PATENT SPECIFICATION (11) 1 395 675

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(21) Application No. 25380/73 (22) Filed 29 May 1973 (19)

(31) Convention Application No. 58477/72 (32) Filed 12 June 1972 in

(33) Japan (JA)

(44) Complete Specification published 29 May 1975

(51) INT. CL.[2] G04C 3/00

(52) Index at acceptance

G3T A5X

(54) ELECTRONIC TIMEPIECE

(71) We, KABUSHIKI KAISHA SUWA SEIKOSHA, a Japanese body corporate, 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 electronic timepieces.

The present invention seeks to provide an electronic timepiece having a plurality of counters wherein a cary signal from one counter and an external correction signal can be combined independently, freely and at any time so that a combined signal is applied to the next counter.

According to the present invention, there is provided an electronic timepiece comprising an oscillator for producing a time signal, counter means for counting cycles of the time signal, time display means for displaying the output of the counter means, the counter means having a plurality of counters and combining means electrically connected between adjacent counters, the arrangement being such that a carry signal from one counter and an external correction signal can be combined in the succeeding combining means to produce a combined signal which is supplied to the next counter.

In one embodiment the electronic timepiece includes producing means for producing either a pulsiform carry signal or a pulsiform correction signal whose period is short compared to that of the respective correction signal or the respective carry signal.

Preferably the or each combining means is an exclusive OR gate.

The producing means may include a flip-flop circuit.

Preferably the counter means is of integrated circuit construction.

The invention is illustrated, merely by way of example, in the accompanying drawings, in which:

Figure 1 is a block diagram of part of a conventional timepiece;

Figure 2 illustrates the waveforms of a carry signal and a correction signal of the conventional timepiece of Figure 1;

Figure 3 is a block diagram of part of a timepiece according to the present invention;

Figure 4 illustrates the waveforms of a carry signal, a correction signal, and a combined signal of the timepiece of Figure 3;

Figure 5 shows in greater detail a combining circuit of the timepiece of Figure 3;

Figure 6 illustrates the waveforms of a modified timepiece according to the present invention; and

Figure 7 illustrates a circuit for producing the waveforms illustrated in Figure 6.

In the drawings like parts have been designated by the same reference numerals.

Figure 1 shows part of a conventional timepiece having a lower column counter 10 and an upper column counter 11. The counter 11 may receive a carry signal Sc from the counter 10 and an external correction signal Sm. If both these signals are supplied to the counter 11 at the appropriate time then the output thereof is corrected. Conventionally, the carry signal Sc and the correction signal Sm are supplied to the counter 11 either when they are both increasing in the positive direction or when they are both increasing in the negative direction. If, however, the carry signal and the correction signal are supplied to the counter 11 in the relationship shown in Figure 2 the carry signal becomes ineffective and only the correction signal enters the counter 11.

In Figure 2 the point We of the carry signal Sc and of the correction signal Sm are points where effective addition of the two signals is performed so that the output of the counter 11 is corrected. The point Wn of the carry signal is where addition of the two signals is not performed and there is no correction of the output of the counter 11. If there is no effective addition of the carry signal and the correction signal it is as if no correction signal had been applied at all.

The conventional timepiece, therefore, has the disadvantage that a correction of the output of the counter 11 can only be per-

formed if the carry signal and the correction signal have the appropriate time relationship to one another.

Referring now to Figure 3 there is shown part of a timepiece according to the present invention. The timepiece basically consists of an oscillator for producing a time signal, counter means for counting cycles of the time signal, and time display means for displaying the output of the counter means. The counter means consists of a plurality of counters two of which are shown in Figure 3. This timepiece is such that correction of the output of the counter 11 can be effected with certainty because the time relationship between the carry signal and the correction signal is less material than in the conventional timepiece described in connection with Figures 1 and 2.

The carry signal Sc from the counter 10 is supplied to a combining circuit 12 to which the correction signal Sm is also supplied. A combined signal Sw from the combining circuit 12 is then supplied to the counter 11. As shown in Figure 4, the combined signal Sw is a combination of the carry signal Sc and the correction signal Sm. The combining circuit 12 may consist of an exclusive OR gate such as that shown in Figure 5.

Where the counter means of the timepiece is of integrated circuit construction and the counters are formed on a single base plate, the combining circuits can also be of integrated circuit construction and mounted on the same base plate since generally they are of relatively small size.

It will be seen from Figure 4 that after the carry signal Sc has passed through the combining circuit and has been combined at a point Wo with the correction signal Sm, part of the combined signal is inverted or phase shifted by 180° relative to the carry signal. Under certain circumstances this may be undesirable. To avoid this, the correction signal Sm, which has a stepped waveform, may be used so that either as it increases in the positive direction or as it increases in the negative direction it acts as a trigger to produce a pulse signal Smd (Figure 6) having a width T_0. The width or period T_0 is short compared with the period of the carry signal. The pulse signal Smd is combined with the carry signal in the combining circuit 12 and a combined signal Swd which may have a waveform as shown in Figure 6 is produced. The combined signal Swd is then supplied to the counter 11 at a point We^1 which is shifted from the point of the correction signal Sm by only the width T_0.

Instead of converting the correction signal Sm into the pulse signal Smd, the carry signal can be converted into a pulse signal whose period is short compared to that of the correction signal. The same result will be obtained. It has been found sufficient if the width T_0 is such that it cannot be felt by a person, and it may, for example, be about $^1/_{64}$th. second.

