COMMENTS ON THE ARTICLE "MATHEMATICAL MODELING OF HEAT EXCHANGERS AS CONTROLLED ELEMENTS WITH DISTRIBUTED PARAMETERS"

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The paper cited (reference [1]) examined the question of mathematical modeling of unsteady processes in groups of heat exchangers on analog computers. For the cases analyzed in the paper — constant temperature of heating medium and internal heat sources constant over the volume of the wall — the transfer functions obtained contained the term (the numbering of [1] has been retained):

$$W_2(p) = \exp\left[-\frac{A(p)}{B(p)} x\right],\tag{27}$$

which may be written in the form

$$W_2(p) = \exp\left(-\frac{T_0}{T_{12}}\right) \exp\left(-T_0 p\right) \exp\left(\frac{a}{Tp+1}\right).\tag{35}$$

For modeling an element with transfer function $(a/(Tp+1))$ a series expansion of this function is used:

$$\exp\left(\frac{a}{Tp+1}\right) = 1 + \frac{a}{Tp+1} + \frac{a^2}{2!\,(Tp+1)^2} + \frac{a^3}{3!\,(Tp+1)^3} + \cdots\tag{40}$$

To realize an element with transfer function (40), a scheme was proposed (Fig. 3 in [1]) that retains three terms of the expansion and requires three integrating amplifiers 7, 8, and 15 and an inverter 3.
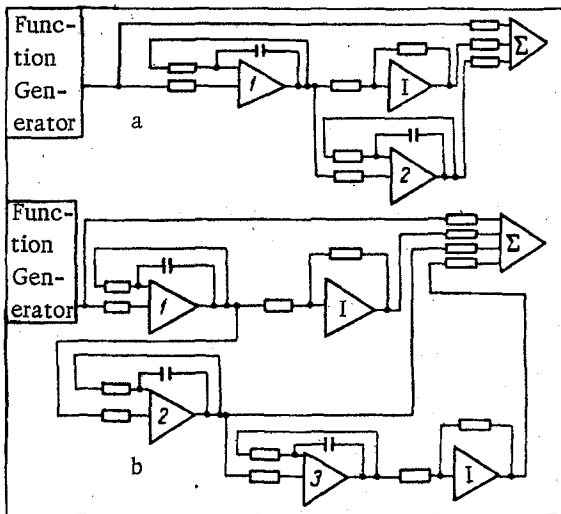

Fig. 1. Block diagram of transfer function (40) for (a) three and (b) four terms of the expansion.

In our opinion, this scheme is not optimal from the viewpoint of the number of integrating amplifiers. In fact, the scheme we propose here (Fig. 1a) allows the number of integrating amplifiers to be reduced from three to two. In this case the gains are a and $a/2$ for integrating amplifiers 1 and 2, respectively.

On the other hand, if the accuracy of representing the transfer function $(a/(Tp+1))$ by three terms of series (40) is inadequate, then, to include four terms of (40), one may use the scheme of Fig. 1a, which employs three integrating amplifiers 1, 2, and 3 with gains of a, $a/2$, and $a/3$, respectively, and two inverters I. Thus, the addition of one inverter, compared with Fig. 3 of [1], allows four terms of (40) to be retained instead of three. This increases the accuracy: the statistical error for the example given in [1] is lowered from 1.4 to 0.8%. Alternatively, and this is more important, a statistical error of ~ 1.4% may be obtained for values of the coefficient $a \leq 0.9$, whereas, using the scheme with three integrating amplifiers [1], the statistical error is 6.3% at $a = 0.9$.

The principle proposed (Figs. 1a, b) can also be used to construct block diagrams for even larger numbers of terms of (40), using fewer integrating amplifiers than would be required by the scheme of Fig. 3 in [1].

REFERENCE

1. P. A. Andriyanovich and I. M. Maslennikov, IFZh, no. 4, 1964.