Synchronized Multistage Linear Screw and Belt Units

P. Jurda, V. Andrlík

***Abstract*—Existing applications solving problems of full-strokes are based on using non-synchronized telescopic guides working with mechanical, hydraulic or pneumatic motion drives [1]-[4]. In these cases the full-stroke in general is not possible to position and control reliably.**

One of the disadvantage of non-synchronized full-strokes using especially double-sided full-stroke is uncontrollable movement of extending parts, which can stagnate in various positions during the working cycle.

Creating of a synchronized full-stroke using mechanical kinematic structure between particular components of the telescopic unit can solve these problems mentioned above.

Index Terms— **belt unit, manipulation, screw unit, synchronization, telescopic unit.**

I. Introduction

The basic idea of this invention is creating a mechanical kinematic structure using cogged belts with driving pulleys or ball screw with gear transmission to achieve a synchronized movement of extending parts (fig. 1 - 4). Some examples of designed belt and screw units are shown in the pictures below and will be described in details in the chapter 2 and 3.

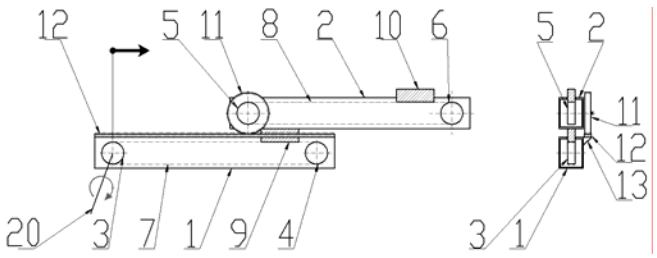

Fig. 1 Belt synchronized unit

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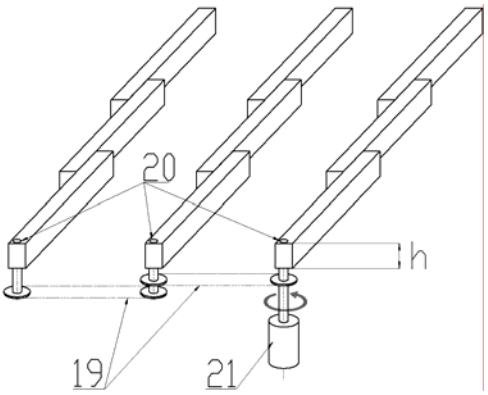

Fig. 2 Telescopic synchronized belt platform

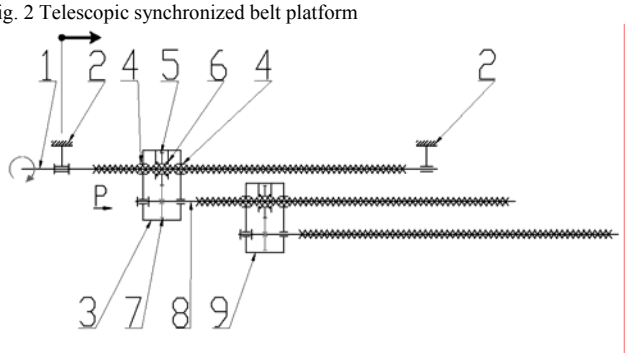

Fig. 3 Screw synchronized parallel unit

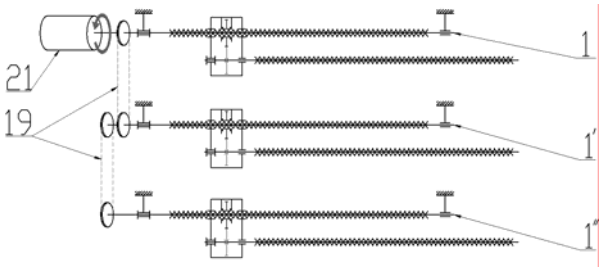

Fig. 4 Telescopic synchronized screw platform

II. Synchronized Belt Unit

Invention applies to a telescopic unit (fig. 5) consists of one linear unit 1 created of driving shaft 20 connected with driven shaft 4 by belt/roller chain 7 with at least one moving slider 9. At least one another linear unit 2 is connected to that moving slider 9 and its at least one shaft 5 is equipped with cogged wheel/chain wheel 11, which is in contact with cogged system 12 fixed to linear unit 1.

