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(54) Improvements In or Relating to Devices for Reducing Irrational Base Codes to Minimal Form

(57) A device for reducing irrational-base codes, such as the Fibonacci *p*-code and the "golden" *p*-proportion code, to a minimal form comprises *n* substantially identical functional cells 1 equal in a number to that of code digits, whereof each *l*-th functional cell comprises a flip-flop 8, and a convolution AND gate 10 having one of its inputs connected to an inverting output 9 of the flip-flop. A set input 2, a reset input 6, and a count input are provided for the flip-flops. The remaining input of the *l*-th convolution AND gate 10 are a first convolution signal input 4 from cell *l*—1 and a second convolution signal input 5 from cell *l*—*p*—1. The count signal input of the *l*-th functional cell is connected to the information output 3 of the (*l*—1)-th functional cell. The convolution signal output of the *l*-th functional cell is connected to the reset input 6 of the (*l*—1)-th functional cell. The device changes the states of the *l*-th, (*l*—*p*—1)th and (*l*—1)th flip flops sequentially, thereby avoiding switching ambiguities.

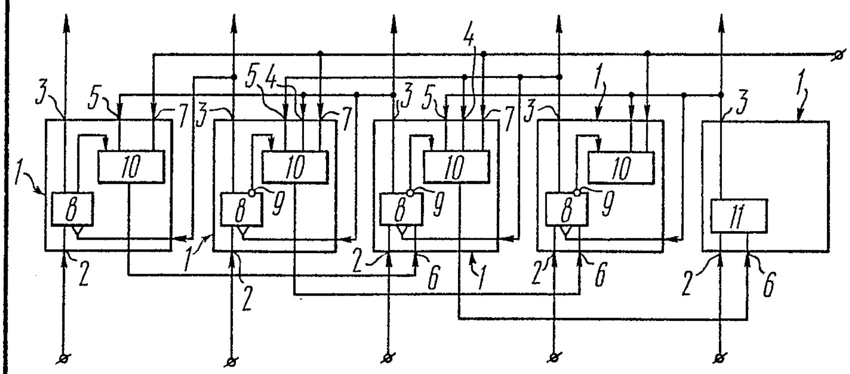

FIG. 1

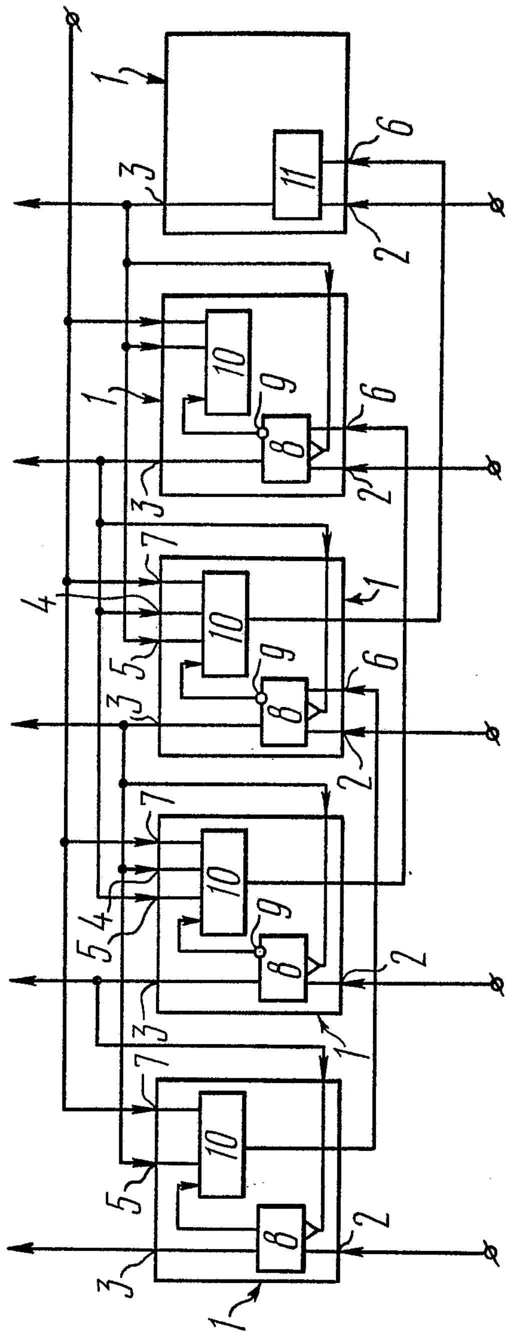

FIG. 1

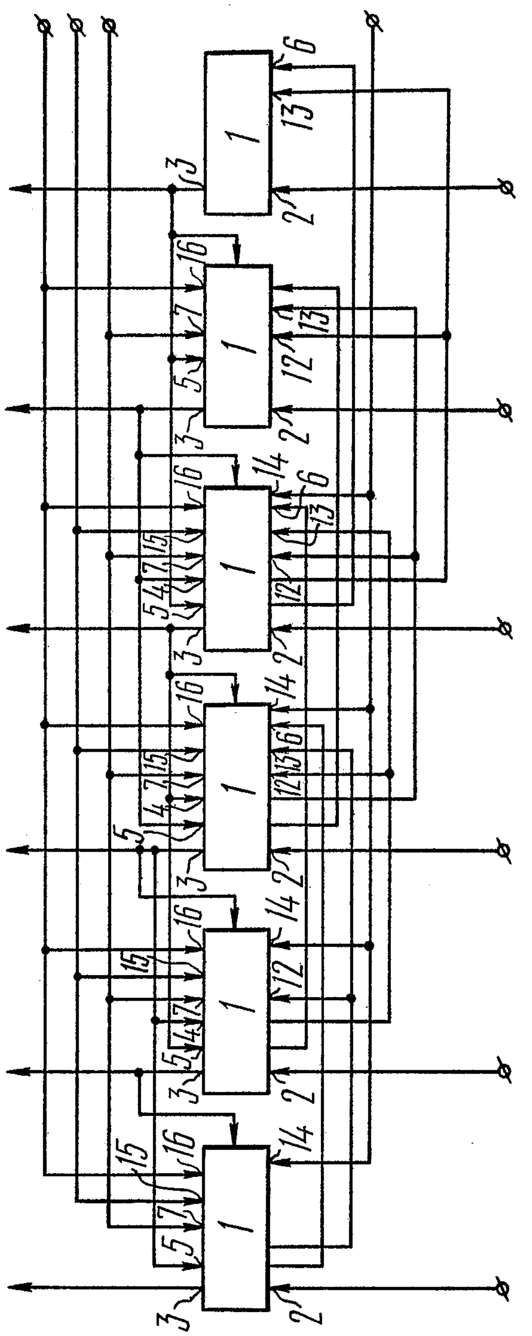

FIG. 2

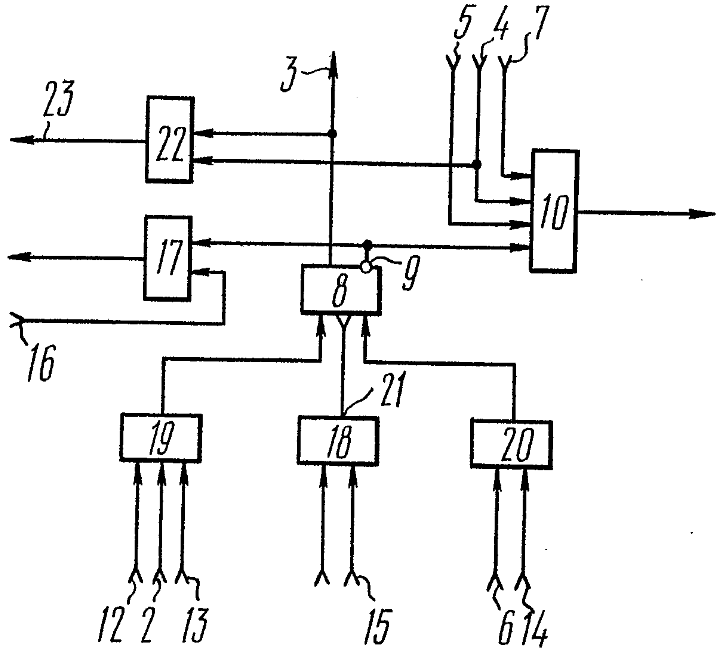
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FIG. 3

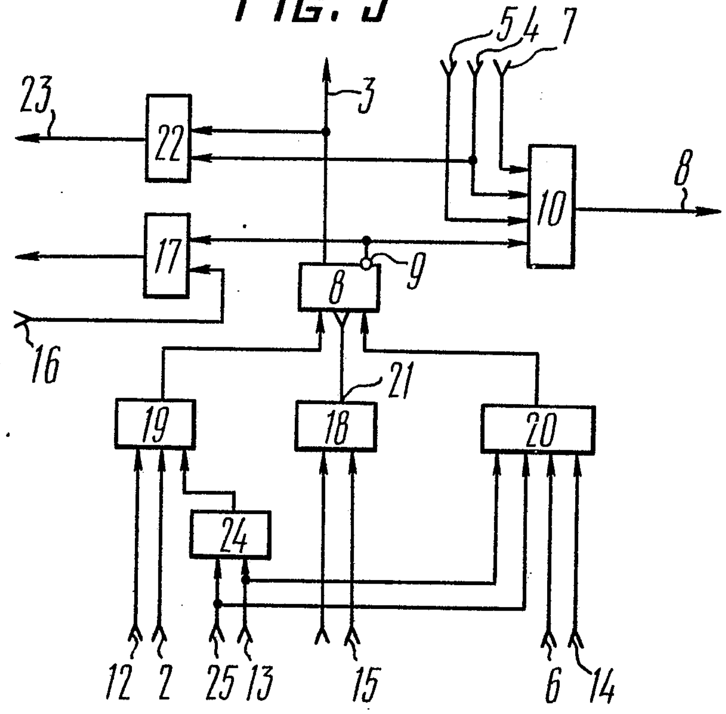
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FIG. 4

SPECIFICATION

Improvements in or Relating to Devices for Reducing Irrational-base Codes to Minimal Form

The present invention relates to computer equipment and, more particularly, to devices for reducing irrational-base codes to a minimal form.

Such devices may be used in digital computers, digital data processing systems, digital measuring instruments and systems for reducing irrational-base codes to a minimal form.

According to the invention, there is provided a device for reducing irrational-base codes to a minimal form, comprising n substantially identical functional cells equal in a number to the number of code digits, each of the functional cells having at least an information input, an information output, a convolution set input, two convolution information inputs, a convolution control input, a convolution signal output and an inversion signal input, the convolution signal output of the l-th functional cell being connected to the convolution set input of the $(l-p-1)$-th functional cell, the information output of the l-th functional cell being connected to the first convolution information input of the $(l+1)$-th functional cell and the second convolution information input of the $(l+p+1)$-th functional cell, the inversion signal input of the l-th functional cell being connected to the information output of the $(l-1)$-th functional cell, where $l=0, 1, 2, \ldots, (n-1)$, $p=1$.

