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HOW TO DIMINISH THE WEAR FOR CHAINS WHICH ARE TIGHT ON THE SPROCKETS

Summary. The speech in this article is going about the standard bush-roller chain for bicycle, machine-tool or for conveyor. And the chain can be settled in the different spatial position, namely in vertical, horizontal or in the slope. In all these cases we have to stretch the chain periodically because of wear during the operation. For this aim the people apply different contact methods: spring-loaded rollers, flat springs (as a pair of friction), stretchers and so on [2, 3]. But here we describe a new way how to stretch the chain constantly and without any additional pairs of friction at all [1, 2, 3] using only magnet. It simplified design and enhanced the resistance against wear essentially.

Keywords: Bush-roller chain, sprocket, stretchers

JAK ZMNIEJSZYĆ ZUŻYCIE ŁAŃCUCHÓW, KTÓRE CIASNO PRZYLEGAJĄ DO ZĘBATKI

Streszczenie. W tym artykule mowa będzie o standardowym tulejkowym łańcuchu dla rowerów, obrabiarek lub do ciągnienia. Łańcuch może być osadzony w różnej pozycji przestrzennej, czyli w pionie, poziomie lub po skosie. We wszystkich tych przypadkach trzeba rozciągać łańcuch okresowo, ze względu na zużycie w czasie eksploatacji. Do tego celu ludzie stosują różne metody kontaktowe: wałki sprężynowe, sprężyny płaskie (jako parę tarcia), napinacze i tak dalej [2, 3]. W artykule opisano nowy sposób, jak rozciągać łańcuch stale oraz bez użycia dodatkowych par tarcia [1, 2, 3] jedynie przy użyciu magnesu. To istotnie uprościło konstrukcję oraz zwiększyło odporność na zużycie.

Słowa kluczowe: Łańcuch, zębatka, napinacz

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1. INTRODUCTION

In up-to-date machines, mechanisms, different equipment there are various working elements or the whole junctions which during many years didn't have any alterations in their design, very likely, with the exception of technology to manufacture the parts. For example, let's take the standard bush-roller chain for bicycle or for conveyor. It is stretched and put on the sprockets. In practice the next important and main characteristics can be changed: the long of the chain, pitch, mass, the distance between sprockets, diameters, number of tooth and members, number of the lines, power and high-speed factors, peculiarities of tension and lubrication.

As a tradition way of the relative position for sprockets is their vertical strengthening on the axis. In the capacity of the tension device (stretcher) we usually use the spring-loaded rollers mounted on their axis with frictionless bearings or sprockets, and seldom they are the flat springs. Moreover we can draw a chain by means of the spiral working principles which are accommodated in the special grooves. In these cases it demands for the most of these mechanisms the manual adjustment by means of the transference of the stretchers in the slots.

Although these named principles have been using for a long time, they are rather complicated during manufacture, have not high reliability for operation, forms the additional pairs of friction and wear out the chains.

During operation process a chain always has its natural wear and tear, the chain becomes longer that's why the angle of the girth for the tooth will be smaller. It reinforces the vibration and oscillations. In its turn this situation changes the distribution of efforts and strains both in chain and in tooth of sprockets. If the tension for the chain will be too weak, the chain can jump off the sprockets at all. In this case it brings to damage or even to fracture of our mechanism.

And what is more in practice we have a large problem with chains if they are placed in a horizontal position. In this case the wear for chain and sprockets grows repeatedly and essentially. The point is that in such situation the sagging of chain doesn't useful both for chain and for the tooth of sprockets because of their intensive wear. Our practice in operation of many chains shows that the wear and tear we can see not only on the surfaces of tooth but on the "body" of sprockets also.

2. METHODOLOGY OF EXAMINATION

That's why the described situation it is needed to consider as the great problem. In this article we show the new and very simple/effective method how to solve it (Fig. 1, A, B).

As it was mentioned above, if there are special rollers or sprockets to stretch the chains we use bearings in a design, apply lubricant in which any abrasive can get in it during operation. It leads both a spoiling for lubricant and wear for bearing.

The same negative pictures we can see if we use in the design the spring plates.

In my way the all named negative moments connected with chains and sprockets accommodated in various space position (vertical, horizontal or with a slope) were deleted in full.

For example, at the vertical arrangement of the chain (Fig. 1) the effective tension for the links of chain we reach by means of constant magnet 4. The presence of the block with a screw helps us to regulate the position of our (constant or even electrical) magnet both in vertical and in horizontal disposition because the block is placed in a guide.

