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(54) Analog function generator with electronic linear components.

(57) The invention is relating to the analog function generator with electronic linear components having a function of generating the non-linear function dependence between the input (V 1.1) and the output (V4) of the electronic circuit, exclusively by linear components, and being comprised of two or more operational amplifiers (2, 2.1, 2.n) and the appertaining linear resistors (R 2.1, R 2.2, R 2.n).

By the analog function generator with electronic linear components we can desirably generate any defined and required function connection, respectively, between the input voltage (V 1.1) and the output voltage (V4) of the electronic circuit,and that,with an extraordinary mathematical exactness with which the influences of the ambient temperature and the heat of the linear components upon the stability and the precisness of the circuit operation are entirely eliminated, with the function generator frequency band-width being extremely enhanced. Due to this the field of application of the analog function voltage generator with electronic linear components is very wide; we can use it with different transducers of non-electric quantities to electric ones: inductive displacement transducers, pressure transducers, NTC and PTC resistors, magnetic converters, optical converters...

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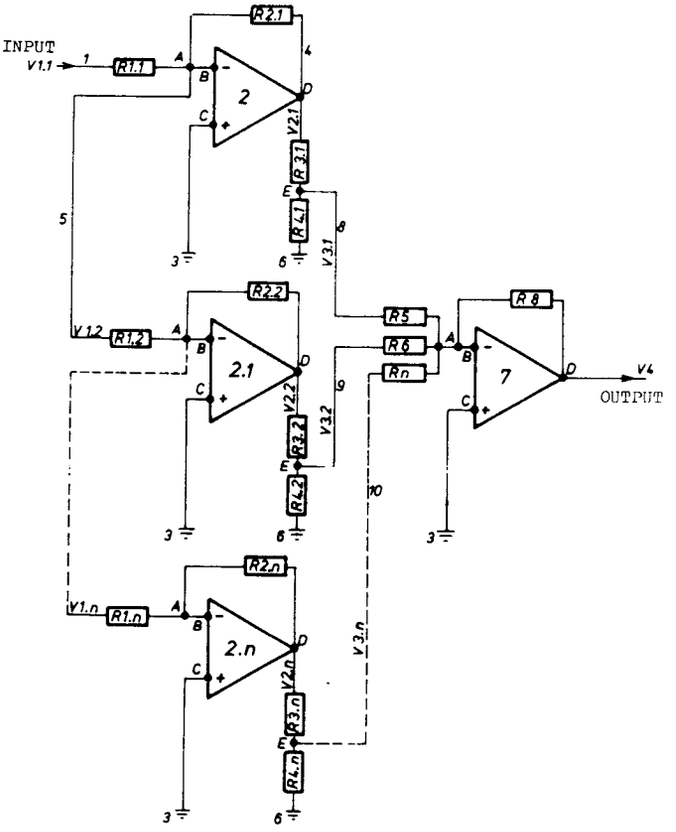
INPUT
V1.1
1
R1.1
A
B
C
D
2
R2.1
4
V2.1
R3.1
E
R4.1
6
V3.1
5
3
R2.2
V1.2
R1.2
2.1
V2.2
R3.2
R4.2
R2.n
V1.n
R1.n
2.n
V2.n
R3.n
R4.n
R5
R6
Rn
R 8
7
V4
OUTPUT
10

Fig. 1

Field of technique

The field of technique to which the present invention belongs ore electronic analog function generators, the present invention concretely relating to the operational amplifiers of the electric voltage, having a function of changing the function dependence between the input and the output electric voltages of the electronic circuit.

The foreseen classification of the invention subject according to IPC: G 06G 7/26, G 06F 15/31, H 03K 4/06, G 01R 13/40.

