UNIVERSITY OF NIŠ
The scientific journal **FACTA UNIVERSITATIS**
Series: **Mechanical Engineering** Vol.1, N° 5, 1998 pp. 621 - 628
Editor of series: Nenad Radojković, e-mail: radojkovic@ni.ac.yu
Address: Univerzitetski trg 2, 18000 Niš, YU
Tel: +381 18 547-095, Fax: +381 18 547-950
http://ni.ac.yu/Facta

STRUCTURAL ANALYSIS OF MECHANICAL ON-OFF SWITCHES DRIVING MECHANISMS

UDC:57.02

Miloš Milošević, Slobodan Jovanović

Faculty of Mechanical Engineering, University of Niš
Beogradska 14, 18000 Niš, Yugoslavia

Abstract. *The objective of this paper is to perform the structural analysis of the mechanical on-off switches driving mechanisms. Thus, the basic prerequisite has been realised to help a constructor who has to use electrical switches, buttons of keyboard, regulating or control switches to determine the best construction of the mechanical on-off switches driving mechanisms with proper kinematics and dynamics features for performing the requested course of shifting. The elementicular consideration to structural analysis of tight driving mechanisms and driving mechanisms with jump motion is underlined. According to the way of controlling the driven element motion they also can be divided into two groups: driving mechanisms with brakes and driving mechanisms with limiters.*

1. INTRODUCTION

Mechanical on-off switches driving mechanisms are mechanisms that have a driven link which is shifted from one into another stable state where it remains until the following process of shifting. For the performing its basic function these driving mechanisms are made of a basic mechanical structure with brakes, limiters, springs and another added elements for carrying out some specific features.

In the theory of machines and mechanisms there is a difference between a mechanism and a driving mechanism. Thus, a driving mechanism is a mechanism which enables potential energy to be transferred from an element that has ability of its accumulating to a driven link for realizing its motion, whereas in a mechanism forced transferring of motion or force from a driving to a driven link is realised according to previously beforehand determined transfer function.

In agreement with the above mentioned the structural analysis of the mechanical on-off switches realised as tight driving mechanisms and driving mechanisms with jump

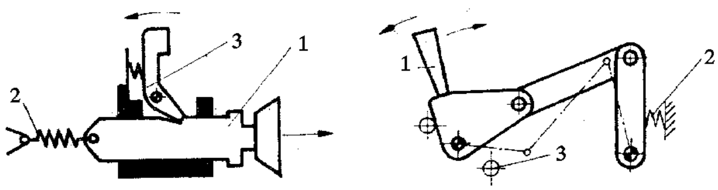
Received December 3, 1998

motion will be performed in this paper.

2. TIGHT DRIVING MECHANISMS

Tight driving mechanisms are mechanical on-off switches driving mechanisms with springs that are used for accumulating potential energy. These driving mechanisms can take two stable states, tightened and untightened and they can remain either in one or in the other arbitrary long without any external force which should maintain them in that state. The elements for tightening and untightening exist in a tight driving mechanisms and they are independent of each other.

The basic forms of the tight driving mechanisms with a brake and with limiters are shown in Fig. 1 a) and b) respectively.



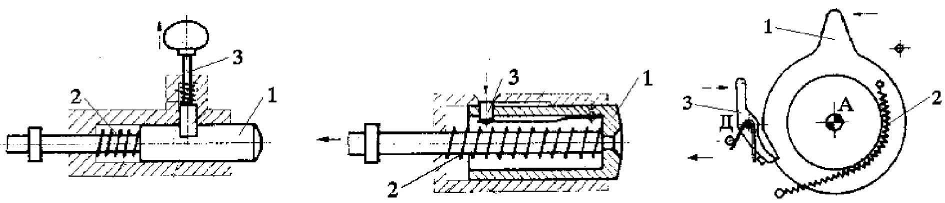
a) b)

Fig. 1. The basic forms of the tight driving mechanisms

The process of shifting of a mechanical on-off switches driving mechanisms is followed with striking forces and noise. Thus, its structure should have been made in such a way that it can overcome these forces, while the noise can be reduced by using some kind of damping materials on the places of the strike.

2.1. Tight driving mechanisms with brakes

The basic form of the tight driving mechanisms with a brake that is shown in Fig. 1 a) is composed of a element for tightening 1, a spring 2 and a brake 3. An external motion is transferred from the element for tightening to the spring which becomes tight, while potential energy becomes accumulated. The function of the brake is to maintain the element for tightening in reached position until the following cycle. After releasing the brake, accumulated potential energy in the spring is transformed into kinetic energy of moving of the driven link which is in relation with the element for tightening.



a) b) c)

Fig. 2. The tight driving mechanisms with a brake and a lever for tightening

Some different structures of the tight driving mechanisms with brakes are presented in Fig. 2. Mechanisms with structures shown in Fig. 2 a) and b) represent driving mechanisms that have the element for tightening with motion in a straight line along the fixed frame. The structure in Fig. 2 c) is a tight driving mechanism with rotation of the element of tightening.