Preferably, in a device where the irrational-base code is the Fibonacci p-code and the "golden" proportion p-code, each functional cell, beginning with $l=1$, includes a flip-flop with a count input, its inverting output being connected to an input of an AND gate whose other inputs are respectively connected to the convolution information inputs and convolution control input of the same functional cell, an output of the AND gate and a direct output of the flip-flop being respectively connected to the convolution signal output and the information output of the same functional cell, whereas a set input, a reset input and a count input of the flip-flop of the l-th functional cell are respectively connected to the information input, convolution set input and inversion signal input of the same functional cell, the functional cell corresponding to the low order of the code being a flip-flop.

In order to perform a code devolution operation, preferably each functional cell additionally includes two devolution signal inputs intended to receive devolution signals, a reset signal input, a convolution inhibit signal input, a devolution inhibit signal input and a devolution signal output which in the l-th functional cell is connected to the first devolution signal input of the $(l-1)$-th functional cell and to the second devolution signal input of the $(l-p-1)$-th functional cell, whereas the devolution inhibit signal inputs and convolution inhibit signal inputs are respectively connected to two common points which are the devolution inhibit signal input and convolution inhibit signal input, respectively, of the device for reducing irrational-base codes to a minimal form.

In order to perform the operation of devolution, preferably each functional cell of the device includes a devolution inhibit gate, a convolution inhibit gate, a flip-flop setting OR gate and a flip-flop resetting OR gate, a first input of the devolution inhibit gate being connected to the inverting output of the flip-flop, while a second input and an output of the devolution inhibit gate are the devolution inhibit signal input and devolution signal output, respectively, of the same functional cell, a first input and a second input of the convolution inhibit gate being the convolution inhibit signal input and inversion signal input, respectively, an output of the convolution inhibit gate being connected to the count input of the flip-flop whose set input is connected to the information input and to the devolution signal inputs of the same functional cell *via* the flip-flop setting OR gate, the reset input of the flip-flop being connected to the reset signal input and the convolution set input *via* the flip-flop resetting OR gate.

In order to check if the device operates properly, preferably each funcational cell includes a check output and contains an AND check element whose first input and second input respectively connected to the information output and convolution information input of the same functional cell, whereas its output serves as a check output of the functional cell.

In order to expand the functional range of the device, preferably where the irrational-base code is the "golden" p-proportion code the l-th functional cell, beginning with $l=2$, has a functional input and includes an OR delay element whose inputs are connected to the remaining inputs of the flip-flop resetting OR gate, a third input of the flip-flop setting OR gate being connected to the functional input and the second devolution signal input of the l-th functional cell *via* the OR delay element.

It is thus possible to improve the operating reliability of devices for reducing irrational-base codes, namely, Fibonacci p-codes and the "golden" p-proportion codes, to a minimal form. A simplified functional cell circuitry may be provided and additional operations such as the transformations of degrees of the "golden" p-proportion code, the counting of pulses and adding up "golden" p-proportion codes may be performed.

The invention will be further described, by way of example, with reference to the accompanying drawings, wherein:

Figure 1 is a functional diagram of a device constituting a preferred embodiment of the invention for reducing irrational-base codes to a minimal form, which performs the convolution of code combinations;

Figure 2 is a block diagram of another device constituting another preferred embodiment of the invention which performs the convolution and devolution of code combinations;

Figure 3 is a functional diagram of an embodiment of a functional cell; and

Figure 4 is a functional diagram of another functional cell which accounts for a broader functional range of the device for the case of the transformation of "golden" p-proportion codes.

Figure 1 shows a functional diagram of a preferred embodiment of the invention for reducing irrational-base codes to a minimal form with $p=1$ and $n=5$, where n is the digit capacity of the code and where the irrational-base code is the Fibonacci 1-code or "golden" proportion 1-code.

The device comprises n, i.e. five, identical functional cells 1, whereof each l-th cell (by way of illustration, let it be assumed that $l=2$) has an information input 2 intended to record information in the form of a code digit. The l-th cell further includes an information output 3 for reading out information on the state of the functional cell 1, as well as a first convolution information input 4 and a second convolution information input 5 which are intended to receive information on the state of the $(l-1)$-th and $(l-p-1)$-th, i.e. $(l-2)$-th, functional cells 1. Each l-th functional cells 1 further has a set input 6 which receives a one signal for resetting the l-th functional cell; the l-th cell further includes a convolution control input 7 which, when receiving a one signal, enables a possible operation of convolution; the l-th cell further has a convolution signal output connected to the set input 6 of the $(l-p-1)$-th functional cell 1 (a one signal is produced at the convolution signal output if the convolution condition is satisfied); the l-th cell further includes an inverting input intended to receive a signal for inverting the state of the functional cell 1 while performing the convolution operation. The convolution signal output of the l-th functional cell 1 is connected to the convolution set input 6 of the $(l-p-1)$-th, i.e. $(l-2)$-th, functional cell 1. The information output 3 of the l-th functional cell 1 is connected to the first convolution information input 4 of the $(l+1)$-th functional cell 1 and the second information input 5 of the $(l+p+1)$-th, i.e. $(l+2)$-th, functional cell 1. The convolution control inputs 7 of all the functional cells 1 are connected to a common bus which serves as a control input for the whole device, which receives a one control signal whenever it is necessary to reduce a Fibonacci p-code or a "golden" proportion p-code to a minimal form. The information outputs 3 of all the functional cells 1 make a multidigit information output of the device with a number of digits equal to n. The information inputs 2 of all the functional cells 1 make up a multidigit information input of the device, intended to enter the information on the number in an irrational-base code.

