Krzysztof FILIPOWICZ
Silesian University of Technology, Faculty of Mining and Geology
Institute of Mining Mechanisation
Akademicka 2, 44-100 Gliwice, Poland
Corresponding author. E-mail: krzysztof.filipowicz@polsl.pl

NEW SOLUTIONS OF DRIVING SYSTEMS WITH THE TORSIONALLY FLEXIBLE METAL COUPLING

Summary. At work a conception was presented of structure of the new type of driving systems with the metal flexible torsional coupling. Depending on needs, from the type it coupled machines, applied in driving arrangements, it can have a different structural form. the advantages of the new coupling among others is the great permanence of a lack of non-metallic susceptible elements, possibility of moving great torques and considerable relieving momentary overload.

NOWE ROZWIĄZANIA UKŁADÓW NAPĘDOWYCH Z METALOWYM SPRZĘGŁEM PODATNYM SKRĘTNIE

Streszczenie. W pracy przedstawiono koncepcję budowy nowego typu układów napędowych z metalowym sprzęgłem podatnym skrętnie. W zależności od potrzeb, od rodzaju maszyny, zastosowane w układach napędowych sprzęgło, może mieć różną postać konstrukcyjną. Zaletami nowego sprzęgła są m.in. duża trwałość przy braku niemetalowych elementów podatnych, możliwość przenoszenia dużych momentów obrotowych oraz znacznego łagodzenia chwilowych przeciążeń.

1. INTRODUCTION

They are in great demand in the coal mining industry that designed systems for machines that have increased carrying capacity and the reliability of action. Implementing innovative forms of structural machines and their elements is needed for users, as well as for producers of machines and devices because of increasing competitiveness of these products. Conducting the restructuring of the mining causes the need to implement new structural, guaranteeing the growth solutions for effectiveness of the mine's production. It concerns both of the entire system arrangements and individual machines.

Driving arrangements are one of the links of getting and mining system, and with elements of driving arrangements on which among others the reliability of the functioning of getting and transporting mining machines depends there are mechanical transmission gears, of which the failure frequency is significant [16].

Issues of the reliability, on account of economic effects and the safety of the work, in particular concerns winding machines, mechanized supports, mechanical coal miners, coal planers, face and gangway conveyor [2].

Intense progress in the world technology of the exploitation with longwall system, of exploitation of headings and haulage to the mine is face with applying reliable machines which in the fundamental way influence is extorting mining and supply of materials to the indicator of the output [3]. It is possible to get the appropriate reliability of action of systems through increasing elements and units of machines by carrying capacities and increasing to get carrying capacities it is possible by appropriate their structural forming, what to spell also reducing the influence of destroying factors perhaps.

In driving systems of mining machines units of this system, so are like couplings and exposed toothed gear transmissions to particularly intense exploitation influences which result from great and changeable loads with notable momentary overloads and from the great frequency of start-ups [6].

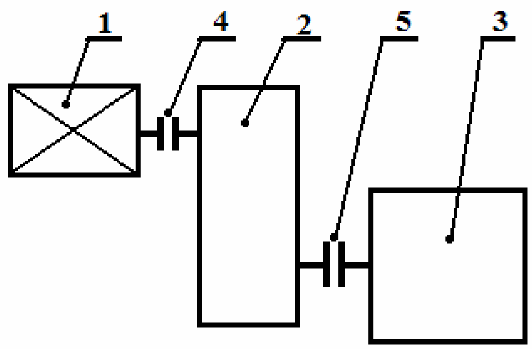

Fig. 1. Drive system of the machine, where: 1 – motor, 2 – gear, 3 – working machine, 4 – coupling on the entry of the gear, 5 – coupling on the exit of the gear

Rys. 1. Układ napędowy maszyny, gdzie: 1 – silnik, 2 – przekładnia, 3 – maszyna robocza, 4 – sprzęgło podatne na wejściu do przekładni, 5 – sprzęgło na wyjściu z przekładni

2. FLEXIBLE COUPLINGS IN DRIVES OF MINING MACHINES

It coupled the unit in the driving system which is destined to linking shafts and handing around one shaft over to second of torque without the change of its direction. The coupling is making up from the active element (driving, input) and of passive element (driven, initial) and of connector. The connector is characteristic to a coupling and a way of sending the torque from the active element to the passive element determines.

