

PATENT SPECIFICATION

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(54) IMPROVEMENTS IN OR RELATING TO COMBINED ELECTRONIC TIMEPIECES AND CHRONOGRAPHS

(71) We, KABUSHIKI KAISHA SUWA SEIKOSHA, a Japanese company, of 3-4, 4-chome, Ginza, Chuo-ku, Tokyo, Japan, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:—

This invention relates to combined electronic timepieces and chronographs that is to say to electronic timepieces including means for performing stop watch functions. The invention seeks to provide improved combined electronic timepieces and chronographs whereby a number of lap times within a certain elapsed time can be measured, the lap times and the elapsed time being measurable accurately and reliably by operating simple control means which control the operative condition of the stop watch constituent of the timepiece. As will be seen later the invention provides combined electronic timepiece and chronographs which will effect measurement, inter alia, of a number of lap times, and interrupted elapsed time, and independent times which terminate together or close together by means of a single stop watch constituent in a timepiece having two manually operable controls, one of which is commanding the start and stop of time measurement, and the other of which is for indication and release of lap time, the manual control for indication and release of lap time performing the return to zero, or reset, of the means for measuring and indicating time only when the time measurement is stopped, the indication of lap time is released and the elapsed time is indicated.

Conventional stop watches are mechanical, and a mechanical stop watch capable of performing the various functions above mentioned would have to have an undesirably large number of winding crowns, making operation by the user troublesome and difficult. Moreover the internal mechanism of such a stop watch would be undesirably complex. Because of these facts conventional mechanical stop watches are, in general, only capable of per-

forming start and stop functions. The present invention provides electronic timepieces which have extensive capabilities when performing stop watch functions but do not have the defects and limitations of conventional stop watches.

According to the invention in one aspect there is provided a combined electronic timepiece and chronograph comprising means for measuring time electrically and indicating time measured; an electronic control circuit for controlling the operation of said measuring and indicating means in accordance with the following steps in the order stated namely starting the measurement of elapsed time, indication of lap time, which is a shorter elapsed time occurring within the aforesaid elapsed time, release of indicated lap time, the stopping of elapsed time measurement and indication of elapsed time and the return to zero of the measuring and indicating means; and manual control means arranged to control the operation of said electronic control circuits and including first and second manually operable controls of which the first is arranged to effect control of the starting and stopping of time measurement and the second is arranged to effect control of the indication and release of lap time.

According to the invention in another aspect there is provided a combined electronic timepiece and chronograph comprising means for measuring time electrically and indicating time measured; an electronic control circuit for controlling the operation of said measuring and indicating means in accordance with the following steps in the order stated, namely starting the measurement of elapsed time, indication of lap time, which is a shorter elapsed time occurring within the aforesaid elapsed time, the stopping of elapsed time measurement, release of indicated lap time and indication of elapsed time; and the return to zero of said measuring and indicating means and manual control means arranged to control the operation of said electronic control circuit and including first and second

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manually operable controls of which the first is arranged to effect control of the starting and stopping of time measurement and the second is arranged to effect control of the indication and release of lap time.

The electronic control circuit may be arranged to effect return to zero of the measuring and indicating means under the control of said second manually operable control only when said first and second manually operable controls are in the condition calling for such return to zero, time measurement is stopped, lap time indication is released, and elapsed time is indicated.

The invention is illustrated in and further explained in connection with the accompanying drawings in which:

Figure 1 is a diagrammatic illustration of one embodiment and shows a control circuit to which signals from two manual controls are applied; and

Figures 2 and 3 are explanatory graphical time charts relating to the circuit of Figure 1.

The invention is not limited to the circuitry shown in Figure 1. Any electronic circuit capable of providing inputs and outputs consistently with the time charts of Figures 2 and 3 may be used in carrying out the invention.

Figure 2 is a time chart for a case in which signals for controlling indication are changed in an order based on the following mode of operation:— start of time measurement, indication of lap time, release of indicated lap time, stop of time measurement and indication of time elapsed, and finally, reset of the measuring and indicating means.

Figure 3 is a time chart for a case in which signals for controlling indication are changed in an order based on the following mode of operation:— start of time measurement, indication of lap time, stop of time measurement, release of indicated lap time and indication of the time elapsed, and finally reset of the measuring and indicating means.