Technical problem

The present invention solves the problem how to remove the undesirable influence of the ambient temperature and the heat formed during the operation of electronic components and to reach this way the technically required accuracy of measuring converters of non-electric quantities to the electrical ones, of sensors and all other analog electronic circuits with which the function dependence between the input and the output electric voltages of the definite circuit shall be changed. Thus, the invention solves the problem how to remove the characteristic disadvantages with the up-to-now known performances of electronic function generators which are expressed in sensitivity to temperature changes, limited band-width and in their non-applicability with the characteristics with a-high non-linear deviation.

State of technique

The up-to-now known electronic function generators work on the principle of the forward junction voltage, a zener diode or a temperature-varying resistors and on the principle of all those electronic circuits whose operation is based on the application of non-linear components.

In the analog technique,until now,above all,the diode function generators (DFG) have been used which have the bad characteristic to be very sensitive to temperature changes. Due to this the DFG are very difficult to calibrate and they also have an unstable characteristic and are therefore applicable first of all for laboratory works where they can be many times checked and adjusted.

The described weak points and the disadvantages of the DFG are valid also for electronic function generators with zener diodes but with the difference that in the latter ones the zener voltage points depend upon the zener voltage.

The up-till-now known function generators have, accordingly the following characteristic weak points and disadvantages: they are sensitive to the ambient temperature changes and also to their own inner temperature changes, they have a limited band-width and are non-applicable with the characteristics with a high non-linear deviation.

From the German patent application OS 2 237 109, applied by the French applicant Fa. CROUZET, an analog function generator is known which works on such a principle that a differential receiver provides electric D.C. voltage proportional to the pressure difference and which is received from a static pressure meter and from a total pressure meter which is carried out in the form of a Pitot tube. The differential receiver provides a voltage which is proportional to the local difference pressure Q_{ci} and which is a sum of a true difference pressure Q_c and a differential pressure deviation dQ_c , as a function of Mach number of Q_c and P_s.

The central analog computer calculates in a known way the dQ_c value and provides a D.C. voltage proportional to dQ_c . Both voltages Q_{ci} and dQ_c will be summed up in a summing amplifier which delivers a voltage $Q_c = Q_{ci} - dQ_c$ which is available at the junction B.

From the above described known invention it is evident that the voltage Q_c and the difference voltage V_0 will be applied on the linear amplifier A_1, with the appertaining resistors (R1, R2, R3, R4), which gives the output voltage $V_1' = a'Q_c + b'$. The second linear amplifier A_2 with the appertaining resistors (R5, R6, R7, R8) to which the voltage is supplied from the junction point B, as well, gives the output voltage $V_2' = c'Q_c + d'$ where a', b', c', d', depend on the circuit arrangement.

Both voltages V_1' and V_2' will be applied to the linear potentiometer P each from one side. The voltage V' on the rotor contact x' represents a function of the rotor contact x' position on the potentiometer P provided the total rotor contact path is given by x'. The rotor contact x' shift, i.e. the turning angle of the potentiometer P, represents a hyperbolic function of Q_c.

The above described known invention is applicable first of all in analog anemometric centrales for air vehicles.

The disadvantage of this known invention is above all in the fact that the analog function generator comprises a series of mechanical components which are exposed to mechanical damages (and consequently, to breakdowns and inaccuracy) what inevitably causes an incorrect or disturbed operation of the analog function generator and, consequently, a possible vital mistake in air vehicles.

We have also made a research work on the known inventions from the following patent applications: OS DE 32 29 and OS DE 34 10 935 both dealing with function generators which produce voltage functions on the digital principle what is impossible to be directly compared with the es-

sence of the solution according to our invention.

Presentation of the invention and a description of the technical problem solution based on an example of embodiment and a figure description

Regarding the preliminary described weak points and disadvantages of the up-to-now known function generators and, with reference to this, the stated technical problem, the latter will be solved by the analog function generator with linear electronic components according to our invention with a function of transforming any input function to any optional output function and is, in effect, comprised of two or more operational amplifiers with appertaining linear resistors interconnected by two or more summing junctions which can desirably generate, so that on the voltage output the desired output voltage is obtained what is, in effect, an exact sum of two or more partial voltages.

