LUNAR CALENDAR DATE COMPUTING SYSTEM

This invention relates to a lunar calendar date computing system for use in an electronic pocket information device or an electronic watch for example.

In Japan and other countries of Asia, the lunar date and ROKUYO are occasionally used in daily life. ROKUYO is based on the lunar calendar and is composed of Taian, Shakko, Sensho, Tomobiki, Senpu and Butsumetsu.

Information on the lunar calendar and ROKUYO is generally solely available from calendars, literature and the like specially printed with such information. However, such calendars, literature and the like are not handy to carry and hence are not of significant practical use.

An electronic timepiece, electronic calculator and the like including means for computing the lunar date and ROKUYO from the Gregorian calendar are disclosed in Japanese Published Patent No. 149547/1984 and Japanese Published Patent No. 18141/1979. However, the amount of data which has to be stored is substantial and so the size of the timepiece or calculator becomes large, or alternatively if a smaller amount of data is stored (a 4 bit micro-computer being used, for example, for a CPU), the number of processing steps is increased so that the computation takes a long time.

The present invention, at least in its preferred form described below, seeks to provide a lunar calendar date computing system for calculating lunar calendar dates from the Gregorian calendar more quickly and using a smaller amount of storage than the known arrangements.

According to the present invention, there is provided a lunar calendar date computing system comprising means for storing for a selected year according to the Gregorian calendar lunar month data representing the corresponding order of months according to the lunar calendar occurring in the selected year and first day data representing the aggregate number of days having occurred at the end of each lunar month since the beginning of the selected year, means for converting a date according to the Gregorian calendar within the selected year into second day data representing the total number of days in the selected year corresponding to the date, and means for comparing the first day data and the second day data whereby to establish the day and the month according to the lunar calendar corresponding to the date.

The system may further comprise means for computing ROKUYO from the computed day and month according to the lunar calendar.

As described below, information necessary for computing lunar calendar dates for a predetermined number of years is processed and stored in a ROM (read only memory) or the like in such a manner as to permit the memory size to be minimised. When a respective year is newly set, data co-ordinating with the year is transferred to predetermined storage means, and the lunar month data and the first day data is computed from the processed information. The second day data is then compared successively with the first day data until the aggregate number of days represented by the first day data becomes greater than the total number of days

represented by the second day data. At that point, the day and month according to the lunar calendar are determined and, following this, ROKUYO is also determined.

The invention is described further, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 is a block diagram of a lunar calendar date computing system according to the present invention;

Figure 2 (a) is a table showing information employed in such a system indicating the Gregorian date corresponding to the first day of each lunar month and the number of days in each lunar month for the Gregorian year 1984 A.D. as an example;

Figure 2 (b) is a table indicating data obtained from the information shown in Figure 2 (a);

Figure 3 (a) is a table indicating the contents of reference day storage means containing reference data in respect of the year 1984;

Figure 3 (b) is a table indicating the contents of day number storage means in respect of the year 1984;

Figure 3 (c) is a table indicating the contents of leap information storage means in respect of the year 1984;

Figure 4 is a flow chart representing the operation of first integrated day computing means of the lunar calendar date computing system;

Figure 5 is a flow chart representing the operation of lunar month computing means of the lunar calendar date computing system;

Figure 6 (a) is a table indicating the contents of first integrated day storage means of the lunar calendar date computing system;

Figure 6 (b) is a table indicating the contents of lunar month storage means of the lunar calendar date computing system; and

Figure 7 is a flow chart representing the operation of comparison means, lunar calendar date computing means, and ROKUYO computing means of the lunar calendar date computing system.

Referring initially to Figure 1, plural data storage means 120, which is for example a ROM (read only memory), has written therein beforehand the earliest day of each Gregorian year corresponding to the first day of a new moon or lunar cycle for a predetermined number of years (hereinafter simply called the "earliest first day") and the lunar month beginning on the earliest first day (hereinafter simply called the "first cycle month"). The plural data storage means 120 further has written therein beforehand the number of days in the lunar month beginning on the first day of the last lunar cycle of each preceding year (hereinafter called the "day number of the last cycle of the preceding year"), leap information for this cycle (hereinafter called the "last leap data of the preceding year"), the number of days in each lunar month beginning on the first day of a respective lunar cycle throughout the year (hereinafter called the "day number of the lunar month") and leap information (hereinafter called the "leap data").