Greater number of different positions can be realised with numerous elements for tightening as it is shown in Fig. 3 a) and b).These types of driving mechanisms are mainly used for electrical push buttons, buttons of keyboard, regulating or control switches etc.

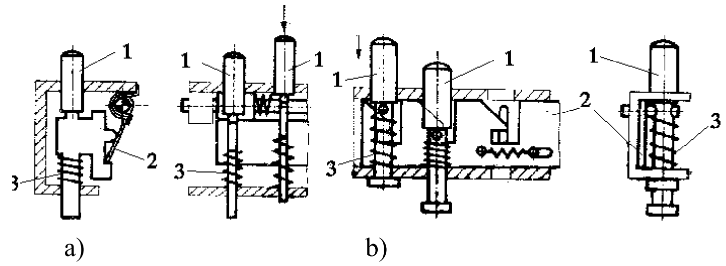


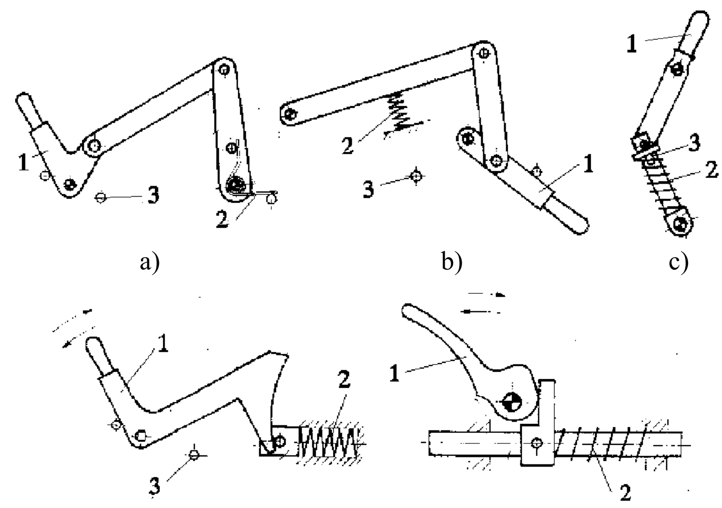
Fig. 3. The tight driving mechanisms with a brake and two elements for tightening

2.2. Tight driving mechanisms with limiters

The main form of the tight driving mechanisms with limiters is shown in Fig. 1 a). It consists of a lever for tightening 1, a spring 2 and limiters 3 that restrict the lever for tightening moving. The mechanism that exists in the structure of this tight driving mechanism is a four bar linkage. Also, other types of mechanisms that are derived from the four bar mechanisms like a slider crank mechanisms or an oscillating slider mechanisms can be used. Moreover, some other types of mechanism are able to be used, for example cam mechanisms. An external force that affects the lever for tightening enables performing its two stable states. During the shifting from one stable state to another a tight driving mechanism goes through a state in which the spring is tight maximally. In this state the driving mechanism has unstable state of equilibrium. Maintaining the reached state requires the existing of a spring. The motion region of tight driving mechanisms with limiters is defined by locations of limiters.

A distinction between a tight driving mechanism with limiters and a tight driving mechanism with brakes is that the type with brakes requires different elements for shifting, while the unique element executes shifting in the type with limiters. This has a consequence that in general tight driving mechanisms with limiters are made with fewer components.

Some different structures of the tight driving mechanisms with limiters are presented in Fig. 4. Mechanisms shown in Fig. 4 a) and b) have a four bar mechanism in their structures, while the structure in Fig. 4 c) is a tight driving mechanism with an oscillating slider mechanism in its base. A cam mechanism is used for the structure of mechanisms in Fig. 4 d) and e) so that the transfer function depends on the curved profile of the cam. For all of these mechanisms the locations of limiters are presented except in the case of the last structure where the extreme positions are defined by the shape of the command profile of the lever for tightening.

