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[54] SIMPLIFIED MEANS OF SKIPPING SELECTABLE SEGMENTS OF A TIMED PROGRAM

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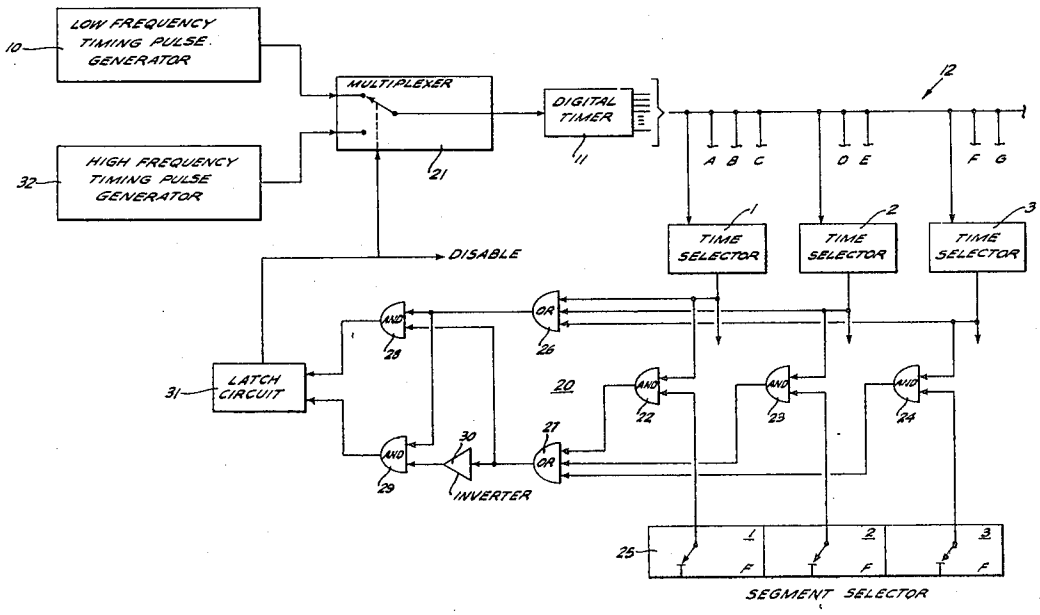
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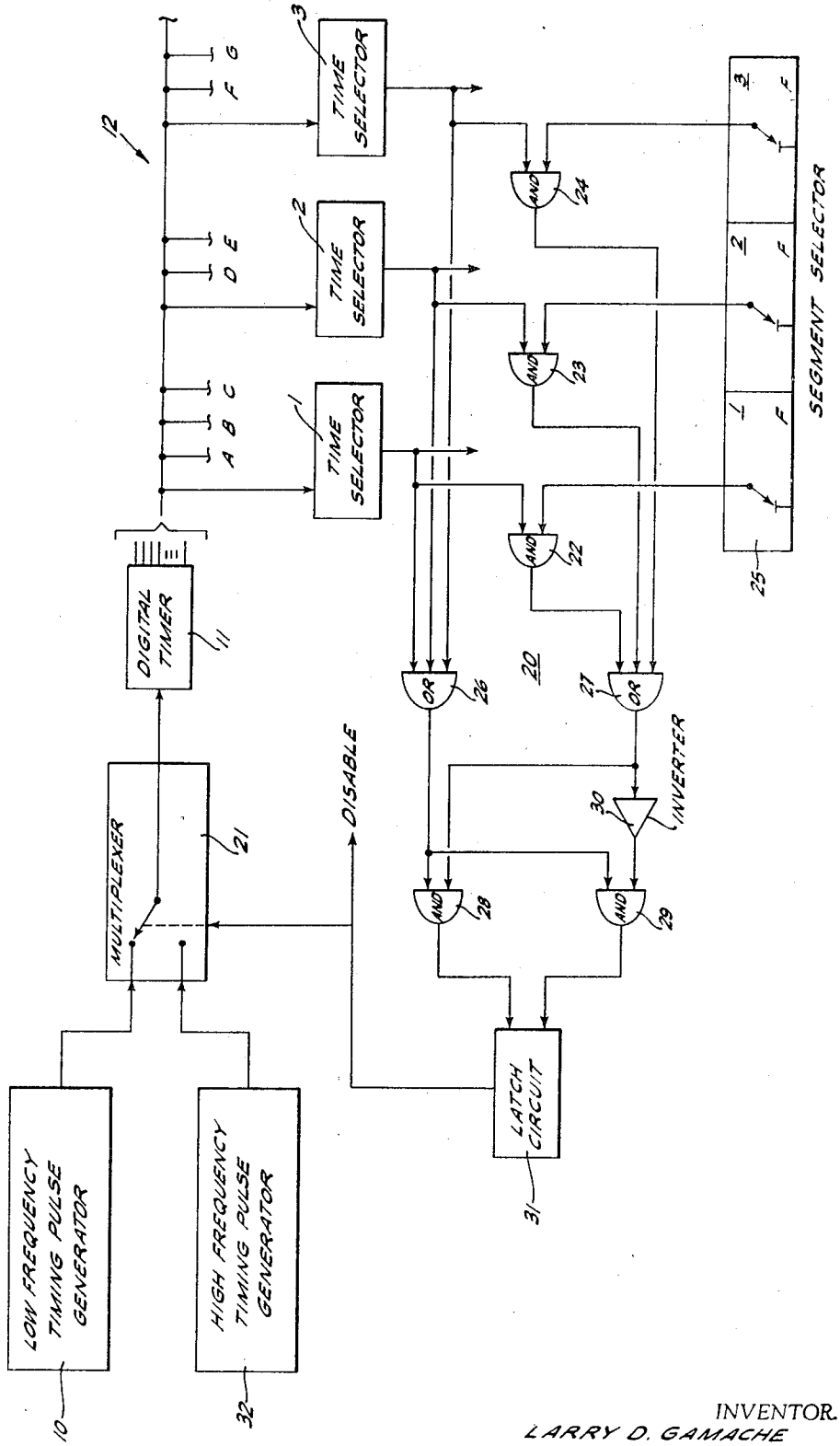
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[57] **ABSTRACT**

