

PATENT SPECIFICATION (11)

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(54) CALCULATOR

(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:—

The present invention relates to calculators, and more particularly to calculators that can perform mixed senary and decimal calculations.

When performing calculations involving time indications, a senary calculation is necessary in the 10 seconds place (the second column) and the 10 minutes place (the fourth column). So if two time indications are subtracted or if two or more time indications are added, it is impossible to use an abacus or a conventional decimal electronic calculator. If these conventional calculators are used, it is necessary to convert the time indications into their decimal equivalents.

Recently, an increasing number of services are being charged for by the amount of time for which the service has been used. For example, in parking places, skating rinks and swimming pools the customer or user pays according to time. In these cases, the times when use of the service began and ended is recorded and a subtraction is performed between these two times thus, the time for which the particular service has been used may be calculated. Heretofore, salary or overtime payments have been calculated by determining the time between the starting and finishing of working and this time has been multiplied by a rate for the work, e.g. an hourly wage, to arrive at an amount due to the worker.

Thus, there are many instances where, in effect, time is bought and sold. But to compute the amount of time in question and to compute the charge involves mixed senary and decimal calculations and these calculations, heretofore, have been tedious to perform.

According to one aspect of the present in-

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vention there is provided a calculator having a decimal calculator device and means arranged in operation to control said decimal calculator device so that it can perform selectively pure decimal calculations, and mixed senary and decimal calculations, said means including a converting device arranged in operation selectively to add 4 to and subtract 4 from the result of a decimal calculation performed by the decimal calculator device to convert said decimal calculation to a senary calculation.

The calculator may include switch means arranged to control the calculator so that it will perform selectively pure decimal calculations and mixed senary and decimal calculations.

The calculator may include entry means for entering a time indication, entry means for entering a charge rate per unit time, and multiply means for multiplying said time indication by the charge rate to calculate a charge corresponding to said time indication.

Alternatively, the calculator may include entry means for two time indications, entry means for a charge rate per unit time, and multiply means for multiplying the difference between the time indications and the charge rate to calculate a charge corresponding to the difference between the time indications.

A timepiece is preferably provided to generate at least one of the time indications.

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

Figures 1 to 4 show entry states in two registers by way of explanation of operation of a calculator according to the present invention;

Figure 5 is a block diagram showing a decimal calculator;

Figure 6 shows a block diagram of a calculator according to the present invention; and

Figure 7 shows timing pulses for controlling the calculator of Figure 6;

In a conventional electronic calculator only decimal calculations are possible. How-

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ever, with a calculator according to the present invention it is possible to perform addition and subtraction calculations involving mixed senary and decimal calculations. That is to say, with a conventional calculator one cannot perform calculations on time indications with a single operation because it is only possible to perform decimal calculations on such machines. On the other hand, with a calculator according to the present invention such calculations may be performed in a single operation.

The method of performing a mixed senary and decimal calculation with a calculator according to the present invention will be described with reference to Figures 1 to 4.

When a time indication of 2 hours 35 minutes and 42 seconds and a time indication of 1 hour 28 minutes and 20 seconds are to be added, they are entered into registers as shown in Figure 1. Carry or borrow operations for the senary calculations are necessary for the second and fourth columns.

In a conventional decimal calculator the result of the addition would be as shown in Figure 2, namely, 3 hours 63 minutes and 62 seconds. But "63 minutes 62 seconds" is unconventional so it is necessary to subtract 6 from the second column so that the seconds reads "02 seconds" and to carry 1 to the third column. Then the minutes indicated becomes "64 minutes". Similarly, it is necessary to subtract 6 from the fourth column so that the minutes are indicated by "04 minutes" and to carry 1 to the fifth column which then shows "4 hours". The final result is, therefore, 4 hours 04 minutes 02 seconds (Figure 3).