In flexible couplings a resilient connector is a basic element, of which enabling the momentary relative rotation of the passive shaft with respect to the active shaft is a task. Thanks to the susceptibility of the connector these couplings can reduce the influence of dynamic loads on the work of the drive (among others during the start-up), to relieve oscillation, to reduce unevennesses of the moved torque, among others in flexible couplings connectors are made most often of rubber or in completely metal couplings from springs of most diverse shapes [14, 15].

Driving systems of heavy machines, e.g. mining, are usually working in very difficult conditions. These conditions are characterized among others by a great frequency of start-ups and they require practicing protections of different kind. Using appropriate overload couplings in them is one of ways of protecting driving systems, selected depending on expected characteristics of straining the machine.

In the case of driving arrangements they should be characteristic of mining, getting and transporting mining, couplings machines oneself with great torsion susceptibility. Dynamic loads appearing in mining machines require applying in systems driving machines of flexible torsional couplings. Couplings working in mines are exposed to the negative influence of the environment, in which machines are being operated. In mining conditions appearing high dusting influences for increasing usage cooperating elements up and to the reliability of the work of couplings considerably, as well as and of every machine.

Applied in the mining industry there are many different driving layouts.

In these systems machines are performing the important post of moving the torque from the motor to the working unit coupled. Analyzing collected details about the failure frequency of couplings, working in the mining industry it is possible to state that they are one of unreliable sub-assemblies of driving systems.

Examples of structural solutions of mechanical flexible and overload couplings contain positions [1, 4, 5, 8, 9, 10].

3. NEW CONSTRUCTIONS OF ELEMENTS OF DRIVING SYSTEMS

Conditions of the work of driving systems applied in mining machines are determining the use in the agreements of driving couplings on the great torsion susceptibility, immune to the influence of determined conditions of loads. It can provide with the appropriate torsion susceptibility of the coupling solutions worked out at the Institute of Mining Mechanization, Faculty of Mining and Geology at the Silesian University of Technology [12, 13].

3.1. Jointed shaft susceptible torsion into the battery locomotive of the type Lea-BM 12/T

In the battery locomotive of the type Lea-BM 12/T, connecting the shaft of the electric motor with the transmission gear driving wheels are mounted, realized with the help of standard Cardan shaft with joint and splines. Arising considerable surpluses of the torque, especially during the ride along curves of the track, cause frequent damage to this element of the driving arrangement. Cardan shaft under the influence of crossing the acceptable torque, loss of the carrying capacity of welded combinations of the pipe joint is undergoing the breakdown consisting in the fact that it most often follows. As a result of the fact that the shaft is staying divided in two parts which freely turning different elements of the driving arrangement are destroyed. Additional shielding the shaft is a temporary solution, applied in the drive of the locomotive.

In the driving arrangement a connection is a different solution which can be applied of elements of the drive behind the help of the articulated shaft susceptible torsion.

The idea of untying the structural metal coupling can be applied in the jointed susceptible torsion shaft presented in figure picture 2. This shaft is good peculiarly for transferring dynamic torsion loads and it can find application in connections of the motor with mechanical transmission gears where bungs of elements of the driving arrangement aren't coaxial.

Such a structural figure of the shaft is solving the problem of reducing momentary dynamic loads of driving arrangement of the machine in the set-up time. Standard Cardan shaft is stiff and it is transferring impulses, stroke loads and it isn't deadening vibrations. In these shafts a change of the torque is accompanying changes of the angle speed of the passive element what causes generating oscillation on its exit. It is an essence of the new answer that between the transverse joins a flexible coupling is put in the articulated shaft torsion [9, 10].

The shaft is characterized by the fact that it consists of the transverse joins and the connected shaft with motor splined connection with the sleeve, on which on the outside cylindrical surface the unself-locking thread is made, and inside the casing in the hole of this casing a thread cooperating with the thread made on the sleeve is made, in addition the turnover of the shaft causes moving in the screw gear of case, and two springs are losing its shape under the influence of the load.

Action of the articulated susceptible torsion shaft consists in the fact that in the casing of the coupling a multiple unself-locking thread is made which is cooperating with the thread made on the outside surface of sleeve. This screw gear is moving the torque which is being passed on to the sleeve from the shaft via the motor splined connection. The shaft and the casing of the flexible torsional coupling are connected with the help of the transverse joins with abscesses of the motor and of the transmission gear.