In Figures 2 and 3, S/S represents an input for starting and stopping time measurement; CE represents an output for commanding start and stop of time measurement; L/R represents an input calling for indication of lap time and releasing indicated lap time; LAP represents an output for commanding indication of lap time and release of indicated lap time; RC represents an output for resetting the indication and a measuring circuit,

this output being delivered only when $\overline{CE} = M = "1"$ and $L/R = "1"$, ("1" being "1" in digital terminology); ϕ is a clock pulse for synchronisation; M represents a signal for preventing delivery of the output RC at an instant immediately following release of indication of lap time; 11 and 12 are flip-flops constituting a binary counter; 13 is the slave portion of the flip-flop 12 which syn-

chronises the output LAP with the leading edge of the clock pulse ϕ ; 1 is a NAND cir-

cuit for detecting the condition $\overline{CE} = M = "1"$ and $L/R = "1"$; 2 is a NOT circuit acting as a delay and buffer circuit; and 3 is a NOT circuit acting as a delay circuit.

In Figure 1 terminals at which signals represented in Figures 2 and 3 appear, are indicated by the same references as are used for the signals themselves in Figures 2 and 3.

Referring now to Figure 1, 11 and 12 are flip-flops (hereinafter described by the abbreviation F/F) and 13 is the slave portion of a master/slave F/F arrangement 12—13. CL are clock input terminals of 11, 12 and 13.

To these terminals are fed repeatedly the input S/S for starting and stopping time measurement, the input L/R for commanding the indication of lap time and release of indicated lap time, and the synchronising

clock pulse ϕ . $\overline{W}$ are write inputs. Q and

$\overline{Q}$ are oppositely phased outputs from the F/Fs 11 and 12. The output from the Q terminal of F/F 11 is the output CE for commanding start and stop of time measurement.

R is a reset input to which is applied a signal RC as a control signal to the F/F 12 and which, when so applied, causes the output at the Q terminal thereof to fall to "0". The signals S/S and L/R are obtained from signal processing circuitry for processing, by means of a pulse train ϕ , signals supplied from the manual controls (not shown). The circuitry for thus processing the signals from the manual controls forms per se no part of this invention and may be as known per se. Preferably, however, it includes a circuit for eliminating the effects of switch "chatter", and a wave shaping circuit. The frequency of the clock pulse ϕ should be high in relation to the precision of measurement required in the stop watch, since the clock pulse frequency determines the precision of measurement obtained. The output CE is obtained by counting the input S/S by the binary counter F/F 11. When CE is "0", it is a signal which stops measurement: when CE is "1" it is a signal which causes measurement to take place. The input L/R is, as above stated, a signal for commanding the indication and release of indication of a lap time. LAP is the counted output obtained at terminal Q of F/F 12 by counting the input L/R thereto. When LAP is "1", it is a signal for indicating lap time. When LAP is "0", it constitutes a signal for releasing indication of lap time. A NAND circuit 1 provides, via a NOT circuit 2, a reset negative pulse signal RC for the measuring circuit and for indication, this signal pulse being delivered only when an input L/R is



"1" and is applied during the existence of the condition $\overline{CB}=M="1"$. The NOT circuit 2 functions as a delay circuit and as a buffer. The slave portion 13 of the master-slave type F/F arrangement 12-13 which synchronises the output LAP with the rise of the clock pulse ϕ , produces a high level signal M which prevents a reset signal RC being delivered at the moment when the lap time indicated is released and the condition CB is "1" exists, as may occur when the operating mode is in accordance with Figure 3. The NOT circuit 3 is arranged to provide delay in order to prevent misoperation of the circuit being caused by delay of the input L/R in relation to the signal M.

As will be seen from Figure 2 any desired number of lap times can be indicated between start and reset of measurement. Referring to Figure 2 measurement is started when the first S/S pulse is applied and the then changing contents of the measuring circuit are indicated. Next, when the first L/R pulse is applied, the contents of the measuring circuit at that moment are stored in a memory so that a lap time kept in the memory is indicated until the second pulse L/R is applied.

