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Device for measurement of current and voltage differences

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Besides measurements of absolute values of physical parameters, other problems related to the determination of relatively dimensionless values also exist. In them, the ratio between two electric values is a measure determining the measured value.

Such a problem occurs in the measurement of the perpendicular component of the ion drift velocity in the ionosphere, where a multigrid flat trap with separated four-section collector RPASC is used as a preliminary transformer of the non-electric value into an electric one and, hence, we look for the ratio between currents $\frac{I_1}{I_2}$ and $\frac{I_3}{I_4}$ from the four sections of the collector. The ion arrival angle on the four sections of the collector is determined via measurement of the differential difference of currents from two couples of opposite sections, for which it is necessary to orient the perpendicular trap axis along the container vector [1].

The measurement would hardly be justified, if the registration of the minumum differences in the currents from the two opposite collectors under changes in the most sensitive scale and the registration of the minimum differences of the same currents in the coarsest scale is not made with the same sensitivity. This is also valid for the maximum differences (from order to order of current) in the entire range of the measured value. Therefore, the device was developed on the basis of logarithmic amplifiers. It contains two identical measurement tracks (Fig. 1) 1 and 2, i. e. one for each couple of opposite collector sections. Therefore, it is sufficient to examine only one of the measuring tracks.

Two cases are possible:

1. The current variations of the four-section separated collector occur within the range of $I=(1.10^{-11}\div 1.10^{-7})$ A. Then I_1 and I_2 enter the inputs of the two current-voltage converters (CCV_1 and CCV_2), at the outputs of which we obtain respectively U_1 and U_2. At the outputs of the next voltage logarith-

mic amplifiers (LA_1 and LA_2) we obtain voltages which enter the two inputs of the differential amplifier DA_1 and thus we obtain at its output:

(I) $$U_g = k lg \frac{I_1}{I_2}\,.$$

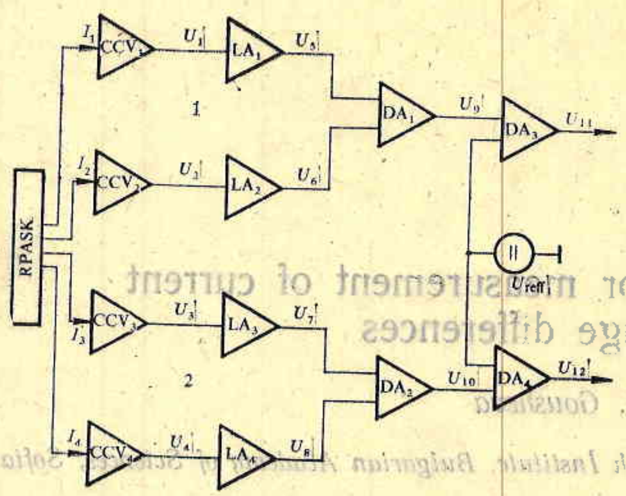

Fig. 1

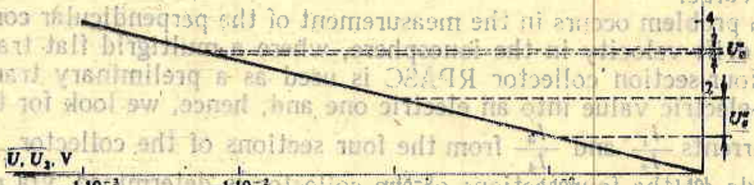

Fig. 2.

We can illustrate two concrete examples for the registration of the current differences (Fig. 2):

a) Ug' for $\Delta \dot{I} = 1.10^{-11}$ A;

b) Ug'' for $\Delta \dot{I} =$ (an order).

Besides, the minimum differences inside the scales (for all the scales and from scale to scale) are equal. The minimum differences which can be measured attain 1.10^{-11} A and the maximum — 4 current orders(from $1.10^{-11} \div 1.10^{-7}$)A.

2. The current variations form the four-section collector are within the range of $\dot{I} = (1.10^{-9} \div 1.10^{-3})$ A. Then, $CCV_{1\div 4}$ are not necessary (Fig. 1) and voltage $LA_{1\div 4}$ are replaced by current ones. The minimum differences which can be measured then are 1.10^{-9} A and the maximum are 6 orders of the current (from $1.10^{-9} \div 1.10^{-3}$) A.