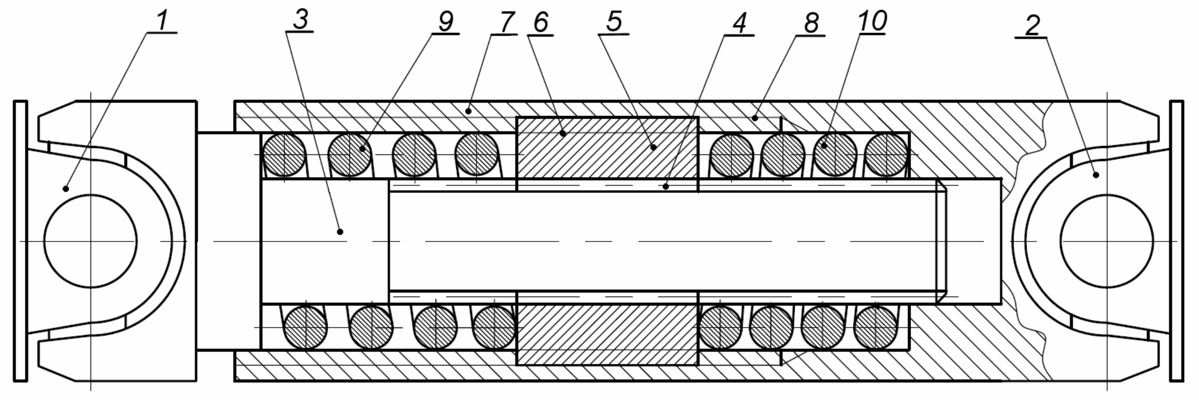

Fig. 2. The example of constructional solution of the jointed flexible torsional shaft, where: 1, 2 – Cardan joints, 3 – shaft, 4 – splined connection, 5 – sleeve, 6 – screw thread mechanism, 7 – casing, 8 – internal thread, 9, 10 – screw springs

Rys. 2. Przykład rozwiązania konstrukcyjnego wału przegubowego podatnego skrętnie, gdzie: 1, 2 – przeguby Cardana, 3 – wał, 4 – połączenie wielowypustowe, 5 – tuleja, 6 – mechanizm gwintowy, 7 – obudowa, 8 – gwint wewnętrzny, 9, 10 – sprężyny śrubowe

In the case of the static or dynamic change of load the articulated shaft susceptible torsion the sleeve will move with regard to the casing and relative to the shaft. The pressure on the spring will cause deformingt and because of that cushioning the dynamic load on the exit from the articulated shaft will follow.

In the shaft as springs, it is possible to use also appropriately selected disk springs. The jointed susceptible torsion shaft is making up from the transverse joins (1) and (2) and from the shaft (3) with the motor splined connection (4) with the sleeve (5), on which, on the outside cylindrical surface, a unself-locking thread is made (6) cooperating with the thread (8) made in the hole of the casing (7). At the turnover of the shaft (3) sleeve (5) is moving in the screw gear (6) made on the sleeve (5) and for casing (7). Springs (9) and (10) are losing its shape under the influence of the load what lets for reducing dynamic loads.

The solution is useful in particular for systems of driving machines in which dynamic burdens are appearing. A driving arrangement of the battery locomotive of the Lea-BM12 type with the standard Cardan shaft can be an example of applying which according to the information is surrendering to frequent breakdowns from the consideration to being found very much big overloading bends on curves by dynamic, occurring during the locomotive’s ride.

3.2. Articulated-overload shaft of two-way action

An articulated-overload shaft of two-way action is a different solution. This shaft is good peculiarly for transferring dynamic torsion loads, and by described overload is disconnecting the drive. This shaft can find application in connections of the motor with mechanical transmission gears where 15° isn't crossing the angle of crossing axes. Overload shaft, and at the same time susceptible torsion it is possible to apply in such driving arrangements where overloading these arrangements can appear by exposing elements to damage.

The structural form of this shaft enables reducing momentary overload of driving arrangement of the machine or setting up in the set-up time and reducing dynamic loads, and a flow is also interrupting the power in the case of exaggerated overloading which often appears in driving arrangements of mining, agricultural and road machines.