By using this method it is possible to convert the product shown in Figure 2 into the product shown in Figure 3. As will be appreciated, in the second and fourth columns when a total therein is greater than or equal to 6 it is necessary to carry "1" to the next column in the case of addition, or to borrow "1" from the next column in the case of subtraction. While the case where the calculation is addition is described above, a similar method is used in the case of subtraction.

The same result is obtained by adding the two time indications together decimally to achieve the results shown in Figure 2 and then decimally adding 4 to the second and fourth columns thereof.

Thus, in the case of addition, the time indications are added decimally and, if in the second column and/or the fourth column a carry operation is necessary, 4 is decimally added to the column or columns on which the carry operation is necessary.

Similarly, in the case of subtraction, the time indications are subtracted decimally and, if in the second column and/or the

fourth column a borrow operation is necessary, 4 is decimally subtracted from the column or columns on which the borrow operation is necessary.

Therefore, to perform a calculation with two time indications, first the calculation is performed decimally and the second and fourth columns are examined to see whether a carry or borrow operation is necessary and the result of the examination is memorised in a flip-flop circuit. When the column where the carry or borrow operation is required is operated upon 4 (0100) is added or subtracted.

At present, conventional decimal calculators using integrated circuits are widely employed. Such a decimal calculator is shown in Figure 5 as having two binary calculator devices 1, 2, a 4-bit shift register 3, a detecting portion 4 for decimal carry or borrow operations, and an AND gate 5. If an addition or subtraction calculation is performed in the calculator device 1 and a carry or borrow operation is required, the gate 5 is opened by an output signal from the detecting portion 4. In the calculator device 2, 0110 is added to or subtracted from the result of the calculation in the calculator device 1 and the product of the decimal addition or subtraction increases by 6. To obtain a signal for a senary carry operation using a decimal calculator as described above, it is necessary to detect the output signal of the calculator device 1 when it is equal to or greater than 6 and memorise it.

Thus in a calculator according to the present invention, two time indications are decimally added or subtracted, an examination is made of the second column and fourth column to determine whether a senary carry operation is required (i.e. if the total in the respective column is 6 or more) and 4 (0100) is added or subtracted in those columns where the carry or borrow operation is required.

Figure 6 shows a circuit diagram of a six-column calculator according to the present invention and Figure 7 illustrates the timing pulses for controlling this calculator.

An AND gate 10 and an OR gate 20 determine whether or not a senary carry operation is required, receiving, as inputs, outputs from a decimal calculator 8 for full add and subtraction. The outputs from the AND gate 10 and the OR gate 20 are memorised in a D-FF gate 30 and a D-FF gate 40. It is only necessary to determine whether or not a senary carry operation is required in the second column and fourth column, logical "1" being memorised in the D-FF gate 30 and the D-FF gate 40 on receipt of a t_1 cp₁ clock pulse at times T_1 , T_4 respectively. After the decimal addition or subtraction of the first column of the time in-

dications on which a calculation is to be performed, the result is memorised in the D-FF gate 30 and the D-FF gate 40. A command to perform a senary calculation on the second column of the time indications is memorised in D-FF gate 70. At time T_2 or T_4 , AND gate 50 is opened and the result and 0100 is either added or subtracted depending upon the calculation being performed. The output of an AND gate 80 is logical "1" and the AND gate 50 is open at time T_2 and T_4 , because the outputs of D-FF gates 30, 40 are both logical "1". At this time an AND gate 90 is open.

In the calculator shown in Figure 6 AND gate 50 is open only when calculations involving time indications are required. Thus when the AND gate 50 is inoperative the calculator will perform pure decimal calculations and when it is operative the calculator will perform senary calculations. Switching means including AND gate 60 may be provided to determine whether the AND gate 50 is operative or inoperative.

The above calculator employs conventional decimal calculator devices such as shown in Figure 5 to perform senary or decimal calculations.

