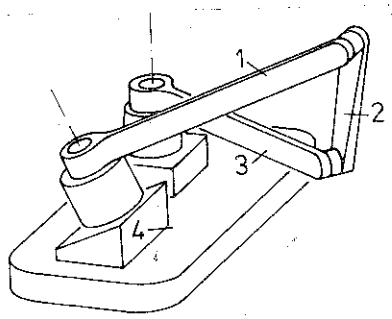
Tafel 2 : Einige Sonderfälle von Getrieben 0. Ordnung mit dem Laufgrad F =+1

Viergliedriges Getriebe mit 4 Gelenkbeweglichkeiten (Benett-Getriebe)

D-D-D-D



Besondere Abmessungen:

$l_1 = l_3$
$l_2 = l_4$
$\lambda_1 = \lambda_3$
$\lambda_2 = \lambda_4$

$$\frac{l_1}{l_2} = \frac{\sin \lambda_1}{\sin \lambda_2}$$

Viergliedriges Getriebe mit 6 Gelenkbeweglichkeiten

D-DS-DS-D

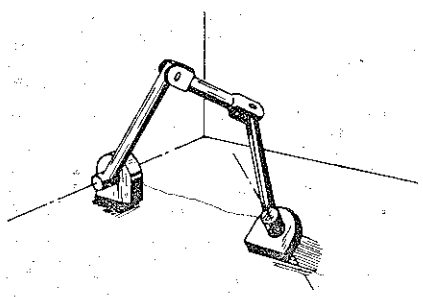


Fig. 1 The Bennett four-link mechanism

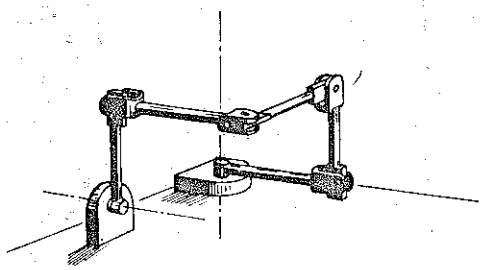


Fig. 2 Franke's "Wirbelkette" six-link mechanism

mechanism can be subjected to additional geometric conditions which create "General Constraints" that alter the function of the mechanism from that created by the constraints of the kinematic pairs.

The Kutzbach Criterion is currently the only available criterion to define the mobility of a three-dimensional kinematic chain. It is totally inadequate for a general survey, since it is based only on the constraints of the kinematic pairs and does not account for the effect of other geometric conditions which can exist. Thus it fails to recognize the existence of such "special" mechanisms as the Bennett four-link [6], Fig. 1, and Franke's "Wirbelkette" [15] six-link, Fig. 2.

Ironically, it seems that there may be a number of extremely practical space mechanism types hidden within the regions of "special" mechanisms with general constraints. The Bennett mechanism is a four-link, four-revolute (RRRR), one-degree of freedom space mechanism which, without its specific geometric conditions, is an immovable structure. Here is an example of the simplest possible form of a constrained, four-link space mechanism which does not exist within the definition of mobility allowed by its pair elements alone.

There are other known examples of "special" space mechanisms mechanisms which, according to Kolchin's classification in Table 1, exist in the 6/0 group of the zero series. All mechanisms identified by the Kutzbach Criterion can be regarded as *the* basic group of all space mechanisms. This 6/0 group has no general constraints restricting the freedom of the links nor special geometric conditions creating idle constraints nor passive freedoms of the pairs. The mobility of the 6/0 group of mechanisms is determined entirely by the constraints of the basic kinematic pairs.

Mechanism Identification

In order to catalog the mechanisms of the 6/0 group it is necessary to establish an identification scheme. Since a space mechanism can exist with a wide variety of pair combinations, the identity of the mechanism is determined by its pairs. It is necessary, therefore, to identify the known physically realizable pairs which can have from one to five degrees of freedom. They are divided into classes labeled according to the number of degrees of freedom as shown in Table 2.

Within each *class* of pairs there are one or more *types* of pairs distinguished by the kinds of freedom allowed by the contacting

Table 1 Mechanism series and groups [21]

	0 series	1st series	2nd series	3rd series	4th series	
	6/0	6/1	6/2	6/3	6/4	Unlimited mechanisms having passive freedoms
Special mechanisms having idle constraints	5/0	**5/1**	5/2	5/3	5/4	
	4/0	4/1	**4/2**	4/3	4/4	
	3/0	3/1	3/2	**3/3**	3/4	
	2/0	2/1	2/2	2/3	**2/4**	Basic mechanisms

The special mechanisms groups contain all mechanisms which have fewer links and pairs than the basic group for the same degree of freedom in each series.

The unlimited mechanisms are all mechanisms which have a lower degree of freedom than their counterpart in the basic group in each series.

The basic mechanisms have equal reduction of freedom and constraint in both the links and the pairs.

Table 2 Classification of kinematic pairs

Class	Degree of freedom	Class symbol	Type number $N_1 N_2 N_3$	Type