The invention will be presented more in detail on base of the embodiment example in Fig. 1 which schematically illustrates the analog function generator with linear electronic components.

From the Fig. 1 it appears th t the operational amplifiers (2, 2.1, to 2.n and 7) are connected with the linear resistors (R 1.1, to R 1.n, R 2.1 to R 2.n, R 3.1 to R 3.n, R 4.1 to R 4.n, R 5.1 to Rn and R8) in the inverting feedback circuit.

To the input of the analog function generator with linear electronic components according to our invention the defined voltage V 1.1 is supplied by the voltage terminal (1) across the resistor R 1.1 into the summing junction A and further into the inverting input B in the operational amplifier (2) what results in amplification of the supplied voltage V 1.1 to the voltage V 2.1 which via the voltage output D of the operational amplifier (2) and across the feedback connection (4) with the included resistor R 2.1 returns to the summing junction A, and that, with the inverted phase. The amplified output voltage V 2.1 is dependent on the resistor ratio R 2.1 : R 1.1 what represents the actual voltage gain factor.

The output voltage V2.1 follows the input voltage V 1.1, taking into consideration the above described voltage gain factor for such a period of time and up to the moment, respectively, until the operational amplifier (2) comes to the state of the electrical saturation (this happens at the instant when the output voltage V 2.1 cannot rise anymore, namely, due to the supply voltage and the internal resistors in the operational amplifier (2). The voltage in the summing junction A equals to 0V (zero volts) up to the moment when the operational amplifier (2) passes to the saturation point. At the moment when the operational amplifier (2) passes to the saturation point the output voltage V 2.1 (via feedback (4) and the resistor R 2.1) loses its effect on the summing junction A and due to this, the voltage in the summing junction A starts rising, and that, in accordance with the increasing input voltage V 1.1. This means that the magnitude of the input voltage V 1.1, up to which the voltage in the summing junction A will be zero (oV) depends on the described voltage gain factor. The above described phenomenon represents the operation base of the analog function generator with electronic linear components according to our invention in the way as well illustrated in Fig. 1:

The summing junction A of the operational amplifier (2) is by the terminal (5) and across the resistor R 1.2 connected with the next summing junction A of the operational amplifier (2.1) where the input voltage V 1.2 is supplied by the terminal (5) whereupon the operational amplifier (2.1) begins to operate on fully identical principle as the previously described operational amplifier (2).

The analog function generator with electronic linear components according to our invention can be formed and composed, respectively, of any desirable even number of operational amplifiers (2.n) and appertaining resistors (R 4.n), namely, in dependence upon the need of generating any desirable and required number of the summing junctions An, respectively, foreseen by a mathematical function. Furthermore, the output voltage V 2.1 is lead from the voltage output D of the operational amplifier (2) across the resistors R 3.1 and R 4.1 into the earthing (6) where a definite portion of the output voltage V 2.1 is taken from the junction E positioned between the resistors R 3.1 and R 4.1, as a partial voltage V 3.1, by the terminal (8) and across the resistor R5 and through the summing junction A into the inverting input B of the operational amplifier (7).

The output voltage V 2.2 of the operational amplifier (2.1) is lead from the voltage output D across the resistors R 3.2 and R 4.2 as a partial voltage V 3.2 from the junction E by the terminal (9) and across the resistor R6 and through the summing junction A into the inverting input B of the operational amplifier (7).

According to the same principle and in the same manner also the output voltages V 2.n of other operational amplifiers (2.n) included in the electronic circuit, are lead where the analog function generator with electronic components according to our invention is composed of two or more operational amplifiers with the appertaining linear resistors.