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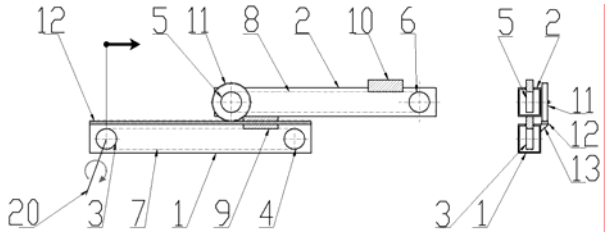

Fig. 5 Basic scheme of designed belt unit

Translation movement is in this way transferred to appropriate number of connected linear units to achieve a telescopic arm with controlled extension and insertion by using only one driving motor. These serial connected linear units may be connected in parallel way to obtain a telescopic platform with controlled extension and insertion by using also only one driving motor and synchronous shaft.

A. Some Possibilities of Designed Synchronized Belt Unit

Variants below are mentioned briefly. For more details see [5].

- One-sided extension
- Double-sided separated extension
- Double-sided synchronous extension
- Double-sided extension for long strokes
- Different length extension of particular stages
- Telescopic arm (serial connection of belt units)
- Telescopic platform with synchronous shaft (parallel connection of belt units)
- Telescopic platform with cogged belts (parallel connection of belt units)
- Variant designs of possibilities mentioned above

Double-sided extension principle for long strokes (fig. 6 and 7) is the same as double-sided extension. Linear unit 2 is connected with its slider 10´ on the slider 9 of the linear unit 1. Rigid connected slider 9, 10´ increases the length of the stroke compared to double-sided design twice.

The prototype of one-sided synchronized telescopic belt unit (fig. 8) according to described design concept was made. From information acquired from experimental verification arise that the unit came up to expectation and showed its possibility to be viable.

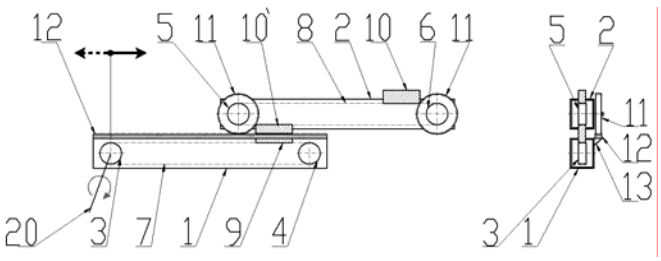

Fig. 6 Scheme of designed double-sided extended unit for long strokes

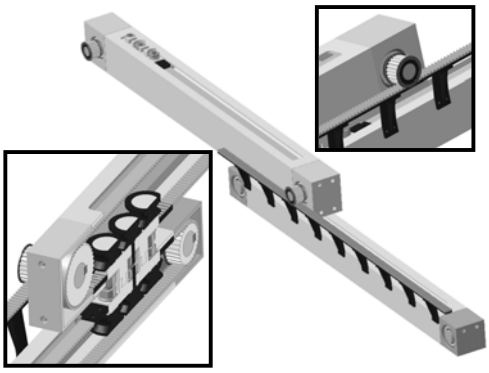

Fig. 7 3D model of designed double-sided extended unit for long strokes

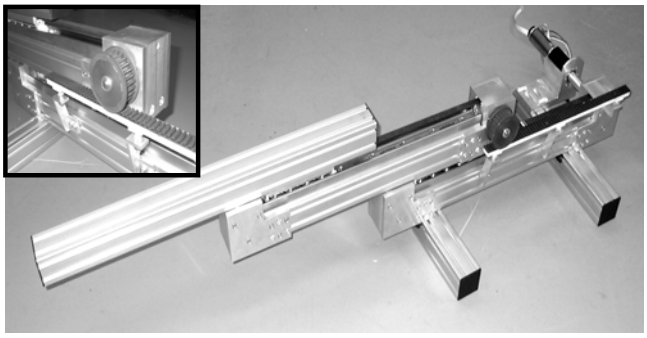

Fig. 8 Real model of designed belt unit - Detail of synchronous cogged wheel (upper left corner) and fully ejected linear belt unit

III. Synchronized Ball screw Unit

Invention applies to a telescopic unit (fig. 9 and 10) consists of driving shaft 1 with at least one gear unit 3 connected with at least one another shaft 8. Driving shaft 1 is rotary connected with frame 2 to obtain only rotary move and another shaft 8 is connected with gear unit 3 in connection which provides another shaft 8 in respect of gear unit 3 only rotary move.