Switching means 111 operable by means of an external switch 121 selects whether the lunar date and ROKUYO for the current day according to the Gregorian calendar as counted on time counting means 101 are to be computed, or whether the lunar date and ROKUYO for an arbitrarily set day according to the Gregorian calendar as determined by date changing means 103 and data

storage means 102 are to be computed.

The following description refers to the case where the lunar date and ROKUYO for a day stored in the date storage means 102 are to be computed in response to operation of the switching means 111.

According to year data stored in the date storage means 102, stored information transmission means 119 transmits data representing the earliest first day and the first cycle month from the plural data storage means 120 to reference day storage means 104, the number of days in the last cycle of the preceding year and the number of days in the first cycle of the next year from the plural data storage means 120 to day number storage means 105, and the last leap data of the preceding year and the leap data from the plural data storage means 120 to leap information storage means 106.

Taking 1984 as an example, Figure 2 (a) shows the Gregorian date for each lunar cycle first day and the day and month of the lunar calendar corresponding therewith, together with the number of days in each lunar month. Since the number of days in each lunar month is thirty or twenty nine only, the day number data for each lunar month can be represented in 1 bit b_c with thirty days as "1" and twenty nine days as "0" (see Figures 2 (b) and 3 (b)). Similarly, if the leap information for a lunar month is represented as "1" when it is not a leap month, and "0" when it is a leap month, the leap information for each lunar month can also be represented in 1 bit b'_c (see Figures 2 (b) and 3 (c)). Thus, the memory size of the plural data storage means 120 may be substantially smaller than in the case where the days are merely stored directly.

The contents of the reference day storage means 104, the day number storage means 105, and the leap

information storage means 106 after data has been transmitted thereto by the stored information transmission means 119 are shown in Figures 3 (a), 3 (b) and 3 (c) respectively (again taking the data for 1984 as an example). Then, starting with the first day of January of the year as "1", the total number of days occurring after that at the end of each lunar month is computed from the earliest first day data in the reference day storage means 104 and the day number data in the day number storage means 105 by means of first integrated day computing means 107, and the computed values are stored in sequence in first integrated day storage means 108. The data obtained in this case is denoted as T_c ($c = 0, 1, 2 \ldots$) hereinafter. Figure 4 is a flow chart showing an example of this operation.

First, the number of days in the year (e.g. 1984) is stored in a register DT in step 401. Then, the earliest first day is stored in a register T in step 402. In step 403, a counter C is set to 0. These three steps serve to initialise the process.

After initialisation, the count value of the counter C is compared with "1" in step 404. If the count value is equal to or smaller than "1", the count value of the counter C is further compared with "zero" in step 405. When the count value of the counter C is equal to "zero", a check is made as to whether the bit $\underline{b}_0$ is set to 1 in step 406. If yes, thirty is stored in a date register D (step 407). If not, twenty nine is stored in the register D instead (step 408). Then, the contents of the register D are subtracted from the contents of a register T and the result is stored in a register TD in step 409. In step 405, if the count value of the counter C is not equal to 0, that is the count value is equal to one, zero is set in the

register D in step 410 and the contents of the register D are added to the contents of the register T and the result is re-stored in register T in step 414. In step 415, the contents of the register T are stored in the register TD.

In step 404, the count value of the counter C is not equal to zero or one, then a check is made in step 411 as to whether the bit b_{c-1} is set to 1. If yes, thirty is stored in the register D in step 41[illegible] If not, twenty nine is stored in the register D in ste[illegible] 413 instead. The contents of the register D are again added to the contents of the register T and the result is re-stored in the register T in step 414. The contents of the register T are stored in the register TD in step 415.

The contents of the register TD are stored sequentially in the first integrated day storage means at address C as the data T_c in step 416. The contents of the register TD are compared with the contents of the register DT in step 417. If the contents of the register TD are larger than the contents of the register DT, one is subtracted from the count value of the counter C and the result is stored in a register CN. If not, the count value of the counter C is increased by one and the process is returned to the step 404 and repeated until the contents of the register TD are larger than the contents of the register DT.

Then, the month of the lunar calendar beginning from the first day of each lunar cycle is computed from the first cycle month data in the reference day storage means 104 and the leap data in the leap information storage means 106 by lunar calendar month computing means 109, and the computed data is stored in sequence in lunar calendar month storage means 110. The data

obtained in this case is denoted as KM_c (c = 0, 1, 2 ...) hereinafter. Figure 5 is a flow chart showing an example of this operation.