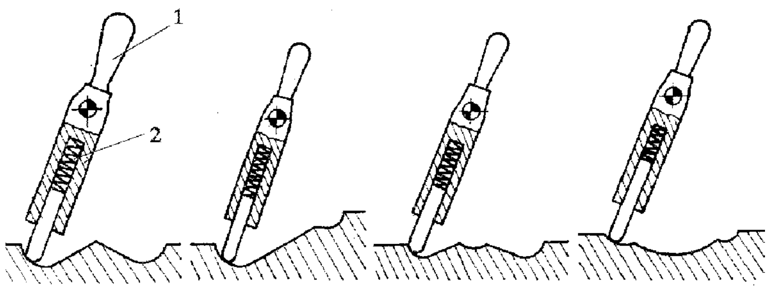


a) b) c)

d) e)

Fig. 4. The tight driving mechanisms with limiters

Great number of stable states or special features of motion can be realised by using proper surfaces with characteristic shapes, as it is shown in Fig. 5. From these types of tight driving mechanisms the tight driving mechanisms with interruptions in their moving are developed.



a) b) c) d)

Fig. 5. The tight driving mechanisms for realising special features of moving

3. Driving mechanisms with jump motion

The driving mechanisms with jump motion have been developed from the tight driving mechanisms by realising two separate elements for driving and driven motion. In this way a driven element that is able to perform jump motion during the shifting has been obtained. The main feature of these driving mechanisms is that their driven elements with jump motion can be stopped only in stable positions.

Likewise, the driving mechanisms with jump motion can be divided according to their structures into two basic forms with a brake and with limiters. A brake enables the moving of a driven link when it is released, while in driving mechanisms with limiters the shifting will be done when an appropriate element reaches and steps across the position of maximally spring tightening.

The driving mechanisms with limiters are only made for shifting when the driving and driven links have the same direction of movement, whereas, the driving mechanisms with brakes can be made for both shiftings in the same and in the opposite direction.

3.1. Driving mechanisms with jump motion and brakes

By using different structures with brakes it is possible to realise the following types of motions: jump motion to one and uniform motion to another side, uniform motion to one and jump motion to another side and jump motion to both sides.

In Fig. 6 some examples of driving mechanisms with alternating jump motion are given. The mutual position of structural elements and their functions are shown in Fig. 6 a). By pulling the lever for tightening 1 the spring 3 is getting tight. The brake 4 forbids the moving of the element with jump motion 2. When the limiter 5 comes into contact with the brake 4 the driven element becomes free and it starts its jump moving. By pushing the lever for tightening 1 to the opposite direction all elements are put back into the initial state in which the driving mechanism is ready for the next shifting.

Structures shown in Fig. 6 b), c) and e) have such types of brakes which use the forces that came from spring elements. Mechanisms given in Fig. 6 a) and b) after their shifting has been done, have to get back into initial state when they are ready for subsequent shifting. Switches in Fig. 6 c), d) and e) are able to perform alternating jump motion, while the last switch has elements with motion in a straight line. Fig. 6 f) shows a driving mechanism with jump motion of the driven link which is in the different direction according to the moving of the driving lever. After the shifting has been done the lever for tightening is put back into the starting position.

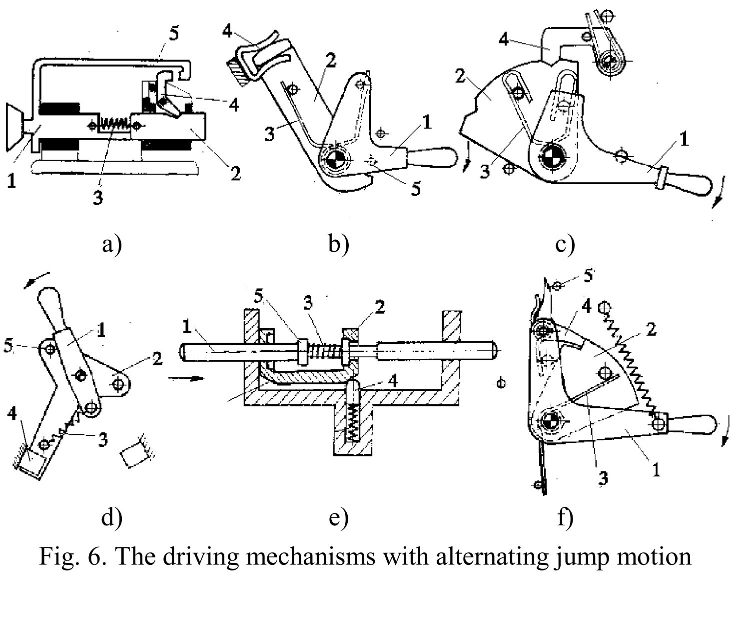


Fig. 6. The driving mechanisms with alternating jump motion

3.2. Driving mechanisms with jump motion and limiters

Driving mechanisms with jump motion and limiters are used when there is a necessity to transform a uniform motion of a driving link to a jump motion of a driven link. It is necessary to highlight that the speed of the driven link is independent of the speed of the driving link. These driving mechanisms are only realised with two stable states and with a driven and driving links that are characterised with alternating motions.

