration circuit 41. Unit 22 comprises a delay line section 24 including a plurality of taps such as 46, 47, 48 . . . 85 and 86 and the corresponding coincidence circuits, the number of which is equal to that of the taps. The coincidence circuits are constituted by triodes 68, 69, 70, 71 and 72. Between two regeneration circuits and

when making use of delay lines such as are commercially available, it is possible to insert easily up to ten coincidence circuits.

The regeneration circuit includes tubes 62, 63, 64. Tube 62, which has two control grids, achieves coincidence between the gate signal at the output 60 of the preceding line section (signal 55 of Fig. 4), and the pulse train 54 (Fig. 4) applied at 65. The cathode 87 of the tube 62 is given a positive bias so that said tube is not conductive in the state of rest. There is obtained at its anode a negative pulse of short duration which determines the time of starting of the new gate signal. This signal starts the monostable multivibrator 63, 64 which supplies in its anode circuit a negative rectangular signal of a width equal to Δt . This signal, reversed by transformer 67, is applied to the input 61 of the delay line section 24.

The coincidence circuits that are shown have been chosen for their great simplicity, their low consumption of anode current and their safety of operation.

Tube 74 is connected in series with the whole of tubes 68, 69, 70, 71, 72 and 73 in the feed circuit. Tube 74 is made non conductive at rest by the positive biasing of its cathode 75. It receives at 76 the positive pulses b' (resulting from a resetting in phase of pulses b as above stated) which make it conductive. When this occurs, there is only one tube in the series 68, 69, 70, 71, 72 and 73 through which current is flowing, to wit that the grid bias of which is the most positive. In the absence of a gate signal along the line, this is the case of tube 73, the grid of which is positively biased, for instance at +130 v., whereas the grids of tubes 68, 69, 70, 71 and 72 are positively biased at a slightly lower value, for instance 125 v. If there is a gate signal on section 24, the tube through which current is flowing is that which is receiving this signal, at the time when pulse b' is arriving. The anode of this tube receives a negative signal which is applied to a counting system (not shown). Fig. 5 shows only the connections 78, 79, 80, 81 and 82 toward this counting system.

The delay line section 24 ends on its characteristic impedance 83 so as to avoid any reflection of the gate signal and the output signal is applied at 84 to the next regeneration circuit (not shown on Fig. 5).

We will now indicate how it is possible if so desired, as in conventional selectors, on the one hand, to modify the width of the bands and, on the other hand, to delay analysis, these two operations being possibly performed simultaneously.

Concerning the first one, it is possible without changing the frequency of the main oscillator to obtain by means of the same delay lines, band widths which are integral multiples of the elementary width Δt defined as above stated in accordance with said delay lines and with the oscillator frequency.

In order to obtain this result: the pulses b of the second kind are set in phase with a period n times greater than that of the oscillator (n being an integer), which means that, means being provided to determine a succession of time periods equal to $n\Delta t$ in synchronism with the passing of the gate signal at every n th tap, we transmit a pulse b' in response to every event of the second kind, but with a variable delay such that every pulse b' coincides with the end of the time period $n\Delta t$ during which said event of the second kind has occurred; the delay line is closed upon itself so that the gate signal can flow therethrough n times during every cycle of the selector; the number N of taps is chosen to have no common divisor with n so that every tap works once, and only once, during each cycle.

Fig. 6 diagrammatically shows a delay line 88 closed upon itself through a regeneration circuit which is not shown. It is provided with four taps 89, 90, 91 and 92 corresponding to four coincidence circuits (not shown),

and a fifth coincidence circuit is connected with the output 93 of the line which constitutes a fifth tap.

If it is desired for instance to increase the band width from Δt to $3\Delta t$, the counting should be made in the order 91, 89, 92, 90, 93. As a matter of fact, the gate signal which is travelling through the line in the direction of arrow F will reach tap 91 at the time $3\Delta t$, tap 89 at the time $6\Delta t$, and so on. Consequently, any event B occurring during the time interval from zero to $3\Delta t$ will be registered on the counting system corresponding to tap 91. Any event B occurring in the time interval from $3\Delta t$ to $6\Delta t$ will be registered on the counting system corresponding to tap 89, and so on.

With this arrangement, the resetting into phase for every $3\Delta t$ interval makes it necessary to obtain a pulse train having a frequency equal to one third of that supplied by the oscillator. By effecting a coincidence between this pulse train and the signal at the output of the delay line, we obtain a signal corresponding to the end of the full cycle of the time selector (equal in this case to $nN\Delta t$, that is to say $15\Delta t$). This signal may serve to stop the operation of the selector for instance by stopping the oscillator.