The l-th functional cell 1 further has an inversion signal input connected to the information output 3 of the $(l-1)$-th functional cell and intended to receive an inversion signal which alters the state of the l-th functional cell 1.

Each l-th functional cell 1, beginning with $l=1$, has a flip-flop 8 with a count input. In all the functional cells 1, with the exception of that functional cell 1 which corresponds to the lower digit of the code, an inverting output 9 of the flip-flop 8 is connected to an input of a convolution AND gate 10. The other inputs of the convolution AND gate 10 are respectively connected to the convolution information input 4, convolution information input 5 and convolution control input 7 of the functional cell 1. An output of the convolution AND gate 10 serves as a convolution signal output of the l-th functional cell 1. A one signal is produced at the output of the convolution AND gate 10 if the flip-flop 8 is reset and if one signals are applied to the first information input 4, the second information input 5 and the convolution control input 7. A direct output of the flip-flop 8 is the information output 3 of the functional cell 1. The set and reset inputs of the flip-flop 8 are respectively connected to the information input 2 and convolution set input 6 of the functional cell 1.

The functional cell 1, which corresponds to the lower order of the code, is a flip-flop 11. As shown in Figure 1, some inputs are not activated in the functional cells 1 corresponding to two lower ($l=0$, $l=1$) digits and the higher ($l=n-1$) digit. For example, the convolution information input 5 is not activated in the functional cell 1 corresponding to the first digit; the set inputs 6 are not activated in the functional cells 1 corresponding to the third and fourth digits. However, all the functional cells I are of the same type; if a greater number of digits is required, the chain of the functional cells I is to be built up on the side of the higher ($l=n-1$) digit so as to activate all the inputs of the third and fourth functional cells I. In this case the lower order functional cell 1 remains as shown in Figure 1.

Figure 2 shows an alternative embodiment of the device according to the invention for reducing irrational-base codes to a minimal form with $p=1$ and $n=6$. In this case the irrational-base codes are the Fibonacci 1-code and the "golden" proportion p-code. The device of Figure 2 comprises six identical functional cells 1 and differs from the device of Figure 1 in that each functional cell 1 has a first devolution signal input 12 and a second devolution signal input 13 whereat a one signal is applied while performing a devolution operation, which signal brings the functional cell 1 to the one state; a reset signal input 14 intended to receive a one signal and thus reset the functional cell 1; a convolution inhibit signal input 15 intended to receive a signal which inhibits the convolution operation; a devolution inhibit signal input 16 intended to receive a signal which inhibits the devolution operation; a devolution signal output connected to the inputs 12 and 13 of the $(l-1)$-th and $(l-p-1)$-th functional cells 1. A one signal is produced at this output if the devolution condition is satisfied. The convolution inhibit signal inputs 15 of all the functional cells 1 are connected to a common convolution inhibit bus of the device; a one signal at this bus inhibits possible convolutions. The devolution inhibit signal inputs are connected to a common devolution inhibit bus of the device; a one signal at this bus inhibits possible devolutions.

As shown in Figure 2, some inputs of the functional cells 1 are not activated. For example, the convolution inhibit signal input 15 and devolution inhibit signal input 16 are not actuated in the functional cell 1 corresponding to the lower (l=0) digit, which equally applies to the devolution signal output and the devolution signal input 12; the convolution inhibit signal input 15 and the devolution signal output are not activated in the functional cell 1 of the first digit; the devolution signal inputs 12 and 13 are not activated in the functional cell 1 corresponding to the higher (l=n—1) digit; the devolution signal input 13 is not activated in the functional cell 1 corresponding to the (n—2)-th digit. If it is necessary to have more than n digits, the chain of the functional cells 1 should be built up on the side of the higher digit so as to activate all the above-mentioned inputs and outputs.

Figure 3 presents an embodiment of the l-th (for the purpose of illustration, let it be assumed that l=2) functional cell 1 which comprises a devolution inhibit gate 17, a convolution inhibit gate 18, a flip-flop setting OR gate 19 and a flip-flop resetting OR gate 20.

A first input of the devolution inhibit gate 17 is the devolution inhibit signal input 16; a second input of the devolution inhibit gate 17 is connected to the inverting output 9 of the flip-flop 8; an output of the devolution inhibit gate 17 is the devolution signal output.

The devolution inhibit gate 17 is intended to block the passage of a one signal from the inverting output of the flip-flop 8 to the devolution signal output in the presence of an inhibit signal at the devolution inhibit input 16. The convolution inhibit gate 18 is intended to block the passage of a one signal from the information output 3 of the (l—1)-th (Figure 2) functional cell 1 to the inversion signal input while performing the operating of convolution and in the presence of an inhibit signal at the convolution inhibit input 15. The output of the flip-flop setting OR gate 19 (Figure 3) is connected to the set input of the flip-flop 8. The inputs of the flip-flop setting OR gate 19 are intended to receive signals from the first devolution signal input 12, the information input 2 and the second devolution signal input 13. These inputs serve to enter initial information in the flip-flop 8 and set it while performing devolution. The output of the OR gate 20 is connected to the reset input of the flip-flop 8. The inputs of the OR gate 20 are intended to receive signals from the reset signal input 14 and the convolution set input 6. These inputs serve to reset the flip-flop 8 while performing devolution and convolution, respectively.