The fact that in the articulated Cardan shaft a flexible coupling is put in is a distinctive feature of the structure torsion of double-sided action, and all at the same time it is an overload coupling. Construction of this new articulated-overload shaft relies on the fact that between the transverse joins of the shaft additionally a flexible torsional coupling is situated which is an overload coupling all at the same time. Action of the articulated-overload coupling it relies on the fact that in the casing has coupled fastened rollers, in one plain in radial direction, they are sticking out inside the casing and they are cooperating with oblique grooves made on the outside surface of sleeve. These rollers put in furrows are moving the torque which is being passed on to the sleeve from the shaft via the motor splines connection. articulated-overload shaft is being linked with the help of the transverse joins of Cardan with bungs of the motor and the transmission gear (fig. 3). Rollers are fastened in the casing, and oblique with respect to the axis of the shaft grooves, are made on the outside surface of the sleeve.

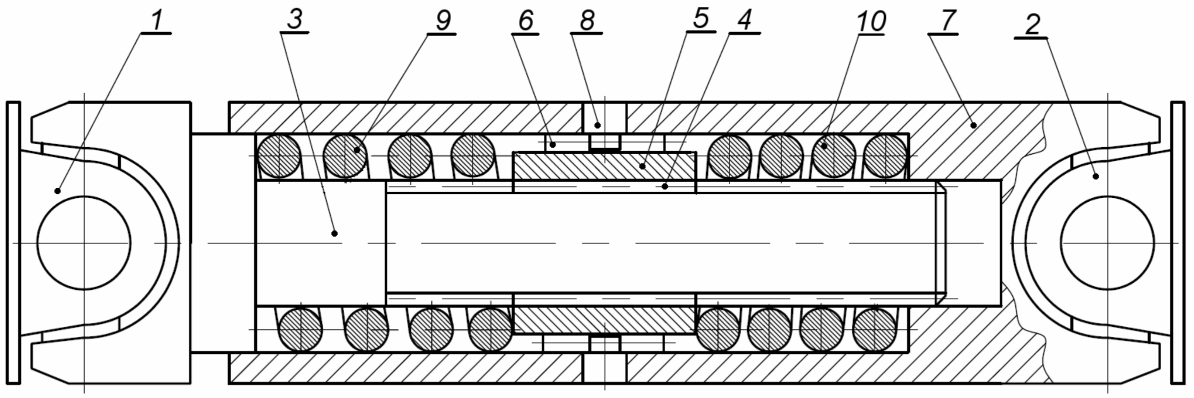

Fig. 3. The articulated-overload shaft of the two-way activity, where: 1, 2 – Cardan joints, 3 – shaft, 4 – splined connection, 5 – sleeve, 6 – skew grooves, 7 – casing, 8 – parallel roller, 9, 10 – springs

Rys. 3. Wał przegubowo-przeciążeniowy dwustronnego działania, gdzie: 1, 2 – przeguby Cardana, 3 – wał, 4 – połączenie wielowypustowe, 5 – tuleja, 6 – skośne rowki, 7 – obudowa, 8 – wałeczki, 9, 10 – sprężyny śrubowe

In the case the sleeve will reschedule overloading the articulated shaft oneself on motor splines pressing the shaft for one of springs but rollers from the casing coupling will come out from oblique grooves of the sleeve and a free rotary motion of the shaft will come with the sleeve in the casing. When the load reduces, it is a spring pressing the sleeve it will cause after the determined part of the turnover of the shaft with the sleeve that rollers then again will be in furrows of the sleeve.

This solution can also be useful to systems of driving machines in which they are appearing big of overloading the correct alignment of shafts together with the problem, and it concerns particularly mining, road, building and agricultural machines [8, 10].

3.3. Driving drum integrated with the coupling

It is a model applying securing drives of mining conveyor the conception worked out at the Institute of Mining Mechanization coupled susceptible, of which constitutes the casing, e.g. corps of the driving drum with chain seat of the curry comb conveyor or the loader of coal miner [10]. In this solution the chain drum of the conveyor is connected with the metal flexible torsional coupling.

In the example of the idea of the structure of the chain driving drum, introduced in picture 4, resistance of the set of disk springs (4), at the rotary motion of the shaft of the drum (3), results from the pressure of the spring to the nut (5) and it causes the increase in storage powers in district direction on the thread. The increase in these powers on the thread is increasing the torque and when it achieves value of the working moment of the machine, a rotary motion of the driving drum, being its working movement is starting. The coupling allows for the correct work of the chain drum in both directions of turnovers.