In a programmer for controlling the operation of a plurality of segments in a multiple segment selector system that normally sequences all segments in series, wherein a source of low-frequency timing pulses is applied to a digital timer which sequentially activates the segments, a simplified means for selectively bypassing any number of said segments comprising a source of high-frequency timing pulses, selector means for generating a separate disable signal for each of the segments to be bypassed, coincidence means responsive to the activation of each of the segments and the selector means for generating a triggering signal upon the simultaneous occurrence of the activation of a segment and a disable signal for such segment, and means responsive to the occurrence of a triggering signal for switching the input of the digital timer from the low-frequency timing pulse source to the high-frequency timing pulse source so that the segment to be bypassed is executed at a very high speed relative to normal operation whereby the timer is rapidly sequenced to the next segment.

6 Claims, 1 Drawing Figure





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SIMPLIFIED MEANS OF SKIPPING SELECTABLE SEGMENTS OF A TIMED PROGRAM

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a simplified means for skipping selectable segments of a timed program and, more particularly, to a means for selectively bypassing any number of segments in a multiple segment selection system that normally sequences all segments in series.

2. Description of the Prior Art

A wide variety of different types of scientific instruments include a programmer arrangement for operating various functions associated with the instrument in a predetermined time sequence. One such instrument is a process gas chromatograph which separates and measures the components in a gas mixture by passing the mixture through a chromatographic column in a carrier stream of gas. In such a process gas chromatograph, a quantity of sample gas from one or more process streams is introduced into an analyzer having a gas chromatographic column for separating sample constituents. The various mechanical and electrical functions of the analyzer are performed in a predetermined time sequence. These functions may include the operation of valves for taking samples from the process streams at certain times, the switching of valves for injecting the samples into the chromatographic column, the operation of valves for controlling the various chromatographic columns during analysis, and the control of electrical switches for actuating the attenuators and sensors for determining the sample constituents as they enter a detector.