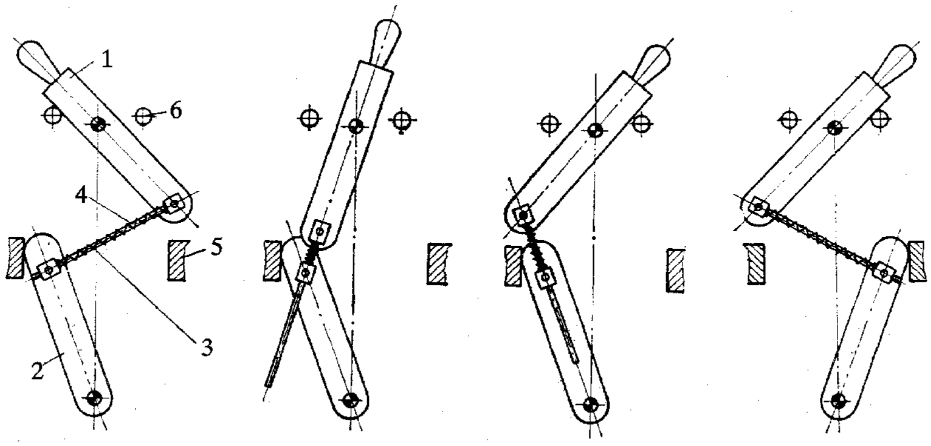


Fig. 7. Stable and unstable positions of a driving mechanisms with alternating jump motion

The main type of driving mechanisms with jump motion and limiters which is derived from a four bar mechanism is given in Fig. 7. It consists of a lever for tightening 1, limiters for reducing of the motion of this element 6, a driven link that has jump motion, limiters that control its motion 5 and a floating link 3 that has a spring 4 on it. The function of this spring is to enable the jump motion of the driven link and maintain the mechanism in reached extreme position, as it is shown in Fig. 7 a). By pulling the lever for tightening 1 around an fixed axis the spring 4 is getting tight. Fig. 7 b) presents the position when the spring 4 is maximally tight. In the position that follows immediately, as it is shown in Fig. 7 c) the spring 4 realises a torque that affects the driven link which causes its jump motion. The other extreme position is given in Fig. 7 d) when the spring 4 is relaxed.

It is very important to pay attention to the construction and realising the structure of a driving mechanism with jump motion and limiters so that the state when the jump motion starts must be reached before the lever for tightening reaches the extreme position that is determined by the limiters 6. The driving mechanisms with jump motion and limiters are used for electrical switches and controlling and regulating mechanisms.

From the basic driving mechanism that is given in Fig. 7 it is possible to derive numerous new structures. Some of them are presented in Fig. 8.