An output 21 of the convolution inhibit gate 18 is connected to the count or clock input of the flip-flop 8. The functional cell 1 further includes an AND check element 22 whose first input is connected to the information output 3, while its second input is connected to the first convolution information input 4 and its output is a control output 23 of the functional cell 1.

The AND check element is intended to check an irrational-base code for a minimal form attribute. A one signal is produced at its output if the l-th and (l—1)-th functional cells 1 are in the one state.

Figure 4 shows an alternative embodiment of the l-th functional cell 1 incorporated in a device which transforms only the "golden" p-proportion code. Unlike the embodiment of Figure 3, each l-th functional cell 1 of Figure 4, beginning with l=2, includes an OR delay element 24 whose first input is connected to the second devolution signal input 13, while its second input is connected to a functional input 25. The second devolution signal input 13 is connected to a third input of the OR gate 20; the functional input 25 is connected to the remaining, i.e. fourth, input of the OR gate 20.

The functional input 25 is intended to receive information on signals while transforming a digital-pulse code of the "golden" p-proportion degrees to the "golden" p-proportion code, as well as while counting pulses in the "golden" p-proportion code or adding up "golden" proportion p-codes.

The device for reducing irrational-base codes to a minimal form (Figure 1) operates as follows. Suppose one has to reduce to a minimal form the number 5 represented in the Fibonacci 1-code which differs from the minimal. The representation is like this:

Weight of Digits	5	3	2	1	1
No of Functional Cell I	4	3	2	1	0
Fibonacci I-Code	0	1	0	1	1

Through the information inputs 2 (Figure I), the code is entered in the flip-flops 8 and the flip-flop 11 of the functional cells of the third, first and zero digits. As a one signal is applied to the control input of the device, the AND gate 10 of the l-th functional cell 1, at whose inputs there arrive one signals from the information outputs 3 of the (l—1)-th and (l—p—1)-th functional cells 1 and from the inverting output 9 of the flip-flop 8 of the l-th cell 1, analyzes the possibility of performing convolution. In this case the condition for convolution (i.e. the presence of a zero signal at the information outputs 3 of the l-th functional cell 1 and of one signals at the information outputs 3 of the (l—1)-th and (l—p—1)-th functional cells 1) applies to the second functional cell 1. A one signal is produced at the output of the AND gate 10, i.e. at the convolution signal output of the second functional cell 1; through the convolution set input 6, this signal resets the flip-flop 11 of the functional cell of the zero digit.

A zero signal is produced at the information output 3 of this functional cell 1 and is applied through the inversion signal input to the count input of the flip-flop 8 of the first functional cell 1 and resets the flip-flop 8. As this takes place, a zero signal is produced at the information output 3 of the first functional cell 1; the zero signal is applied to the count input of the flip-flop 8 of the second functional cell 1 and sets this flip-flop 8. The first convolution is over. The resultant code recorded by the device is thus: 0 1 1 0 0. The convolution condition is satisfied in this case for the fourth functional cell 1. At the convolution signal output of this functional cell there is produced a one signal, whereupon the process continues as described above:

0 1 1

0 1 0

0 0 0

1 0 0

As a result, the initial combination 0 1 0 1 1 becomes 1 0 0 0 0, which corresponds to the minimal form of the number 5 in the Fibonacci 1-code. The duration of the one signal at the control input of the device must necessarily be in excess of the time required for performing all possible convolutions. The convolution being over, the information on the minimal Fibonacci 1-code is read out from the information outputs 3 of the functional cells 1. The "golden" p-proportion code is reduced to a minimal form in a similar manner. It must be emphasized at this point that the device for reducing irrational-base codes to a minimal form rules out ambiguities in reducing any Fibonacci p-code to a minimal form. The device is such that the operation of convolution is carried out sequentially from the $(l-p-1)$-th digit to the $(l-1)$-th digit and from the $(l-1)$-th digit to the l-th digit. If there is a condition for convolution for the l-th, $(l-1)$-th and $(l-p-1)$-th functional cells 1, the first step is the resetting of the flip-flop 8 of the $(l-p-1)$-th functional cell 1. Zero potential is produced at the information output of this cell and is applied to the count input of the flip-flop 8 of the $(l-1)$-th functional cell 1 to reset that flip-flop 8; thus the flip-flop 8 of the l-th functional cell 1 is set. As a result, it is unnecessary to simultaneously change the state of the flip-flops 8 of the three digits.

The devolution of an irrational-base code is carried out as follows. Let it be assumed that the following "golden" proportion 1-code is entered in the device:

α^2	α^1	α^0	α^{-1}	α^{-2}	α^{-3}
1	0	1	0	0	0

An inhibit potential is applied to the convolution inhibit input 15 (Figure 2) from an external control unit (not shown), whereas an enable potential is applied to the devolution inhibit input 16.