As mentioned above this calculator allows calculations involving time indications to be simply performed and it is not necessary to decimalise the time indications before performing the calculations. The disadvantages associated with using an abacus for calculations involving time indications is avoided. Thus the calculator is useful in connection with wage calculations or charge for parking calculations.

In businesses where the charge to the customer is determined by multiplying a charge rate per unit time for the service by the time for which the service has been used, it is often required to know the total number of users of the service or the total amount of time sold. The calculator described above can be used for both calculations since it can be switched from performing mixed senary and decimal calculations to performing pure decimal calculations. Thus the calculator may be capable of performing not only addition and subtraction but also multiplication and division since multiplication and division are, in effect, only repetitive adding and subtracting operations.

The calculator may include means for printing the starting time of utilisation of a service, means for providing a receipt of the calculated charge, and a cash register. A time indicating device may also be provided and arranged to cooperate with the calculator. Thus if the time indicating device may

supply a signal corresponding to a finishing time when the use of the service ended which is entered into the calculator by a key function, and by performing a subtraction of the starting and finishing times, the time for which the service has been used may be calculated.

A similar calculator is also described and shown in our Application Nos. 6984/72 (Serial No. 1,370,981), 6985/72 (Serial No. 1,370,982), 38913/72 (Serial No. 1,370,983), 38914/72 (Serial No. 1,370,984) and 38915/72 (Serial No. 1,370,985).

WHAT WE CLAIM IS:—

1. A calculator having a decimal calculator device and means arranged in operation to control said decimal calculator device so that it can perform selectively pure decimal calculations, and mixed senary and decimal calculations, said means including a converting device arranged in operation selectively to add 4 and to subtract 4 from the result of a decimal calculation performed by the decimal calculator device to convert said decimal calculation to a senary calculation.
2. A calculator as claimed in claim 1 including switch means arranged to control the calculator so that it will perform selectively pure decimal calculations and mixed senary and decimal calculations.
3. A calculator as claimed in any preceding claim including entry means for entering a time indication, entry means for entering a charge rate per unit time, and multiply means for multiplying said time indication by the charge rate to calculate a charge corresponding to said time indication.
4. A calculator as claimed in claim 1 or 2 including entry means for two time indications, entry means for a charge rate per unit time, and multiply means for multiplying the difference between the time indications and the charge rate to calculate a charge corresponding to the difference between the time indications.
5. A calculator as claimed in claim 4 in which a timepiece is provided to generate at least one of the time indications.
6. A calculator as claimed in claim 1 and substantially as herein described with reference to and as shown in Figures 6 and 7 of the accompanying drawings.

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dications on which a calculation is to be performed, the result is memorised in the D-FF gate 30 and the D-FF gate 40. A command to perform a senary calculation on the second column of the time indications is memorised in D-FF gate 70. At time T_2 or T_4 , AND gate 50 is opened and the result and 0100 is either added or subtracted depending upon the calculation being performed. The output of an AND gate 80 is logical "1" and the AND gate 50 is open at time T_2 and T_4 , because the outputs of D-FF gates 30, 40 are both logical "1". At this time an AND gate 90 is open.

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2. A calculator as claimed in claim 1 including switch means arranged to control the calculator so that it will perform selectively pure decimal calculations and mixed senary and decimal calculations.

3. A calculator as claimed in any preceding claim including entry means for entering a time indication, entry means for entering a charge rate per unit time, and multiply means for multiplying said time indication by the charge rate to calculate a charge corresponding to said time indication.

4. A calculator as claimed in claim 1 or 2 including entry means for two time indications, entry means for a charge rate per unit time, and multiply means for multiplying the difference between the time indications and the charge rate to calculate a charge corresponding to the difference between the time indications.

5. A calculator as claimed in claim 4 in which a timepiece is provided to generate at least one of the time indications.

6. A calculator as claimed in claim 1 and substantially as herein described with reference to and as shown in Figures 6 and 7 of the accompanying drawings.

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