The measurement of voltage differences is also made with the block circuit from Fig. 1, without $CCV_{1\div 4}$.

The switching on of a reference source of voltage to the inverting input of the differential amplifier DA_3 provides a possibility of shifting the zero of the service telemetric system. Thus, the increase of one of the currents and

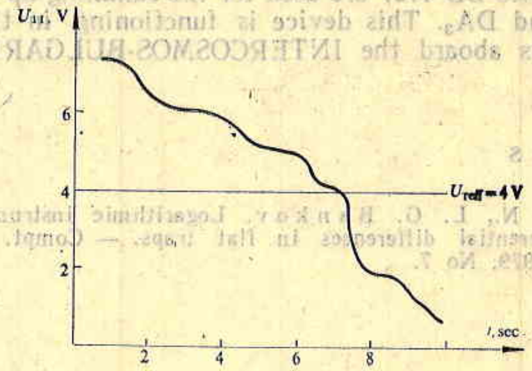

Fig. 3.

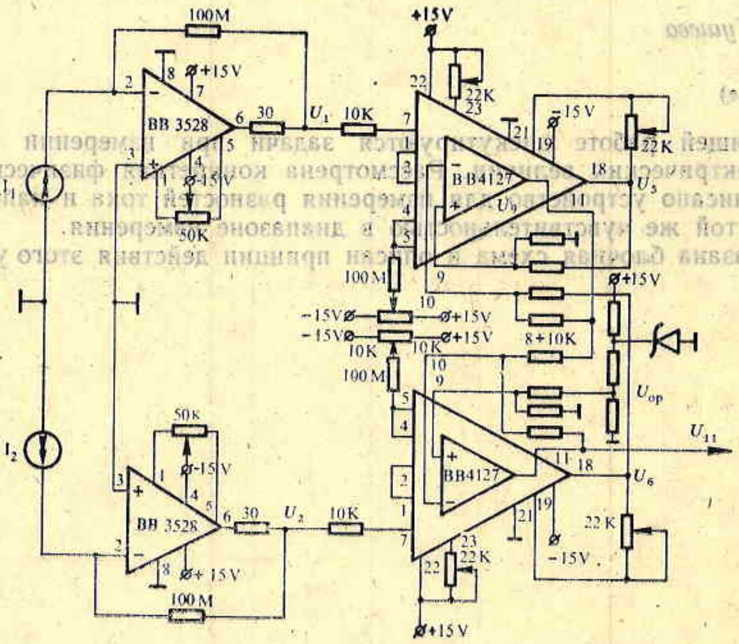

Fig. 4.

the respective decrease of the other (voltage respectively) and the reverse process are easily registrated as

(2) $$U_{11} = k\lg\frac{I_1}{I_2} - U_{ref}.$$

Let $U_{ref}=4V$ (Fig. 3). When the currents are equal, $U_{11}=4V$ increases up to 8 V and decreases down to 0 V, in dependence on which one of the two currents increases.

A concrete version of the device is shown in Fig. 4. Burr-Brown's preamplifiers BB 3528 are used as CCV. The logarithmic amplifiers in voltage measurement mode BB 4127 are made by the same company. The in-built operational amplifiers into BB 4127 are used for the summing-up of the differential amplifiers DA_1 and DA_3. This device is functioning in the instrument for drift measurements aboard the INTERCOSMOS-BULGARIA-1300 satellite.

References

1. Gusheva, M. N., L. G. Bankov. Logarithmic instrument for measuring small differential differences in flat traps. — Compt. rend. Acad. Bulg. Sci., 32, 1979, No 7.

Устройство для измерения разности тока и напряжений

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(Резюме)

В настоящей работе дискутируются задачи при измерении отношения двух электрических величин. Рассмотрена конкретная физическая ситуация и описано устройство для измерения разностей тока и напряжения с одной и той же чувствительностью в диапазоне измерения.

Показана блочная схема и описан принцип действия этого устройства.