A pulse distributor (not shown) is then brought into play and successively applies one signals to the reset signal inputs 14 of all the functional cells 1, beginning with the cell 1 corresponding to α^{-1}. The one signal applied to the reset signal input 14 of the functional cell 1, which corresponds to the weight α^0, resets the flip-flop 8 through the OR element 20. A one signal is produced at the inverting output 9 of this flip-flop 8 and is applied *via* the conducting devolution inhibit gate 17 to the first devolution signal input 12 of that functional cell 1 which corresponds to the weight α^{-1}; this signal is also applied to the second devolution signal input 13 of that functional cell 1 which corresponds to the weight α^{-2}. The one signal is then applied *via* the OR gates 19 to the set inputs of the flip-flops 8 of the above-mentioned functional cells 1 and sets these flip-flops 8. The resultant code is as follows:

α^2	α^1	α^0	α^{-1}	α^{-2}	α^{-3}	
1	0	1	0	0	0	
1	0	0	1	1	0	—new state

As a one signal is subsequently applied to the reset signal input 14 of the functional cell 1 corresponding to the weight α^2, the resultant processes are similar to those described above, and the resultant code is as follows:

α^2	α^1	α^0	α^{-1}	α^{-2}	α^{-3}	
1	0	0	1	1	0	
0	1	1	1	1	0	—new state

At this point the devolution process is over.

The introduction into each functional cell 1 of the AND check element 22 provides for such information storage conditions which make it possible to detect malfunctions of the flip-flops 8 and 11.

Let it be assumed that entered in the device is a minimal code of the "golden" p-proportion, such as:

α^2	α^1	α^0	α^{-1}	α^{-2}	α^{-3}
0	1	0	1	0	0

The introduction of information into the device is a controllable process. In fact, if the recording of the minimal code of the "golden" p-proportion is accompanied by an error in the minimal form attribute of the code, the error is detected by the presence of one signals at the control output 23 of at least one functional cell 1.

Following the recording of the minimal code of the "golden" p-proportion, the storage of the code is also controlled. In order to carry out this process, it is necessary to remove the inhibit signal from the devolution inhibit input 16 and apply an inhibit signal to the convolution inhibit input 15. Let it now be assumed that a spurious signal resets the flip-flop 8 of the functional cell 1 corresponding to the weight α^1. As a result, at the inverting output 9 of the flip-flop 8 of this functional cell 1 there is produced a one signal which is applied *via* the conducting gate 17 to the devolution signal output. This signal is applied *via* the first devolution signal input 12 and flip-flop setting OR gate 19 to the set input of the flip-flop 8 of the function cell 1 corresponding to the weight α^0, whereby this flip-flop 8 is set. This one signal is also applied *via* the second devolution signal input and OR gate 19 to the set input of the flip-flop 8 of the functional cell 1 corresponding to the weight α^{-1}. But this latter flip-flop 8 is already in the one state and thus remains. The resultant "golden" proportion code is thus:

α^2	α^1	α^0	α^{-1}	α^{-2}	α^{-3}
0	0	1	1	0	0

This code differs from the normal. As a result, a one signal, which is indicative of an error, is produced at the control output 23 of the functional cell 1 corresponding to the weight α^0. Thus the device, whose functional cell 1 is shown in Figure 3, makes it possible to detect all malfunctions of flip-flops 8 of the $1 \rightarrow 0$ type. A high percentage of malfunctions of the $0 \rightarrow 1$ (about 99 per cent with $n=20$) is also detected.

The device, whereof the functional cell 1 is shown in Figure 4, provides for information storage conditions such that malfunctions of the $1 \rightarrow 0$ type do not erase digital information. This is due to the introduction of the OR delay element 24 whereof one of the inputs is connected to the second devolution signal input 13. The same input is connected to the third input of the flip-flop resetting OR gate 20.

Suppose the same "golden" proportion code is entered in the device:

α^2	α^1	α^0	α^{-1}	α^{-2}	α^{-3}
0	1	0	1	0	0

There is an inhibit potential at the convolution inhibit input 15; on the other hand, the inhibit potential is removed from the devolution inhibit input 16. Suppose now that again a spurious signal resets the flip-flop 8 of the functional cell 1 corresponding to the weight α^1. A one signal is produced at the devolution signal output of this functional cell and applied to the first devolution signal input 12 of the functional cell 1 corresponding to the weight α^0, whereby the flip-flop 8 of this functional cell 1 is set. The same one signal is applied to the second devolution signal input 13 of the functional cell 1 corresponding to the weight α^{-1}. This leads to the following sequence of events. *Via* the flip-flop resetting OR gate, the one signal is applied to the flip-flop 8 and resets it. As a result, this one signal proceeds *via* the conducting devolution inhibit gate 17 to the devolution signal output of the functional cell 1 corresponding to the weight α^{-1}. This sets the flip-flops 8 of the functional cells 1 corresponding to the weights α^{-2} and α^{-3}, the setting being brought about as described above.

The same one signal from the second devolution signal input 13 of the functional cell corresponding to the weight α^{-1} passes through the OR delay element 24 and is applied, after a time τ from the moment the flip-flop 8 of that functional cell is reset, to the input of the OR element and, consequently, to the set input of the same flip-flop 8, whereby the latter is set. The resultant code is this:

α^2	α^1	α^0	α^{-1}	α^{-2}	α^{-3}
0	0	1	1	1	1

An inhibit potential is then applied to the devolution inhibit input 16, and the inhibit potential is removed from the convolution inhibit input 15. As a one signal is applied to the control input of the device, the given "golden" proportion code is reduced to a minimal form in the manner described above, i.e.:

α^2	α^1	α^0	α^{-1}	α^{-2}	α^{-3}
0	0	1	1	1	1
0	0	1	0	1	1
0	0	0	0	1	0
0	1	0	0	0	0
0	1	0	1	0	0

The resultant code combination coincides with the initial combination, which means that the code is reproduced correctly. Thus if the probability of malfunctions of the 1→0 type is much higher than the probability of malfunctions of the 0→1 type, the device can effectively correct errors; in fact, it corrects all errors of the 1→0 type. If the opposite is true, the device can be used as an error detector.