Although, in this condition, the indication is not changing, the measuring circuit operates without interruption. When the second L/R pulse is applied, the contents of the memory begin again to change coincidently with the contents of the measuring circuit, and indication of elapsed time, as measured every moment, again begins. The foregoing operations for indicating lap times may be repeated any number of times, until a second pulse S/S is applied, whereupon measurement by the measuring circuit ceases.

If an even number of L/R pulses have been applied before a second S/S pulse is applied, i.e. if the contents of the measuring circuit are indicated when the second S/S pulse is applied, the indicated time at the moment said second pulse is applied is held to indicate the time elapsed. If, on the other hand, an odd number of L/R pulses have been supplied before measurement is stopped—i.e. if lap time is indicated when measurement is stopped—the time elapsed which is kept in the measuring circuit is transferred to the memory in response to the next input pulse L/R, and indicated.

Figure 3 illustrates the case when the second S/S input is applied soon after an odd numbered input of L/R. In both of the cases mentioned above, one more L/R input causes an RC output so that the measuring circuit and indication may be returned to zero.

As shown in Figure 3, if measurement is stopped during indication of lap time, the indication is maintained, and the time elapsed

from the beginning to the end of the measurement is not indicated until indication of lap time is released. An input of L/R then causes reset. Accordingly (assuming the stop watch is being used to time a running race) if the winner and the second runner reach the finishing line very close together, the winner's time can be measured as a lap time and the second runner's time can be measured as elapsed time so that, after the winner's time has been registered, the second runner's time can be indicated by operating the second manual control. As will be appreciated from Figures 2 and 3, this invention can be used advantageously to perform such time measurements as the summation of times in an interrupted period of elapsed time as well as effecting time measurements in the order shown in Figures 2 and 3, so long as the required conditions for reset are satisfied.

The invention can be carried into practice to provide the above-mentioned various measuring functions, by providing simple logic circuits to suit the various functions to be performed. By embodying the circuitry employed in carrying out the invention (as regards the stop watch functions) in monolithic integrated circuitry of the C-MOS type, high reliability and stability may be obtained from apparatus which is relatively small and inexpensive and which involves a minimum of units which have to be assembled together. Further, apparatus in accordance with this invention for performing stop watch functions can be made small enough to be incorporated in a wrist watch keeping time in the ordinary way. Such a watch, capable of performing the two functions of time keeping and time interval measurement, could be realised by providing manual selection means for selecting, as may be required, indication of kept time or indication of stop watch times.

WHAT WE CLAIM IS:—

1. A combined electronic timepiece and chronograph comprising means for measuring time electrically and indicating time measured; an electronic control circuit for controlling the operation of said measuring and indicating means in accordance with the following steps in the order stated, namely, starting the measurement of elapsed time, indication of lap time, which is a shorter elapsed time occurring within the aforesaid elapsed time, release of indicated lap time, the stopping of elapsed time measurement and indication of elapsed time and the return to zero of the measuring and indicating means, and manual control means arranged to control the operation of said electronic control circuit and including first and second manually operable controls of which the first is arranged to effect control of the starting and stopping of time measurement and the second is arranged to

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effect control of the indication and release of lap time.

2. A combined electronic timepiece and chronograph comprising means for measuring time electrically and indicating time measured; an electronic control circuit for controlling the operation of said measuring and indicating means in accordance with the following steps in the order stated, namely, starting the measurement of elapsed time, indication of lap time, which is a shorter elapsed time occurring within the aforesaid elapsed time, the stopping of elapsed time measurement, release of indicated lap time and indication of elapsed time; and the return to zero of said measuring and indicating means; and manual control means arranged to control the operation of said electronic control circuit and including first and second manually operable controls of which the first is arranged to effect control of the starting and stopping of time measurement and the second is arranged to effect control of the indication and release of lap time.

3. A combined timepiece and chronograph as claimed in claim 1 or 2 wherein the electronic control circuit effects return to zero of the measuring and indicating means under the control of said second manually operable control only when said first and second manually operable controls are in the condition calling for such return to zero, time measurement is stopped, lap time indication is released, and elapsed time is indicated.

4. A combined electronic timepiece and chronograph having a circuit arrangement substantially as illustrated in the accompanying Figure 1 and operating substantially as herein described with reference to the accompanying Figures 2 or 3, for effecting control for the performance of stop watch functions.

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