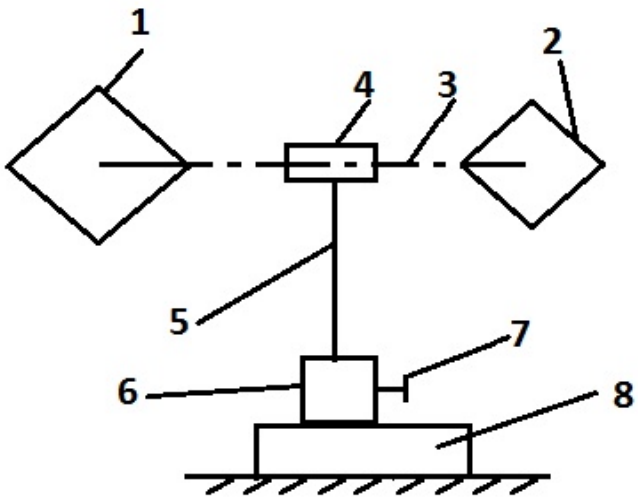

Fig. 1. Example how to realize the pull for the chain without any contact with it: 1 and 2 – sprockets; 3 – chain (for example, bush-roller); 4 – magnet; 5 – vertical support; 6 – block; 7 – keeper screw; 8 – basis

Rys. 1. Przykład jak zrealizować naciąg łańcucha bez jakiegokolwiek kontaktu z nim: 1 i 2 – zębatki; 3 – łańcuch (na przykład, tulejkowy); 4 – magnes; 5 – podpora pionowa; 6 – blok; 7 – śruba gwintowana; 8 – podstawa

If the chain is very long, we can set up two magnets on the definite distance between two sprockets. In any case the magnet makes for the larger girth of sprockets tooth; automatically and constantly tighten the chain during operation deleting all negative aspects named above.

If the chain has the horizontal disposition, we use two magnets once again but set up magnets quite near to the sprockets above of the two lines of a chain. By this way we raise slightly the two lines of a chain at the same time and hold the chain in such position constantly. Using this way we axise both chain and sprockets and it is very important. In this position our mechanical system will work without any distortion (Fig. 2).

In our experiment we have used the standard bush-roller chain for bicycle. The distance between axes of sprockets was 570 mm. To take into account the velocity/speed of a chain, weight, mass and another factors we can apply the definite shape and power of a magnet and assemble it in the definite position. Because of the direct contact between magnet and chain is absent so by this simplest way we eliminate any wear in this place completely.

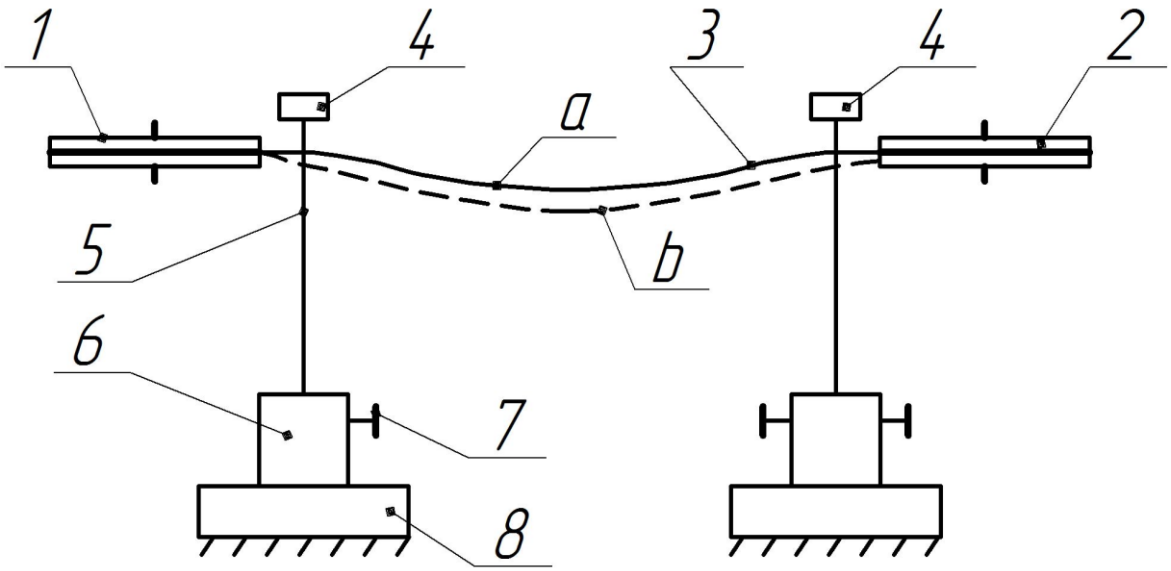

Fig. 2. Schematic version of a distribution sprockets and magnets which raise slightly the two lines of a horizontal chain simultaneously: 1 and 2 – sprockets; 3 – chain (for example, bush-roller); 4 – magnet; 5 – vertical support; 6 – block; 7 – keeper screw; 8 – basis; a – the disposition of a chain if we use magnets; б – sagging of a chain if the magnets are absent (the old traditional/standard sketch of assembling)