A typical programmer arrangement for a process gas chromatographic analyzer as well as other scientific instruments includes a conventional digital timer which is programmed to actuate the various mechanical and electrical functions in a predetermined time sequence. However, under some circumstances, it is desirable to be able to skip certain programmed functions. In the past, the requirement for selectively bypassing any one or more of certain segments of the program has required extensive decoding logic which has, in essence, changed the program to eliminate the unwanted segments. This has resulted in a significant increase in the complexity of the programming system.

SUMMARY OF THE INVENTION

According to the present invention, there is provided a simplified method and means for selectively dropping and regaining any number of segments in a multiple segment selection system that normally sequences all segments in series. By the addition of a simple coincidence circuit and a multiplexer, the present circuit causes the digital timer to operate in a "count fast" mode, thereby effectively skipping the functions within a segment that are not of interest. In reality, no functions are skipped but are executed at a very high speed relative to normal operation. Since performance of the functions, in the case of a chromatograph analyzer, cannot follow high speeds, they effectively appear not to function.

Briefly, the present means for selectively bypassing any number of segments in a multiple segment selection system comprises a source of high-frequency timing pulses, selector means for generating a separate disable signal for each of the segments to be skipped, coincidence means responsive to the activation of each of the segments and the selector means for generating a triggering signal upon the simultaneous occurrence of the activation of a segment and a disable signal for such segment, and means responsive to the occurrence of a triggering signal for switching the input of the digital timer from the normal low-frequency timing pulse source to the high-frequency timing pulse source whereby the timer is rapidly sequenced to the next segment.

It is therefore an object of the present invention to provide a method and means for dropping and regaining segments of a timed program at will.

It is a further object of the present invention to provide a simplified means for selectively bypassing any number of segments in a multiple segment selection system that normally sequences all segments in series.

It is a still further object of the present invention to provide a programmer for a process gas chromatograph which permits the selective skipping of any function that is not of interest.

It is another object of the present invention to provide a simplified means of skipping selectable segments of a timed program by causing the programmer to count fast through a segment to be skipped.

Still other objects, features and attendant advantages of the present invention will become apparent to those skilled in the art from a reading of the following detailed description of the preferred embodiment constructed in accordance therewith, taken in conjunction with the accompanying drawings wherein:

BRIEF DESCRIPTION OF THE DRAWING

The sole FIGURE is a block diagram of a preferred form of means for skipping selectable segments of a timed program constructed in accordance with the teachings of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the sole FIGURE of drawings, a conventional digital programmer for a scientific instrument such as a process gas chromatograph may include a normal low-frequency timing pulse generator **10** connected to the input of a standard digital timer **11** which has a plurality of outputs connected to the inputs of one or more time selectors, generally designated **12**, which have the ability of executing some work function at the outputs thereof. For the purpose of explanation, the drawing shows 10 time selectors grouped into three major segments. The first time selector for each segment is identified by the numerals **1**, **2** and **3**, respectively, whereas the remaining time selectors for each segment are identified by the letters A through G. Such a circuit may be used as the program timer for a process gas chromatograph in which a quantity of sample gas from three process streams are to be analyzed. In such case, time selectors **1**, **2** and **3** would initiate the operation of the valves for taking samples of the three process streams and the time selectors corresponding to letters A through G would initiate the various functions required to complete an analysis of the corresponding stream.

Normally, such conventional digital programming apparatus operates to activate the time selectors in sequence. No provision is made for changing the sequence or skipping certain segments of the program.

According to the present invention, there is provided a logic circuit, generally designated **20**, and a multiplexer **21** which permits the selective bypassing of any number of segments at will. More specifically logic circuit **20** includes a plurality of two-input AND-gates **22**, **23** and **24**, one for each time segment which is to have the capability of being skipped. In the present case, since the output functions to be performed are divided into major time segments, there is only one AND gate for each of time selectors **1**, **2** and **3**. However, in a more general circuit arrangement, in which consecutive time selectors are independently operable, there would be an AND gate for each of such independent time selectors.