The introduction into the functional cell of Figure 4 of the OR element producing a delay with a value of τ makes it possible to expand the functional range of the device. This device can transform the digital-pulse code of the "golden" proportion degrees to the "golden" p-proportion code; it can count pulses and give the result in a "golden" proportion code; it can add up "golden" proportion codes.

When transforming the digital-pulse code of any degree of the "golden" p-proportion code, the device transforms the sum total

$$\underbrace{\alpha^n+^{n-1}+\ldots+\alpha^n}_{\text{N times}}$$

to the "golden" proportion code.

With n=0, the device transforms the sequence of unities

$$\underbrace{1+1+\ldots+1}_{\text{N times}}$$

to the "golden" property code.

To make it possible, it is necessary to apply an inhibit potential to the devolution inhibit input 16 and remove the inhibit potential from the convolution inhibit input 15. This is followed by successively applying short pulses to the functional input 25 of the functional cell 1 corresponding to the degree of the golden proportion subject to transformation. The duration of these pulses is not be be greater than the delay time τ of the OR delay element 24, and the number of these pulses must be equal to a preselected number N. As a short pulse arrives at the functional input 25 of a given functional cell 1, it appears, after the delay τ, at the reset input of the flip-flop 8. The delay is due to the OR element 20. After another delay of 2τ, which is due to the OR delay element 24 and flip-flop setting OR gate 19, the pulse arrives at the set input of the flip-flop 8. If this instant the flip-flop is in its one state, it is first zeroed and after τ is set again. As this takes place, a one signal is produced at the devolution signal output, i.e. at the output of the gate 17 (at this moment the devolution inhibit gate is turned on); the one signal is further applied to the first devolution signal input 12 and the second devolution signal input 13 of the functional cells 1 of the lower digits. The flip-flops 8 of these functional cells 1 are set. If the flip-flop 8 of the functional cell 1 corresponding to the degree of the "golden" proportion subject to transformation is reset, it is set after 2τ. After a certain delay in relation to the count pulses, which delay is to be long enough for the transient involved in the devolution of the "golden" proportion code to come to an end, a control signal must be applied to the convolution control input of the device. The duration of the control signal must be sufficiently long for the transient involved in the convolution of the "golden" proportion code to come to an end.

To perform the operation of convolution, an inhibit potential is applied to the devolution inhibit input 16, while an enable potential is applied to the convolution inhibit input 15.

Consider now the pulse count mode. At the start of the operation, all the flip-flops 8 of the device are reset. There is an inhibit potential at the devolution inhibit input 16 and an enable potential at the convolution inhibit input 15. The first count pulse is applied to the functional input 25 of the functional cell 1 corresponding to the weight α^0 to set the flip-flop 8 of this functional cell I. The following code results:

α^2	α^1	α^0	α^{-1}	α^{-2}	α^{-3}
1=0	0	1	0	0	0

To perform convolution, one signals are applied to the convolution control input of the device. The parameters of these signals are dealt with above.

The second count pulse arrives *via* the flip-flop resetting OR gate 20 to reset the flip-flop 8. As a result, a one signal is produced at the devolution signal output and applied *via* the first devolution signal input 12 and the flip-flop resetting OR gate 20 to the flip-flop 8 of the functional cell 1 corresponding to the weight α^{-1}. The flip-flop 8 is set. The one signal is also applied *via* the second devolution signal input 13, the OR delay element 24 and the flip-flop setting OR gate 19 to the flip-flop 8 of the functional cell 1 corresponding to the weight α^{-2}; this flip-flop 8, too, is set. The second count pulse also arrives *via* the delay OR element 24 and the flip-flop setting OR gate 19 at the set input of the flip-flop 8 of the functional cell 1 corresponding to the weight α^{0}. The appearance of this signal at the set input of the flip-flop 8 occurs after a delay of 2τ, as compared with the time of its arrival at the functional input 25: the flip-flop 8 is set. Thus the second count pulse brings the device to this state:

	α^2	α^1	α^0	α^{-1}	α^{-2}	α^{-3}
2=	0	0	1	1	1	0

As a convolution enable one pulse is applied to the control input of the device, the code convolution is performed as described above; this means that the device is brought to the following state:

	α^2	α^1	α^0	α^{-1}	α^{-2}	α^{-3}
2=	0	1	0	0	1	0

which is the minimal form of representation of the number 2 in the "golden" code.

It is clearly seen that following the arrival of the third and fourth count pulses, the states of the device are changed like this:

	α^2	α^1	α^0	α^{-1}	α^{-2}	α^{-3}
3=	0	1	1	0	1	0
	1	0	0	0	1	0
4=	1	0	1	0	1	0

The device is to a great extent self-supervisory. Operation of the device invariably results in a minimal "golden" proportion code. If a code is not reduced to a mimimal form because of some fault in the circuitry, the malfunction is detected at once by the presence of a permanent one signal at the control output 23 of one of the functional cells 1. Let it be assumed that the output of the convolution AND gate 10 of one of the functional cells 1 is cut off. When this situation arises:

0	1	1

a one signal applied to the control input of the device is not followed by convolution. As a result, there is a permanent one signal at the control output 23 of the functional cell 1 in question. Thus the convolution process is a self-supervisory process.

Consider now the process of adding up numbers in the "golden" *p*-proportion code carried out by a nine-digit device similar to the six-digit device shown in Figure 2.

