UDC 621.924.7

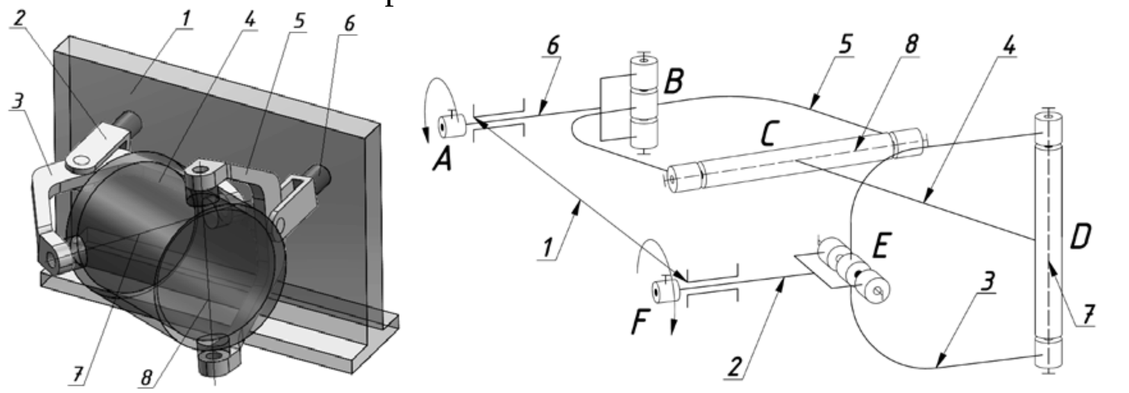
SYNTHESIS OF THE TUMBLING MACHINE SPATIAL MECHANISM

M.G. Zalyubovskiy, Candidate of Technical Sciences, Associate Professor
Open University of Human Development "Ukraine"
I.V. Panasyuk, Doctor of Technical Sciences, Professor
Kyiv National University of Technologies and Design

Keywords: spatial mechanism, passive coupling, capacity, kinematic pair.

For the first time in 1966, the development of the Swiss firm Willy A. Bachofen (WAB) was presented – the basic design of a machine with a complex spatial movement of the working capacity [1] – "Turbula", which was designed to perform the processes of fine bulk solids mixing. Today, this machine design has a much wider scope and can be used both for mixing and for performing various types of plastering technological operations.

Figure 1 (a) shows the model of the well-known basic design of the machine with complex spatial motion of the working tank. Figure 2 (b) shows the kinematic scheme of the spatial mechanism of the machine.



a b

Figure 1: a – the model of the machine; b – the kinematic scheme of the spatial mechanism of the machine

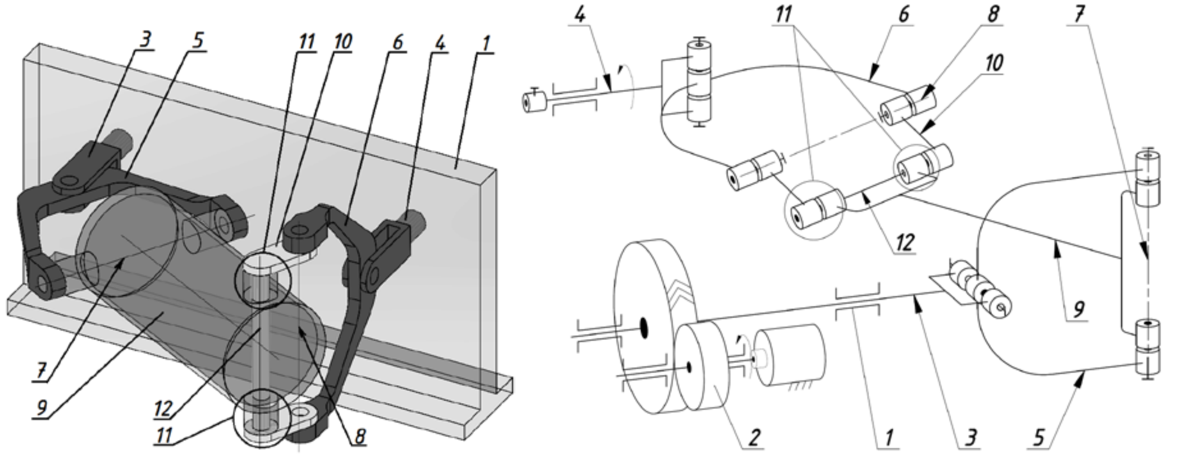
The machine comprises a bed (*1*), a driving (*2*) and a driven (*6*) shafts installed in the bed in parallel to each other in the same plane and connected by a double spatial hinge in the form of a driving yoke (*3*), a driven fork (*5*) and a working tank *4* fixed between the yokes on diametrically mutually perpendicular geometric axes 7 and *8*, respectively. The movable links of the machine form a six-link spatial mechanism with rotational kinematic pairs. The mechanism is a closed kinematic chain *ABCDEF*. Using the Somov–Malyshev formula to determine the degree of mobility of the mechanism establishes that it is zero:

$$W = 6n - \sum_{s=1}^{s=5} (6 - s) p_s = 0,$$

where n is the number of movable links ($w=5$ movable links: driving *1* and driven *6* shafts, driving *3* and driven *5* yokes, working tank *4*; p_s is the number s of movable kinematic pairs ($p_s=6$ kinematic pairs that have $s=1$ mobility).

It was established [2] that the mechanism can function only if its link lengths are in strictly defined ratios. During operation, even slight deformation of one of the links may cause seizure and, thus, failure of the mechanism. In addition, parts must be manufactured with small accuracy tolerance.

It is possible to free the mechanism from the redundant constraint by introducing an additional movable link into the kinematic chain. Thus, adding an additional movable link with two rotational kinematic pairs to the kinematic chain of the mechanism with its axis passing through the middle of the working tank (one kinematic pair is connected to the driven yoke and the other pair is connected to the working tank) we obtain a seven-link hinged spatial mechanism with rotational kinematic pairs. The model of developed a machine is shown in Fig. 2 (a), the kinematic diagram of developed spatial mechanism is shown in Fig. 2 (b).



a b

Figure 2: a – the model of developed a machine; b – the kinematic scheme of developed spatial mechanism of the machine

The machine contains a bed (1), a drive (2) located therein, driving (3) and driven (4) shafts installed in the bed in parallel to each other in one plane. The driving and driven shafts are pivotally connected by their other ends to the driving yoke (5) and the driven yoke (6), respectively. Their the diametrical mutually perpendicular geometric axes (7) and (8) are the axes of attachment of the working tank (9) and the additional movable link (10) whose axis (12) passes through the middle of the working tank, respectively.

References

1. Zaliubovskyi M. G. Synthesis and research of the tumbling machine spatial mechanism / M. G. Zaliubovskyi, I. V. Panasiuk, Yu. I. Smirnov, V. V. Malyshev // Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu, – 2020. – 178, issue 4, 69-75.

2. Zalyubovskii M. G. On the study of the basic design parameters of a seven-link Spatial mechanism of a part processing machine / M. G. Zalyubovskii, I. V. Panasyuk // International Applied Mechanics, 56, issue 1, April 2020, 54 – 64.