We will now consider the means for delaying analysis. It suffices for this purpose to cause the selector to perform several "dead" cycles before admitting the pulses b' to the coincidence circuits. As the duration of a cycle is $nN\Delta t$, where N is the number of taps or counting channels, analysis may therefore be effected between times $knN\Delta t$ and $(k+1)nN\Delta t$. This requires the use of a counter which, after a number of dead cycles equal to k , causes pulses b to be admitted and after $(k+1)$ cycles stops the operation of the selector.

Figs. 7 and 8 show the construction of a time selector made in this way.

On Fig. 7 there is shown a delay line 94 and the corresponding coincidence circuits 95 and counting circuits 96. Pulse a (Figs. 7 and 8) taken as origin for the times is applied at 97 (Fig. 7) on the OR gate circuit 98, on the one hand, and at 99 on the control circuit 100 of an oscillator 102, on the other hand. This control circuit 100 emits the control signal 101 of said oscillator 102. This signal 101 will last until the time $(k+1)nN\Delta t$ which corresponds to the end of the cycle of operation of the apparatus. The oscillator then transmits the train of pulses 103 of period Δt which serves, according to the invention, to "pilot" the gate signal along line 94 (diagrammatic circuit 104).

At the output 105 of the OR gate circuit 98, pulse a operates the monostable multivibrator 106 which delivers the gate signal fed to the input of line 94. This signal flows through said line. At the end of time $N\Delta t$ it reaches the end of this line and is then applied at 108 to the AND gate circuit 109 which permits of collecting the pulse of train 103 existing at time $N\Delta t$. The pulse collected at the output 110 of circuit 109 is applied to the OR gate circuit 98 and creates, in turn, through monostable multivibrator 106, a gate signal 111 offset by $N\Delta t$ with respect to gate signal 107. The whole of the circuits 106 and 109 thus constitutes a regeneration circuit such as that disclosed at 41 on Fig. 5.

The gate signals, such as 107, 111, etc., thus travel along the delay line 94 until the train of pulses 103 has ceased. On the other hand it will be seen that the delay line 94 is closed upon itself whereby it is possible to obtain, in view of the respective positions of the taps of circuits 95, the operation as band multiplier illustrated by Fig. 6.

On the other hand, the train of pulses 103 is applied at 112 to the frequency divider 113 which supplies at its output a new train 114 of a period equal to $n\Delta t$. This train 114 is, in turn, applied at 115 to a second selection circuit 116. The gate signals 117 collected at the output 108 of line 94 permit of selecting from the train

of pulses 114 the impulses 118 of a period equal to $nN\Delta t$ which corresponds to the end of each cycle of the selector.

These impulses 118 are applied to the impulse counter 119 which delivers, on line 120, a first signal 121 at the time $knN\Delta t$ and on line 122 a second signal 123 at the time $(k+1)nN\Delta t$.

These signals are fed to a flip-flop, or trigger, circuit 124 which delivers a signal 125 during the time interval between $KnN\Delta t$ and $(K+1)nN\Delta t$.

During the whole of this signal 125, the blocking circuit 126 admits pulses b arriving from 127 towards a circuit 128 of a known type for setting into phase; these pulses are delivered at 129 (pulses b') and are then in phase with the pulses 114, that is to say correspond to the period $n\Delta t$ and are applied at 130 to the coincidence circuits 95.

The pulse 123 collected at the output 122 of counter 119 is applied at 131 to the control circuit 100 of the oscillator and causes said oscillator to stop at the time $(k+1)nN\Delta t$.

Fig. 8 diagrammatically shows the pulses and signals as a function of the time, plotted in abscissas. The original time is the time of transmission of a pulse a . This figure corresponds to the simple case where $N=5$, $n=3$, $k=2$, which complies with the conditions above set forth (N having no common divisor with n).

As soon as the control signal 101 appears, the oscillator transmits the train of impulses 103 of a period equal to Δt ; at 114 is shown the train of oscillations having a period $3\Delta t$ obtained from the first train 103.

During the first two cycles which end respectively at times $t_1 = Nn\Delta t = 15\Delta t$ and $t_2 = 2nN\Delta t = 30\Delta t$, pulses b are not admitted to the coincidence circuits and no counting takes place. These are two dead cycles.

At time t_2 the signal 125 occurs, for the admission of the pulses b . We have shown both the pulses of the type b and those of the type b' reset in phase with the multiplied train 114 ($n\Delta t$).