The combined signal Swd (or a combined signal Scd produced when the carry signal is converted into a pulse signal) can be produced, for example, in a master-slave flip-flop circuit 13 (see Figure 7). The flip-flop circuit 13 is fed with a continuous pulsiform signal ST_0 which may be from one of the preceding counters of the counter means in which case it is unnecessary to provide an additional oscillator. The correction signal Sm or the carry signal Sc triggers the flip-flop circuit 13 so that the pulse signal is produced, this pulse signal being fed to a combining circuit 12 the output of which is the combined signal Scd or the combined signal Swd.

The timepiece according to the present invention and described above has the advantage that the counter means can be made of integrated circuit construction and of small size.

WHAT WE CLAIM IS:—

1. An electronic timepiece comprising an oscillator for producing a time signal, counter means for counting cycles of the time signal, time display means for displaying the output of the counter means, the counter means having a plurality of counters and combining means electrically connected between adjacent counters, the arrangement being such that a carry signal from one counter and an external correction signal can be combined in the succeeding combining means to produce a combined signal which is supplied to the next counter.

2. An electronic timepiece as claimed in claim 1 including producing means for producing either a pulsiform carry signal or a pulsiform correction signal whose period is short compared to that of the respective correction signal or the respective carry signal.

3. An electronic timepiece as claimed in claim 1 or 2 in which the or each combining means is an exclusive OR gate.

4. An electronic timepiece as claimed in claim 2 or in claim 3 when dependent thereon in which the producing means includes a flip-flop circuit.

5. An electric timepiece as claimed in any preceding claim in which the counter means is of integrated circuit construction.

6. An electronic timepiece substantially as herein described with reference to and as shown in Figures 3 to 7 of the accompanying drawings.

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Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon), Ltd.—1975.
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY,
from which copies may be obtained.

formed if the carry signal and the correction signal have the appropriate time relationship to one another.

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The carry signal Sc from the counter 10 is supplied to a combining circuit 12 to which the correction signal Sm is also supplied. A combined signal Sw from the combining circuit 12 is then supplied to the counter 11. As shown in Figure 4, the combined signal Sw is a combination of the carry signal Sc and the correction signal Sm. The combining circuit 12 may consist of an exclusive OR gate such as that shown in Figure 5.

Where the counter means of the timepiece is of integrated circuit construction and the counters are formed on a single base plate, the combining circuits can also be of integrated circuit construction and mounted on the same base plate since generally they are of relatively small size.

It will be seen from Figure 4 that after the carry signal Sc has passed through the combining circuit and has been combined at a point Wo with the correction signal Sm, part of the combined signal is inverted or phase shifted by 180° relative to the carry signal. Under certain circumstances this may be undesirable. To avoid this, the correction signal Sm, which has a stepped waveform, may be used so that either as it increases in the positive direction or as it increases in the negative direction it acts as a trigger to produce a pulse signal Smd (Figure 6) having a width T_0. The width or period T_0 is short compared with the period of the carry signal. The pulse signal Smd is combined with the carry signal in the combining circuit 12 and a combined signal Swd which may have a waveform as shown in Figure 6 is produced. The combined signal Swd is then supplied to the counter 11 at a point We¹ which is shifted from the point of the correction signal Sm by only the width T_0.

Instead of converting the correction signal Sm into the pulse signal Smd, the carry signal can be converted into a pulse signal whose period is short compared to that of the correction signal. The same result will be obtained. It has been found sufficient if the width T_0 is such that it cannot be felt by a person, and it may, for example, be about $^1/_{64}$th. second.

The combined signal Swd (or a combined signal Scd produced when the carry signal is converted into a pulse signal) can be produced, for example, in a master-slave flip-flop circuit 13 (see Figure 7). The flip-flop circuit 13 is fed with a continuous pulsiform signal ST_0 which may be from one of the preceding counters of the counter means in which case it is unnecessary to provide an additional oscillator. The correction signal Sm or the carry signal Sc triggers the flip-flop circuit 13 so that the pulse signal is produced, this pulse signal being fed to a combining circuit 12 the output of which is the combined signal Scd or the combined signal Swd.

The timepiece according to the present invention and described above has the advantage that the counter means can be made of integrated circuit construction and of small size.

WHAT WE CLAIM IS:—

1. An electronic timepiece comprising an oscillator for producing a time signal, counter means for counting cycles of the time signal, time display means for displaying the output of the counter means, the counter means having a plurality of counters and combining means electrically connected between adjacent counters, the arrangement being such that a carry signal from one counter and an external correction signal can be combined in the succeeding combining means to produce a combined signal which is supplied to the next counter.

2. An electronic timepiece as claimed in claim 1 including producing means for producing either a pulsiform carry signal or a pulsiform correction signal whose period is short compared to that of the respective correction signal or the respective carry signal.

3. An electronic timepiece as claimed in claim 1 or 2 in which the or each combining means is an exclusive OR gate.

4. An electronic timepiece as claimed in claim 2 or in claim 3 when dependent thereon in which the producing means includes a flip-flop circuit.

5. An electric timepiece as claimed in any preceding claim in which the counter means is of integrated circuit construction.

6. An electronic timepiece substantially as herein described with reference to and as shown in Figures 3 to 7 of the accompanying drawings.

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Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon), Ltd.—1975.
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY,
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