The device performs the functions of a sequential-type adder-accumulator. This is done as follows. Suppose the operation of 4+4 has to be performed in the "golden" code. For this purpose, the "golden" code of the first summand is entered in the device:

α^4	α^3	α^2	α^1	α^0	α^{-1}	α^{-2}	α^{-3}	α^{-3}
0	0	1	0	1	0	1	0	0

after which each of the units digits must be applied to the respective functional inputs 25 of the device. If the addition is carried out from the lower digits side, the process is as follows:

1) as a one signal of the second digit is applied:

	α^4	α^3	α^2	α^1	α^0	α^{-1}	α^{-2}	α^{-3}	α^{-4}	
	0	0	1	0	1	0	1	0	0	addition
+	0	0	0	0	0	0	1	0	0	
	0	0	1	0	1	0	1	1	1	reducing code to minimal form
	0	0	1	0	1	1	0	0	1	
	0	0	1	1	0	0	0	0	1	
	0	1	0	0	0	0	0	0	1	

2) as a one signal of the fourth digit is applied:

	α^4	α^3	α^2	α^1	α^0	α^{-1}	α^{-2}	α^{-3}	α^{-4}	
	0	1	0	0	0	0	0	0	1	addition
+	0	0	0	0	1	0	0	0	0	
	0	1	0	0	1	0	0	0	1	

3) as a one signal of the sixth digit is applied:

	α^4	α^3	α^2	α^1	α^0	α^{-1}	α^{-2}	α^{-3}	α^{-4}	
	0	1	0	0	1	0	0	0	1	addition
+	0	0	1	0	0	0	0	0	0	
	0	1	1	0	1	0	0	0	1	reducing code to minimal form
	1	0	0	0	1	0	0	0	1	

The addition is over.

It can easily be inferred from the above that the device for reducing irrational-base codes to a minimal form features a higher reliability and a broader functional range than the prototype. It can be used as the basic units of systems operating with Fibonacci p-codes and "golden" proportion codes. It can be used as a principal component around which all the basic units of a self-supervisory digit instrument can be built. Thus, it is possible to achieve an increased accuracy and reliability of digital instrumentation operating with irrational-base codes.

Claims

1. A device for reducing irrational-base codes to a minimal form, comprising n substantially identical functional cells equal in a number to the number code digits, each of the functional cells having at least an information input, an information output, a convolution set input, two convolution information inputs, a convolution control input, a convolution signal output and an inversion signal input, the convolution signal output of the l-th functional cell being connected to the convolution set input of the $(l-p-1)$-th functional cell, the information output of the l-th functional cell being connected to the first convolution information input of the $(l+1)$-th functional cell and the second convolution information input of the $(l+p+1)$-th functional cell, the inversion signal input of the l-th functional cell being connected to the information output of the $(l-1)$-th functional cell, where l=0.1.2,..., ((n−1), p=1.

2. A device as claimed in Claim 1, wherein the irrational-base codes are the Fibonacci p-code and the "golden" p-proportion code and each functional cell, beginning with l=1, includes a flip-flop with a count input, whose inverting output is connected to an input of a convolution AND gate whose other inputs are respectively connected to the convolution information inputs and the convolution control input of the same functional cell, an output of the convolution AND gate and a direct output of the flip-flop being respectively connected to the convolution signal output and the information output of the same functional cell, a set input, reset input and count input of the flip-flop of the l-th functional cell being connected to the information input, the convolution set input and the inversion signal input, respectively, of the same functional cell, the functional cell corresponding to the lower-order digit of the code being a flip-flop.

3. A device as claimed in Claim 1, wherein each functional cell is additionally provided with two devolution signal inputs, a reset signal input, a convolution inhibit signal input, a devolution inhibit signal input and a devolution signal output, the devolution signal output of the l-th functional cell being connected to the first devolution signal input of the $(l-1)$-th functional cell and the second devolution signal input of the $(l-p-1)$-th functional cell, the devolution inhibit signal inputs and the convolution inhibit signal inputs being respectively connected to two common points which respectively serve as a devolution inhibit signal input and a convolution inhibit signal input of the device for reducing irrational-base codes to a minimal form.

4. A device as claimed in Claim 3, wherein each functional cell includes a devolution inhibit gate, a convolution inhibit gate, a flip-flop setting OR gate and a flip-flop resetting OR gate, a first input of the devolution inhibit gate being connected to the inverting output of the flip-flop, a second input and an output of the devolution inhibit gate respectively serving as the devolution inhibit signal input and a devolution signal output of the same functional cell, a first input and a second input of the convolution inhibit gate respectively serving as the convolution inhibit signal input and the inversion signal input, an output of the convolution inhibit gate being connected to the count input of the flip-flop whose set input is connected to the information input and the devolution signal inputs of the same functional cell

via the flip-flop setting OR gate, the reset input of the flip-flop being connected to the reset signal input and the convolution set input *via* the flip-flop resetting OR gate.

5. A device as claimed in Claim 4, wherein each functional cell has a control output and includes an AND check element having its first input and second input respectively connected to the information output and the first convolution information input of the same functional cell, its output being the control output of the functional cell.

6. A device as claimed in Claims 4 or 5, wherein the irrational-base code is the "golden" *p*-proportion code and each *l*-th functional cell, beginning with *l*=2, has a functional input and includes an OR delay element whose inputs are connected to the remaining inputs of the flip-flop resetting OR gate, a third input of the flip-flop setting OR gate being connected to the functional input and the second devolution signal input of the *l*-th functional cell *via* the OR delay element.

7. A device for reducing irrational base codes to a minimal form, substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

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