From two or more partial voltages V 3.1, V 3.2 to V 3.n, supplied into the common summing junction A and further on into the inverting input B of the operational amplifier (7) we get on the voltage output D of the operational amplifier (7) the output voltage V4 representing an exact sum of two or more partial voltages V 3.1 + V 3.2 +... V 3.n what

is achieved by the resistor R8. The quantity of the operational amplifiers in the analog function generator with electronic linear components according to our invention, depends upon the number of linear approximations from which the defined desirable function consists of, where the slope and the angle of the voltage rise of individual linear approximations of the selected function, respectively, is determined by the already described voltage gain factor, and that for each individual operational amplifier separately.

The voltage gain in each operational amplifier (2, 2.1 to 2.n) is defined mathematically, by defining the output voltage portion of the individual operational amplifier with the resistor voltage dividers (R 3.1 - R 4.1, R 3.2 - R 4.2, to R 3.n - R 4.n) and that, on the base of the selected or in advance defined mathematical functions.

By means of the function generator with electronic linear components according to our invention the possibility is given to transform any input function (regardless of its form and size) into any or desired output function, the signals of these functions being direct current (D.C) or alternating current (A.C).

The analog function generator with electronic linear components according to our invention is for its system characteristics, as well as for its, in advance assured and determined constant output voltage, respectively, applicable for measuring converters of non-electric quantities to electrical ones; furthermore, for sensors and all other function analog circuits which should, for different reasons, comply with the requirement of the function dependence change between the electronic circuit input and output.

Claims

1. The analog function generator with electronic linear components having a function of transforming the function dependence between the input and the output of the electronic circuit, comprising the operational amplifiers with the appertaining linear resistors which divide the input electric voltage to more partial voltages being characterized in that it is comprised of one, two or more operational amplifiers (2, 2.1, 2.n) where the voltage terminal (1) is across the linear resistor R 1.1 connected with the summing junction A and from it further on with the inverting input B and the non-inverting input C , further on with the voltage output D of the operational amplifier (2), the operational amplifier (2) output D being further on by the feedback (4) and across the linear resistor R 2.1 connected with the operational amplifier (2) summing junction A which is further on via the terminal (5) and the linear resistor R 1.2 connected with the summing junction A of the next operational amplifier (2.1), the operational amplifier (2.1) summing junction A being connected with the inverting input B and the non-inverting input C and with the voltage output D which is further on by the feedback connection and across the linear resistor R 2.2 connected with the operational amplifier (2.1) summing junction A, the operational amplifiers(2.n) following,being carried out and interconnected in the same manner, as well.

2. The analog function generator with electronic linear components according to the claim 1, being characterized in that the summing junction A of the operational amplifier (2) is by the terminal (5) and across the linear resistor R 1.2, connected with the summing junction A of the operational amplifier (2.1), the summing junctions A of the additional operational amplifiers (2.n) being interconnected in the same manner.

3. The analog function generator with electronic linear components according to the claim 1, being characterized in that the partial input voltages (V 1.2, up to V 1.n) are lead off from the summing junctions A of the operational amplifiers (2, 2.1 up to 2.n) and appear across the resistor voltage dividers (R 3.1 - R 4.1, up to R 3.n - R 4.n) and their junctions E, respectively, in form of the partial voltages (V 3.1 up to V 3.n) which are further on lead across the linear resistors (R5 up to Rn) to the collecting summing junction A of the operational amplifier (7) where on its voltage output D the output voltage V4 of the electronic circuit is obtained, the output voltage V4 being equal to the sum of all partial voltages (V 3.1 up to V 3.n).