Rys. 2. Schemat rozkładu kół zębatych oraz magnesów, które jednocześnie nieznacznie zwiększają dwie linie poziome łańcucha: 1 i 2 – zębatki; 3 – łańcuch (na przykład, tulejkowy); 4 – magnes; 5 – podpora pionowa; 6 – blok; 7 – śruba gwintowana; 8 – podstawa; a – dyspozycja łańcucha, jeśli używamy magnesów, b – ugięcia łańcucha jeśli magnesy są nieobecne (stary tradycyjny/standardowy szkic montażu)

Using such method of assembly for chains we decrease wear of chains and sprockets, vibrations, strain in parts, and the design becomes cheaper and has high reliability in operation. Moreover the experiment shows that the sagging of the chain doesn't take place at all in a position for magnets near the sprockets. So in this case the coefficient of sagging will be 1 (instead of 6 for horizontal transmissions and 3 if the slope has $\leq 40^{o}$). For the preliminary tension F_0 of chain from the excessive sagging they use the next formula:

$$F_0 = K_f \, q \, a \, g \text{ [N]} \tag{1}$$

where:
K_f – is the coefficient of sagging;
q – mass of 1 m for chain, [kg/m];
a – the distance between axes of sprockets, [m];
g – acceleration (9,81 [m/s^2]).

Thus, in our case if we have got the horizontal position, the chain and sprockets raise slightly, and the coefficient of sagging will be 1 (as in a vertical position for chain and sprockets).

What kind of picture we can observe if the chain and sprockets have the vertical position? Put our magnet in the space between of the two lines of chain (Fig. 3). In this case the both lines of chain have been attracting by magnet to each other constantly during the all cycle of operation and they encompass of sprockets better.

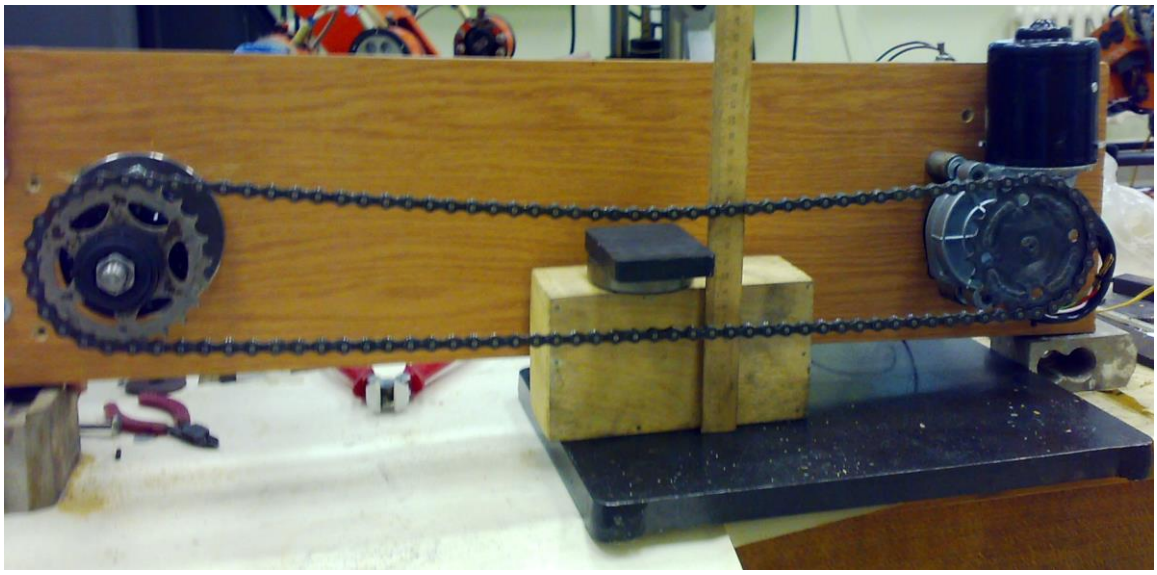

Fig. 3. The demonstration of setting for the magnet using special test bench
Rys. 3. Ustawienie magnesu za pomocą specjalnego stanowiska testowego

In the process of deterioration both the chain and sprockets, and stretching or lengthening of a chain our magnet will always attract both lines of chain. Another positive result of my observation in this case is the next: about one additional tooth will be encompassed by pitch of the chain, that's why it works much better with magnet. The rapprochement for the two lines of chain was about 15 mm.