Finally we have shown at the bottom of Fig. 8 the times at which the gate signals are passing on the taps leading to the respective coincidence circuits which control each one counting circuit. There are five counting circuits ($N=5$), each controlled by a coincidence circuit, respectively. The gate signals pass on the tap of a given coincidence circuit at successive time intervals of $5\Delta t$. For instance, on Fig. 8, 132 represents the times at which the gate signals pass on the tap of the second coincidence circuit (designated by II on Fig. 8). The times of passage of the gate signals on a coincidence circuit tap are offset by Δt with respect to the corresponding times of passage of said gate signals on the tap of the preceding coincidence circuit. This is why the times of passage, shown at 117, of the gate signals on the tap of the fifth coincidence circuit (V) are offset by $3\Delta t$ with respect to those, shown at 132, corresponding to the second coincidence circuit. Now, due to the action of means 113, 128, 129, signals b are transformed into signals b' , which are transmitted to coincidence circuits 95 only at the ends of time periods equal to $3\Delta t$ ($n=3$). Between times t_2 and t_3 , there are five such time periods, the ends of which are indicated on Fig. 8 by the dotted lines u_1, u_2, u_3, u_4, u_5 . Taking for instance a signal b occurring during the fourth of these time periods (i.e., between u_3 and u_4), this signal is transformed into a signal b' transmitted to coincidence circuits 95 at time u_4 . At the same time, a gate signal 133 passes on the tap of the second coincidence circuit and the corresponding counting circuit is operated. In a likewise manner it could be shown, in accordance with what has been stated with reference to Fig. 6, that the gate signals passing on the tap of the first coincidence circuit permit counting of the signals b' delivered at the end u_2 , of the second time period u_1-u_2 , that the gate signals passing

on the tap of the third coincidence circuit permit counting of the signals b' delivered at the end u_4 of the first time period u_1 and so on.

Anyway counting takes place by intervals equal to $3\Delta t$ and no longer by intervals equal to Δt , which truly corresponds to what has been stated above. Furthermore, counting is effected only on every third cycle. Thus, it is possible to expand the band and to delay the analysis.

In a general manner, while we have, in the above description, disclosed what we deem to be practical and efficient embodiments of our invention, it should be well understood that we do not wish to be limited thereto as there might be changes made in the arrangement, disposition and form of the parts without departing from the principle of the present invention as comprehended within the scope of the accompanying claims.

What we claim is:

1. A time selector for establishing time intervals between independently occurring events A and B respectively which comprises, in combination, a plurality of counting circuits, a plurality of coincidence circuits each having its output connected with one of said counting circuits for operating it, each of said coincidence circuits being capable of operating the corresponding counting circuit when both a pulse signal and a gate signal are simultaneously transmitted to the respective inputs of said coincidence circuit, a delay line, means for feeding a gate signal to one end of said line in response to the occurrence of an event of the first kind, a plurality of taps connecting points spaced apart along said delay line each with one input of one of said coincidence circuits respectively, to feed said last mentioned gate signal to said inputs of said coincidence circuits successively at respective time intervals Δt , said delay line being made of a plurality of sections, an oscillator transmitting pilot pulses at a predetermined frequency, means inserted between every two consecutive sections of said delay line and connected with said oscillator for changing the deformed gate signal which leaves the first of said two sections into a gate signal of restored wave form and in synchronism with said pilot pulses, which enters the second of said two sections, an instantaneous signal transmission line, means for connecting to said last mentioned line the respective other inputs of all of said coincidence circuits in parallel, means for determining a succession of time periods equal to $n\Delta t$ in synchronism with the passing of said gate signal at every n th tap, and means operative in response to every occurrence of an event of the second kind for feeding an electric pulse to said instantaneous transmission line at the end of that of said last mentioned periods during which said last mentioned event has occurred, said delay line being closed upon itself and the number of said taps being N , such that N and n have no common divisor.
2. A time selector according to claim 1 further including means for making it inoperative for given time intervals $nN\Delta t$.
3. A time selector for establishing the statistics of the variable time intervals between a series of events of a first kind and a series of events of a second kind, respectively, which comprises, in combination, a plurality of counting circuits, a plurality of coincidence circuits each having its output connected with one of said counting circuits for operating it, each of said coincidence circuits being capable of operating the corresponding counting circuit when both a pulse signal and a gate signal are simultaneously transmitted to the respective inputs of said coincidence circuit, a delay line, means for feeding a gate signal to one end of said delay line in response to the occurrence of an event of the first kind, a plurality of taps connecting points spaced apart along said delay line each with one input of one of said coincidence circuits respectively, to feed said gate signal to said inputs of said coincidence circuits successively at respective time

intervals Δt , said gate signal being pulses of duration Δt , an instantaneous signal transmission line, means for connecting to said signal transmission line the respective other inputs of all of said coincidence circuits in parallel, and means for feeding to said signal transmission line said pulse signal in response to every occurrence of an event of the second kind subsequent to said occurrence of an event of the first kind.

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