Each of AND-gates **22** through **24** receives as one input thereto the output of one of time selectors **1–3**, respectively. The other input to each of AND-gates **22–24** is derived from a segment selector **25** which has a plurality of stages, numbered **1–3**, one for each time segment which is to have the capability of being skipped. Segment selector **25** may simply include a plurality of manual or electronic switches for selectively applying to the input of the corresponding AND gate a true or false signal depending upon whether the particular segment is to be retained or skipped. When a particular segment is to be included in the sequence, the corresponding stage of segment

selector 25 is placed in the true position. On the other hand, if a particular segment is to be skipped, the corresponding stage of segment selector 25 is moved to the false position.

Logic circuit 20 also includes first and second OR-gates 26 and 27, OR-gate 26 receiving at its inputs the outputs of each of time selectors 1–3, and OR-gate 27 receiving at its inputs the outputs of AND-gates 22–24. The output of OR-gate 26 is applied to first inputs of a pair of two-input AND-gates 28 and 29. The output of OR-gate 27 is applied to the other input of AND-gate 28 and through an inverter 30 to the other input of AND-gate 29. The output of AND-gate 28 is applied to a first input of a latch circuit 31 whereas the output of AND-gate 29 is applied to a second input of latch circuit 31. The output of latch circuit 31 is applied to the control input of multiplexer 21 which also receives the outputs of low-frequency timing pulse generator 10 and a high-frequency timing pulse generator 32. Multiplexer 21 may be an electronic device for selectively applying the output of either generator 10 or generator 32 to digital timer 11, depending upon the state of latch circuit 31.

In operation, the outputs of time selectors 1, 2 and 3 are normally false except when they are activated by digital timer 11 to perform their particular work function. At that time, the output of the activated time selector goes true. In addition, AND-gates 22–24 normally receive true inputs from segment selector 25 if the segment is to be permitted to operate.

Assume, for example, that stages 1 and 3 of segment selector 25 are true so that time selectors 1 and 3 are to function and that stage 2 of segment selector 25 is false so that time selector 2 is to be skipped. When time selector 1 goes true, a true signal is applied through OR-gate 26 to the first inputs of AND-gates 28 and 29. A similar true signal is applied to the first input of AND-gate 22. Since stage 1 of segment selector 25 is true, the output of AND-gate 22 goes true and a true signal is applied to OR-gate 27. Since time selectors 2 and 3 are, during the actuation of time selector 1, false, no signals appear at the outputs of AND-gates 23 and 24.

The true signal from AND-gate 22 passes through OR-gate 27 to the second input of AND-gate 28. Since both inputs to AND-gate 28 are now true, latch circuit 31 receives a true signal at its first input thereby connecting the output of multiplexer 21 to a low-frequency timing pulse generator 10 and the timing sequence continues as normal. It should also be noted that the true signal from OR-gate 27 is inverted by inverter 30 before being applied to the second input of AND-gate 29. Since AND-gate 29 receives one true and one false signal, its output remains false thereby disabling the second input of latch circuit 31.

When the count in digital timer 11 activates time selector 2, its output goes true applying a true signal through OR-gate 26 to the first inputs of AND-gates 28 and 29. A similar true input is applied to the first input of AND-gate 23. However, since stage 2 of segment selector 25 is false, the true signal at the first input of AND-gate 23 is inhibited and OR-gate 27 receives a false signal at each of its inputs. As a result, the output of OR-gate 27 remains false disabling AND-gate 28. On the other hand, the false signal at the output of OR-gate 27 is inverted by inverter 30 which applies a true signal to the second input of AND-gate 29. Since both inputs of AND-gate 29 are now true, latch circuit 31 receives a true signal at its second input and latch circuit 31 changes state. This change of state causes multiplexer 21 to connect its output to high-frequency timing pulse generator 32. Digital timer 11 therefore begins counting at a very high speed relative to normal speed. Since the functions in the case of a process gas chromatograph cannot follow high speeds, they appear not to function. On the other hand, if a particular function must be firmly disabled, the output of latch circuit 31 is available for such a purpose.