If the distance between sprockets are big, set two or three magnets between the lines of chain. They will calm the vibration of the oscillation, too.

Now here it is the picture which demonstrates us the real shape of chain and sagging in a horizontal position with sprockets (Fig. 4 and Fig. 5). We made the experiment using special test bench.

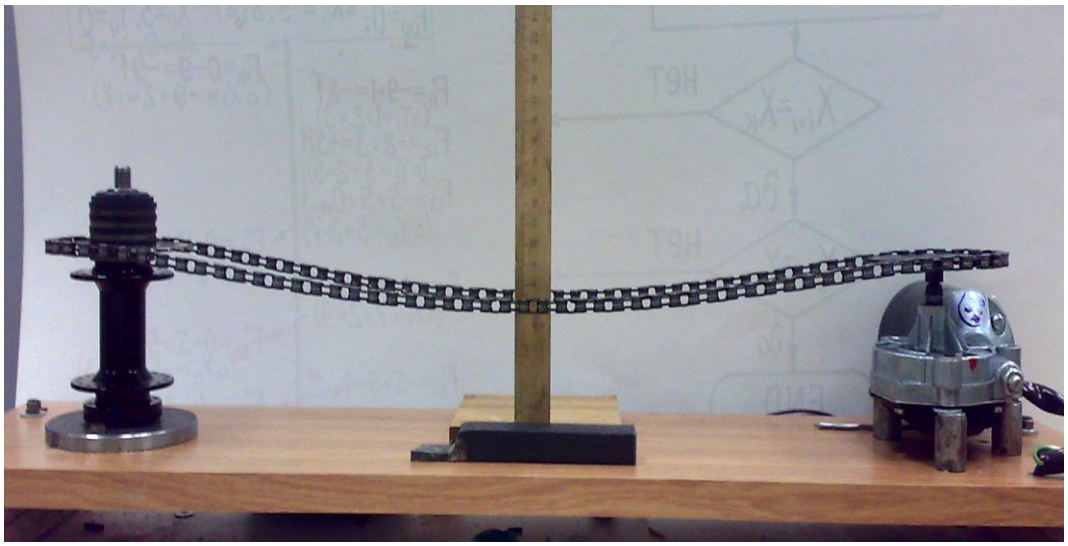

Fig. 4. Laboratory stand to investigate chains and sprockets if they have a horizontal disposition
Rys. 4. Stanowisko laboratoryjne do zbadania łańcuchów i zębatek dla ustawienia poziomego

Fig. 5. Other foreshortening when we can see as the magnet raised slightly the line of the chain and put it in one plane with sprocket
Rys. 5. Inne zniekształcenia, gdy możemy zobaczyć jak magnes podniósł nieznacznie linię łańcucha oraz umieścił go w jednej płaszczyźnie z zębatką

Post-graduate student S.V. Gusev executed many investigations connected with the new technical decision. Namely, he carried out three experiments with each version:

1) for vertical position of the bush-roller chain both without magnet (but with a standard version with two rollers and a spring) and with a magnet, too;
2) for the horizontal disposition of the two sprockets both without magnet (traditional way) and with magnet (this new method);
3) for slope with 45^{o}.

And we had got the next results. We managed to delete the additional pairs of friction (two rollers, two shafts, four bearings), spring and lubricant at all. In this case we needn't to stretch the chain periodically (it fulfils our magnet constantly). Moreover in this case the wear of chain was diminished till 3.9% on average against of the standard design. For slope position using magnet we decrease the wear more than 3 times. We decrease both vibration and the wear of the chain till 8% (on average) against the standard design. For horizontal position of disposition for sprockets using magnet we diminished the rate of wear till 5.2 times against of the standard design (without magnet).

3. EXAMINATION RESULTS AND CONCLUSION

So, we have got the new way to decrease essentially wear and tear for chains and sprockets in their different space disposition (vertical, horizontal or with a slope). This way helps to increase the reliability and durability both for chains and sprockets during their operation.

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