Momentary cause overburdening the working organ additional pressing resilient elements (4), and not-ballasting by relaxing these elements. After excluding the driving arrangement nut (5) pressed by springs (4) is coming back in direction for preliminary putting on the embankment the drum (3). At appropriately big preliminary pressing springs and after excluding the arrangement the nut is returning to the initial location. Appropriately selected set of disk springs and pitch on the input embankment and it releases the nut, under the influence of the nominal load, for getting a job during the normal coupled of screwing the big angle together, till the moment before driving drum (1) will begin the rotary motion.

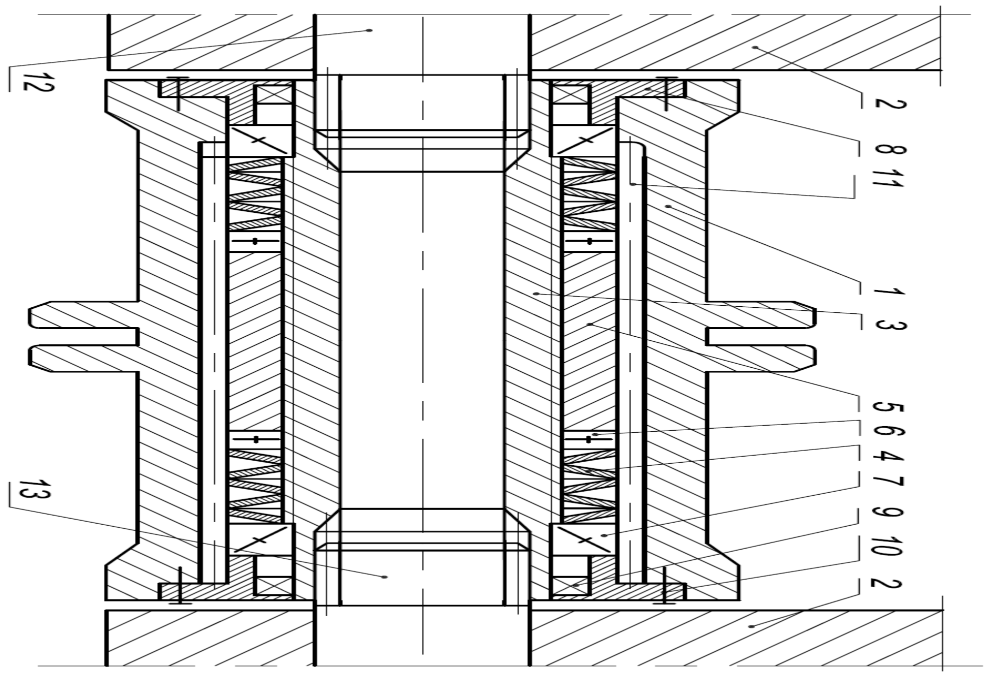

Fig. 4. The example of solution of the constructional driving drum integrated with the flexible torsional coupling, where: 1 – casing of the driving drum, 2 – elements of the frame of drive of curry-comb conveyor, 3 – shaft of driving drum, 4 – disk springs, 5 – nut with notched internal thread and splines, 6 – thrust bearings, 7 – cone bearing, 8 – cover of the drum, 9 – seal, 10 – screws, 11 – splines connection, 12 – drive shaft of gear, 3 – half axle of drive

Rys. 4. Przykład rozwiązania konstrukcyjnego bębna napędowego zintegrowanego ze sprzęgłem podatnym skrętnie, gdzie: 1 – korpus bębna napędowego, 2 – elementy kadłuba napędu przenośnika zgrzebłowego, 3 – wał bębna napędowego, 4 – sprężyny talerzowe, 5 – nakrętka z naciętym gwintem wewnętrznym i wielowypustem, 6 – łożyska wzdłużne, 7 – łożysko stożkowe, 8 – pokrywa bębna, 9 – uszczelnienie, 10 – śruby, 11 – połączenie wielowypustowe, 12 – wał napędowy przekładni, 13 – półoś napędu

4. SUMMARY

Discussed elements of driving arrangements with the used metal coupling of the structure of the Institute of Mining Mechanization are characterized by great torsion susceptibility. They can find application in arrangements of driving heavy machines after designing them to determined, concrete objects and after carrying appropriate research of prototypes out. These examinations to concern should be motor screw gear and of splined connections, since at the start-up of the driving arrangement a movement of the nut will appear in these connections and during the exploitation of the coupling at little, but changeable loads, slight oscillatory moves can appear and it can cause appearing phenomena of fretting [11].

Collected experience will allow in the process of planning the negotiations of driving and metal flexible torsional couplings for taking into consideration different factors, influencing their permanence.

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