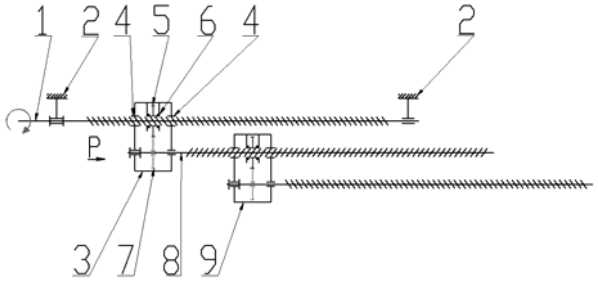

Fig. 9 Basic scheme of designed screw unit

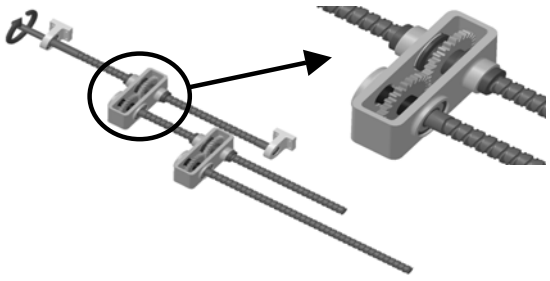

Fig. 10 3D model of designed synchronized screw unit

A. Some Possibilities of Designed Synchronized Ball Screw Unit

There were designed two variants, which are different from using only one lead of screw thread or both left and right lead of screw thread used on one screw (fig. 11). The second variant simplifies the whole construction and for the same length of ejection allows using less number of ball screws or screws with sliding elements.

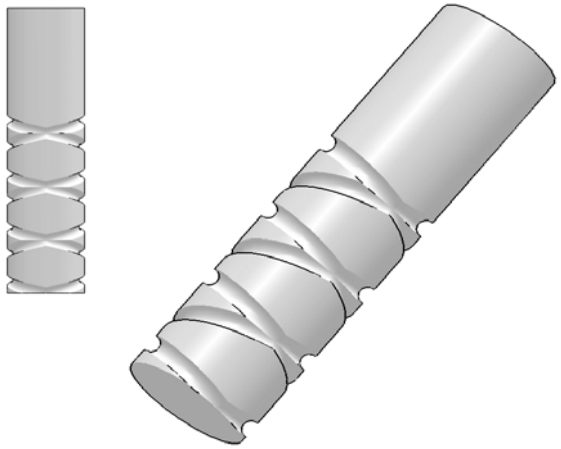

Fig. 11 3D model of designed double-threaded ball screw

Variants below are also mentioned briefly. For more details see [6].

- Sliding design
- Rolling design
- Double-sided separated extension
- Telescopic arm (serial connection of belt units)
- Different length extension of particular stages
- Telescopic platform
- Variant designs of possibilities mentioned above

IV. The Main Advantages of Synchronized Telescopic Units

The main advantage of the designed telescopic unit is in its full-stroke synchronisation, which can be reliably controlled by any motorized driving unit. It is very simple to control position and velocity of every moving parts during working cycle and avoid of collision with surrounding borders of the manipulator. The other advantage is in modular and compact conception to provide using this unit alone or with other parallel units. These units can be connected to synchronous shaft and be driving with only one electromotor. Enough high carrying-capacity provides this unit due to a parallel structure of the telescopic rolling guides. In this way a high rigidity in bend and torsion is provided. Structural principle of this synchronized telescopic unit can be used even for multistage telescopes having severalfold larger working area than its build-up area in the closed stage is.

V. Industrial Usage of Designed Telescopic Unit

Using of a telescopic unit with synchronized stroke is possible in all fields of industry where working in limited area is needed, also in full-stroke applications to take control of velocity and position of extending parts. Mounting position of synchronized telescopic unit is not restricted due to mechanical kinematic structure, which allows the telescopic unit to be installed in various kinds of positions. Industrial manipulators can be also created in combination of these telescopic units with others rotary units.

The main usage of these units seems to be in machine, building, space, civil and medical industry, in field of production machines and mechanisms (robots, picking or laying down manipulator stations, stations for production and assembly lines), in transport systems etc. Mainly in applications where long double-sided controlled ejections and precise positioning are needed.

Very important are applications in medical industry for regardful moving of immobile patients. Applications in fire and cosmic ejecting technique by strict satisfying of environmental requirements.

VI. Conclusion

This report solves issue of synchronisation of linear belt and screw units according to the patent application PV2006-237 (Telescopic belt unit) and PV2006-238 (Telescopic screw unit) from 3rd July 2006 as shown in [5], [6]. Telescopic units designed according to these patents offer rich variability of designed construction for both – one-sided and double-sided extensions of telescopic arms or telescopic platforms.

These units are characterized by simple construction, possibilities of using of modified manufactured linear units, decreasing of demands on maintainance and staff, possibilities of creating very long extensions with precise positioning, environmentally safe duty, speed and position controlling of all moving parts by only one driving motorized unit and very wide industrial usage.

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