Digital timer 11 continues to count at very high speed until time selector 3 is activated. At this time, AND-gate 24 receives true signals at both of its inputs, applying such a true signal through OR-gate 27 to AND-gate 28. AND-gate 28 receives a second true signal from time selector 3 via OR-gate 26. As a result, AND-gate 28 causes latch circuit 31 to revert back to its initial state which switches multiplexer 21 back to low-frequency timing pulse generator 10.

It can therefore be seen that in accordance with the present invention there is provided a simplified method and means for selectively dropping and regaining any number of segments in a multiple segment selection system that normally sequences all segments in series. By the addition of a simple logic circuit 20 and a multiplexer 21, the present circuit causes digital timer 11 to operate in a "count fast" mode, thereby effectively skipping the functions within a segment that are not of interest. In reality, no functions are skipped but are executed at a very high speed relative to normal operation. Since the functions of many instruments, such as a process gas chromotograph, cannot follow high speeds, they effectively appear not to function.

While the invention has been described with respect to a preferred physical embodiment constructed in accordance therewith, it will be apparent to those skilled in the art that various modifications and improvements may be made without departing from the scope and spirit of the invention.

We claim:

1. In a programmer for controlling the sequential operation of a plurality of output devices wherein low-frequency timing pulses are applied to a digital timer which sequentially activates said output devices, the improvement comprising means for selectively bypassing any of said output devices, said means comprising:
   - a source of high-frequency timing pulses, the frequency of said source of high-frequency timing pulses exceeding the highest rate of which said output devices can function;
   - logic means operatively coupled to said output devices for generating a triggering signal when an output device to be bypassed is activated; and
   - means responsive to said triggering signal for switching the input of said digital timer from said low-frequency timing pulses to said high-frequency timing pulses whereby said digital timer is rapidly sequenced to activate the next selected output device.

2. In a programmer according to claim 1, the improvement wherein said logic means comprises:
   - selector means for generating a separate disable signal for each of said output devices to be bypassed; and
   - coincidence means operatively coupled to said output devices and said selector means for generating said triggering signal upon the simultaneous occurrence of the activation of an output device and a disable signal for such output device.

3. In a programmer according to claim 2, wherein said output devices go true when activated, and wherein said disable signal is a false signal, the improvement wherein said coincidence means comprises:
   - a plurality of two-input AND gates, one for each output device, each of said AND gates receiving one input from a corresponding output device and one input from said selector means;
   - first and second OR gates, said first OR gate receiving the outputs of said output devices, said second OR gate receiving the outputs of said AND gates; and
   - means responsive to the outputs of said OR gates for generating said triggering signal when the outputs of said first and second OR gates are simultaneously true and false, respectively.

4. In a programmer according to claim 3, the improvement wherein said means responsive to the outputs of said OR gates comprises:
   - first and second two-input AND gates and an inverter, said first AND gate receiving the outputs of said OR gates, said second AND gate receiving the output of said first OR gate and the output of said second OR gate via said inverter, said second AND gate generating said triggering signal, said first AND gate generating a signal when an output device to function is activated.

5. In a programmer according to claim 4, the improvement wherein said switching means comprises:

a latch circuit, said latch circuit being triggered to a first state by an output from said first AND gate and being triggered to a second state by an output from said second AND gate; and

a multiplexer responsive to said latch circuit for coupling said low-frequency timing pulses to said digital timer when said latch circuit is in said first state and for coupling said high-frequency timing pulses to said digital timer when said latch circuit is in said second state.

6. In a programmer for controlling the sequential operation of a plurality of output devices wherein low-frequency timing pulses are applied to a digital timer which sequentially activates said output devices, means for selectively skipping any of said output devices comprising:

a source of high-frequency timing pulses, the frequency of said source of high-frequency timing pulses exceeding the highest rate at which said output devices can function;

means for selecting which of said output devices are to function and which are to be skipped; and

means responsive to said selecting means for switching the input of said digital timer from said low-frequency timing pulses to said high-frequency timing pulses whereby said digital timer is rapidly sequenced to activate the next selected output device.

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