First, the counter C is set to zero and the first cycle month is set in a register KM in steps 501 and 502 for initialising the process. In step 503, a check is made as to whether the count value of the counter C is equal to zero. If yes, $\underline{b'_1}$ is subtracted from the contents of the register KM and the result is again stored in the register KM in step 504. If not, $\underline{b'_c}$ is added to the contents of the register KM and the result is re-stored in the register KM in step 505. The contents of the register KM are stored in the lunar calendar month storage means 110 at address C as data KM_c in step 506. Then, a check is made as to whether the count value of the counter C is equal to the contents of the register CN in step 507. If yes, the process is ended in step 509. If not, the process is returned to the step 503, after the count value of the counter C is increased by one in step 508, and is repeated until the count value of the counter C is equal to the contents of the register CN.

The above process is carried out once only when the year is changed. The contents of the integrated day and the lunar month storage means obtained as described above for the year 1984 are shown in Figure 6.

A second integrated day computing means 112 serves to compute an integrated day value for the date (year, month and day) selected by the switching means 111 starting with the first day of January of the selected year as "1", and the computed value is stored in second integrated day storage means 113. The computed value in this case will be called GD.

The value GD is successively compared with the

value TC stored in the first integrated storage means 107 by comparison means 114. The month and day of the lunar calendar is computed on the basis of an output received from the comparison means 114 by lunar calendar date computing means 115, and is stored in lunar calendar date storage means 116.

ROKUYO computing means 117 obtain a remainder R by first adding the number of the lunar month and the number of the lunar day stored in the lunar calendar date storage means 116 and then dividing this sum by six. ROKUYO storage means 118 store the remainder R. Table 1 below shows the correspondence of the remainder R and the ROKUYO.

TABLE 1

R [(lunar month + lunar day) mod 6]	ROKUYO
0	Taian
1	Shakko
2	Sensho
3	Tomobiki
4	Senpu
5	Butsumetsu

Figure 7 is a flow chart representing the operation of the comparison means 114, the lunar calendar date computing means 115, the lunar calendar date storage means 116, the ROKUYO computing means 117, and the ROKUYO storage means 118.

First, a counter C is set to zero in step 701.

In step 702, the count value of the counter C is increased by 1. Then a check is made in step 703 as to whether the contents of the register GD are smaller than Tc. If not, the process is returned to the step 702 until the result becomes yes. If yes, T_{c-1} is subtracted from the contents of the register GD and one is added to the result in step 704. The value thus obtained is stored in the register KD. KM_{c-1} is then stored in a register KM in step 705. The contents of the registers KD and KM are stored in the lunar calendar date storage means in step 706. The contents of the register KM are added to the contents of the register KD in step 707, the result is divided by six in step 708 and the remainder is stored in the ROKUYO storage means in step 709.

A specific computation of the lunar date and the ROKUYO will now be demonstrated based on the Gregorian date of November 27, 1984 A.D. as an example.

According to the second integrated day computing means 112, the value 332 is obtained for the number of days represented by the integrated day data GD for November 27, and is stored in the second integrated day storage means 113. The comparison means 114 compares this value GD successively with the integrated day data Tc (c = 1, 2, 3 ...) stored in the first integrated day storage means 108. The operation is shown in Table 2 below:

TABLE 2

Operation order	c-value	GD data value	Tc data value	Comparison of GD with Tc
1	1	332	3	GD > T_1
2	2	"	33	GD > T_2
3	3	"	63	GD > T_3
4	4	"	92	GD > T_4
5	5	"	122	GD > T_5
6	6	"	152	GD > T_6
7	7	"	181	GD > T_7
8	8	"	210	GD > T_8
9	9	"	240	GD > T_9
10	10	"	269	GD > T_{10}
11	11	"	298	GD > T_{11}
12	12	"	328	GD > T_{12}
13	13	"	357	GD < T_{13}
14	KD (moon's day data) = GD - $T_{(c-1)}$ + 1 = 332 - T_{12}(328) + 1 = 5 (days)			
15	KM (moon's month data) = $KM_{(c-1)}$ = KM_{12} = 10 (months)			
16	R = (KM + KD) mod 6 = (10 + 5) mod 6 = 3 (remainder after dividing by 6)			

Accordingly, the date of November 27, 1984 according to the Gregorian calendar falls on October 5 according to the lunar calendar, and since R = 3, ROKUYO is "Tomobiki". Further, since the leap information bit $\underline{b'_{12}}$ corresponding with the obtained lunar month data KM_{12} is 0, it follows that such lunar month October is a leap October.