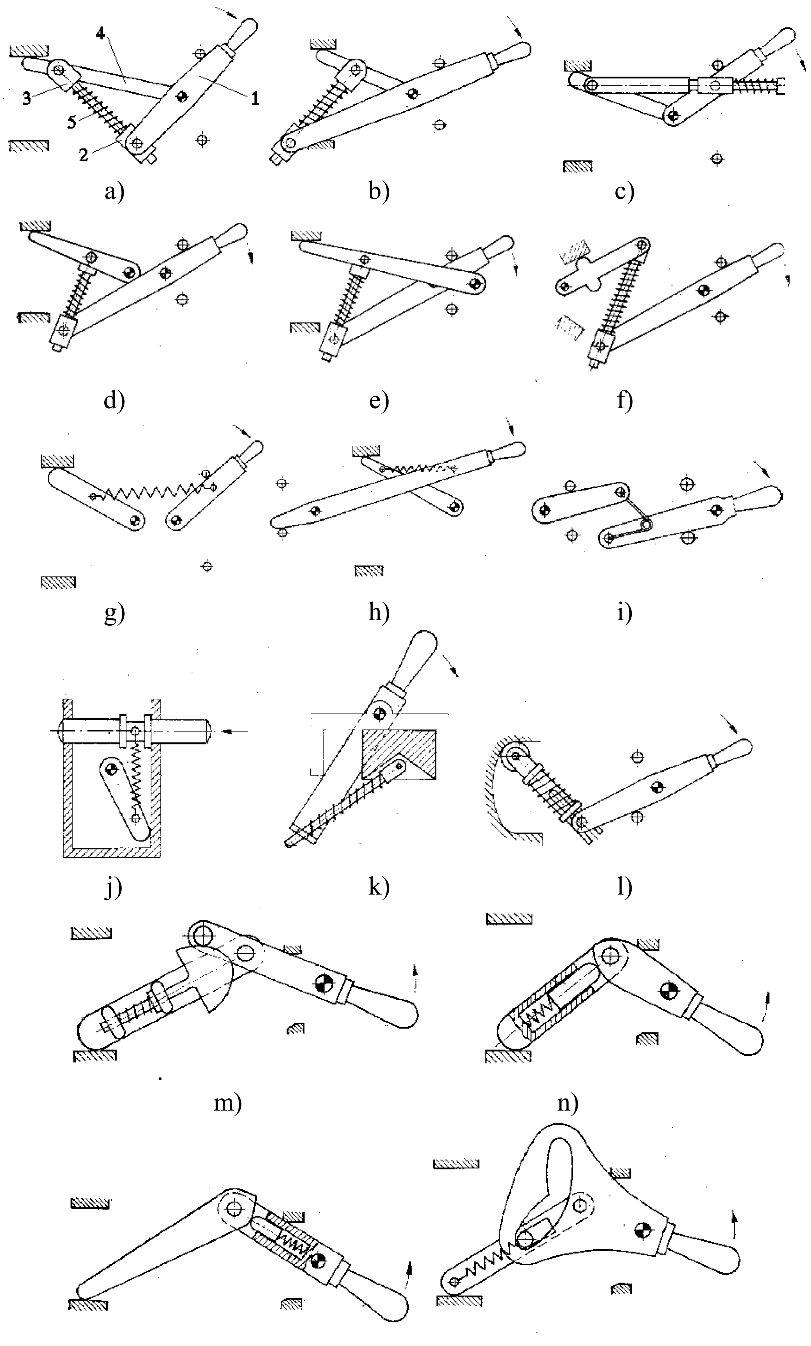


Fig. 8. The driving mechanisms with alternating jump motion

The driving mechanisms with jump motion with common axis of driving and driven links shown in Fig. 8 a), b) and c) have an oscillating slider mechanism in their base. The difference between them is in the position of a floating link with spring in their structures. Setting apart the pivot of a driven link with jump motion from the common axis makes the forms shown in Fig. 8 d), e) and f). The characteristic of these structures is that they have compresion springs. If tension springs are used the following forms in Fig. 8 g) and h) are obtained. Moreover if the spring is loaded so it bends in a such way that leads to the type in Fig. 8 i). The reciprocate motion of a driving link or the jump motion in a straight line of a driven link can be realised by driving mechanisms that are shown in Fig. 8 j) and k) respectively. When the jump motion is not performed around an fixed axis as in previous cases a driving mechanism in Fig. 8 l) is obtained. A cam mechanism is used for the structure of mechanisms in Fig. 8 m), n), o) and p) so that the transfer function depends on the curved profile of the cam with two stable states.

REFERENCES

1. Hildebrand S.: *Feinmechanische Bauelemente*, VEB Verlag Technik, Berlin, 1975.
2. Artobolevsky I. I.: *Mechanisms in Modern Engineering Design*, English translation, Mir Publishers, Moskva, 1979.
3. Živković Ž.: *Teorija mašina i mehanizama*, Mašinski fakultet, Niš, 1992.
4. Milošević M.: *Pregled konstrukcionih rešenja mehaničkih uključno-isključnih pogonskih mehanizama*, Preventivni inženjering i životna sredina, Niš, 1995.
5. Milošević M.: *Nivo buke pri prekljućivanju mehaničke energije udarnim uključno-isključnim mehanizmima*, Buka i vibracije, Niš, 1995.

STRUKTURNA ANALIZA MEHANIČKIH UKLJUČNO-ISKLJUČNIH POGONSKIH MEHANIZAMA

Miloš Milošević, Slobodan Jovanović

Cilj ovog rada je da se izvrši strukturna analiza konstrukcionih rešenja mehaničkih uključno-isključnih pogonskih mehanizama. Time se postavlja osnovni preduslov za konstruktora, pri konstruisanju električnih prekidača, tastera tastatura ili prekidača regulacionih ili upravljačkih delova, da se opredeli za najbolje konstrukciono rešenje sa odgovarajućim kinematičkim i dinamičkim karakterisitkama mehaničkih uključno-isključnih pogonskih mehanizama za realizovanje zahtevanog zakona prekljućivanja. Naročito je posvećena pažnja strukturnoj analizi konstrukcionih rešenja nateznih pogona i pogona sa skokovitim kretanjem, kod kojih je izvršena podela prema načinu regulacije kretanja gonjenog člana na osnovne oblike izvođenja sa kočnicom i sa graničnicima kojima se definišu krajnji položaji.