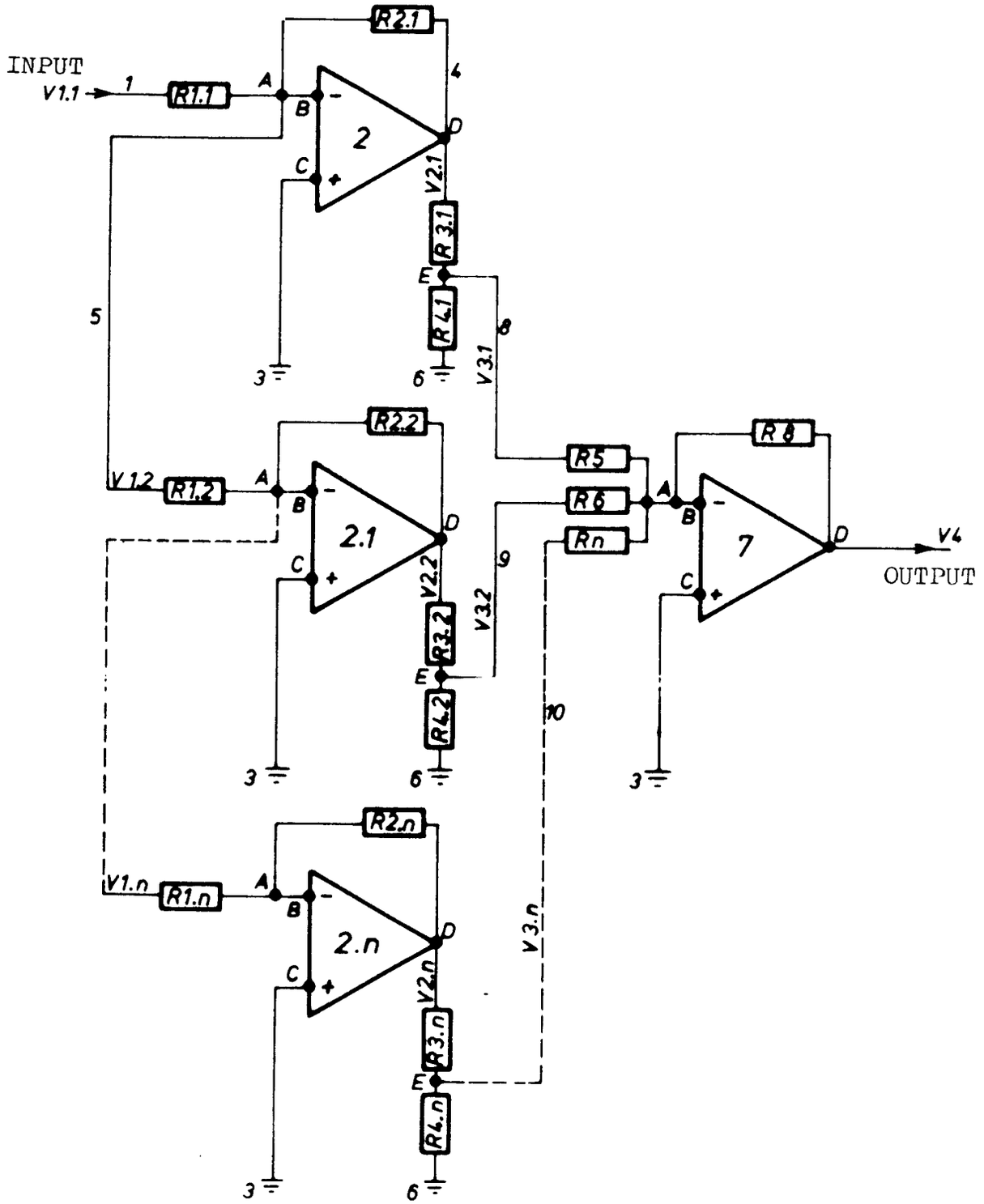
INPUT
V1.1
1
R1.1
A
B
C
D
2
R2.1
4
V2.1
R3.1
E
R4.1
5
3
6
V3.1
8
R2.2
V1.2
R1.2
2.1
V2.2
R3.2
R4.2
9
V3.2
10
R2.n
V1.n
R1.n
2.n
V2.n
R3.n
R4.n
V3.n
R5
R6
Rn
R8
7
V4
OUTPUT

Fig. 1