The last cycle month and day number for the end of the preceding year and the leap information are necessary when the date according to the Gregorian calendar for conversion to the lunar calendar precedes the earliest first day.

According to the invention, the lunar date and the ROKUYO corresponding to a date according to the Gregorian calendar may be obtained simply.

In the case where, for example, the date is changed through external date changing means, the integrated day data in the first integrated day storage means 107 is computed from the respective earliest first day when the year is set. Therefore, for obtaining the lunar date, the integrated day data GD for the changed month is obtained, the integrated day data GD is compared with the data in the first integrated day storage means, and where the latter becomes greater, its preceding value is subtracted from GD and "1" is added thereto to provide the day of a lunar month. The month data for the lunar calendar has also been obtained at the point in time when the year was set, and therefore the lunar month is also readily computed. Thus, when the year is not changed, the lunar date can easily be calculated.

C L A I M S

1. A lunar calendar date computing system comprising means for storing for a selected year according to the Gregorian calendar lunar month data representing the corresponding order of months according to the lunar calendar occurring in the selected year and first day data representing the aggregate number of days having occurred at the end of each lunar month since the beginning of the selected year, means for converting a date according to the Gregorian calendar within the selected year into second day data representing the total number of days in the selected year corresponding to the date, and means for comparing the first day data and the second day data whereby to establish the day and the month according to the lunar calendar corresponding to the date.

2. A system according to claim 1 further comprising means for generating the lunar month data on the basis of information relating to the respective lunar month beginning on the first day of a new moon in the selected year and on the basis of information relating to the occurrence or otherwise of leap days in the selected year.

3. A system according to claim 1 or 2 further comprising means for generating the first day data on the basis of information relating to the first day of a new moon in the selected year and on the basis of the number of days in each lunar month associated with the selected year.

4. A system according to any of claims 1 to 3, further comprising date storing means for storing the date within the selected year.

5. A system according to claim 4 further comprising

date changing means which are selectively operable for modifying the date in the date storing means.

6. A system according to any preceding claim further comprising display means for displaying the computed day and month according to the lunar calendar.

7. A system according to any preceding claim further comprising means for computing ROKUYO from the computed day and month according to the lunar calendar.

8. A method of computing a lunar calendar date comprising providing for a selected year according to the Gregorian calendar lunar month data representing the corresponding order of months according to the lunar calendar occurring in the selected year, providing first day data representing the aggregate number of days having occurred at the end of each lunar month since the beginning of the selected year, converting a date according to the Gregorian calendar within the selected year into second day data representing the total number of days in the selected year corresponding to the date, comparing the first day data and the second day data, and thereby establishing the day and the month according to the lunar calendar corresponding to the date.

9. A lunar calendar arithmetic unit comprising: date storing means for storing date information regarding year, month and day; plural data storing means for storing information on the first day of a new moon (hereinafter called the "first day") of each year for a predetermined number of years and month data of the lunar calendar beginning from the first day, day number data for each month of the lunar calendar beginning from the last first day of the preceding year and leap data as to whether or not the day is leap, and day number data for the month of the lunar calendar beginning from each first day of the year and leap data;

first integrated day computing means for obtaining integrated first days with the first day of January of the year as "1" from information on the earliest first day of the year stored in the reference day storing means and day number information for the month of the lunar calendar beginning from each first day stored in the day number storing means; first integrated day storing means for storing the integrated days; lunar calendar month computing means for computing on which month of the lunar calendar each first day falls from month information of the lunar calendar beginning from the earliest first day of the year and leap information of the month of the lunar calendar beginning from each first day; storing means for storing the computed moon's month; second integrated day computing means for computing integrated days with the first day of January of the year as "1" from the date storing means; second integrated day storing means for storing the computed integrated days; comparison means whereby a plurality of first integrated days stored in the first integrated day storing means are compared with the second integrated days stored in the second integrated day storing means successively from the earliest first day of the year, and when the first integrated days are greater, a signal is generated accordingly; lunar calendar computing means whereby the integrated day one preceding the first integrated day used for comparison is subtracted from the second integrated day when the signal is generated from the comparison means, "1" is added to the result to obtain a day of the lunar calendar, and for the lunar calendar month lunar calendar month data corresponding to the integrated day one preceding the compared first integrated day obtained; and lunar calendar storing means for

storing the obtained lunar calendar month and day data.