A set of cable gears for a wheelchair with a handrim dirve

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It can be observed that wheelchairs with manual drives are not fully adapted to the individual needs and physical capabilities of users. They face many physical limitations that prevent them from moving freely. Manually-operated wheelchairs available on the market today are also not suitable for use everywhere. Handrim drive works efficiently mainly in closed areas - it is ideal for use on even surfaces at low speed. At the other hand, the fully electric drive increases the dimensions of the wheelchair. This type of wheelchair is suitable for use mainly in open areas, such as streets and parks. Increasing user requirements and an aging population mean that there is an increasing demand for modern wheelchair solutions. Many of the solutions produced today are not suitable for simultaneous use on both hard and soft surfaces. As a result, they are not adapted to the situation and needs of a specific person.

On this basis, it is possible to identify the existence of a certain lack or greater need in the whole society. Therefore, it would be beneficial to develop solutions in the field of manual wheelchairs that would allow them to be adapted to the current needs of the user in terms of generating the drive. The presented invention aims to meet such identified social needs by developing innovative manual wheelchair drives.

Presented invention P.434936 of August 11, 2020: "A set of cable gears for a wheelchair with a handrim dirve". The solution is based on the use of a cable gear system in the wheelchair, which will allow the operator to change the ratio between the handrims and the wheels of the wheelchair. As a result, it will be possible to adjust the demand for drive torque to the current requirements and physical capabilities of the user. It is planned to use elements of mechanical transmissions used in various muscle driven devices. In other words (greatly simplifying) the planned modifications can be imagined as an attempt to make bicycle gears (popular "derailleur") in a wheelchair drive system in a number of different variants.

The developed mechanisms will make it possible to choose the ratio of the drive system. This will reduce the difficulties associated with overcoming uneven terrain and make it easier to navigate on low hardness surfaces, both inside (carpets) and outside (unpaved road). Appropriate selection of the gear ratio will allow for more effective driving on flat and paved surfaces. Thanks to the better adjustment of the drive system to the user's physical abilities, the range of movement in the wheelchair will also increase. In the indicated solution, the kinematics of propelling the wheelchair does not change (the operator will not need training).

It is planned to develop the structure and build prototypes of three wheelchairs. The first two of them are wheelchairs with manual (handrim) drive using cable transmissions (one with a chain transmission and one with a belt transmission) of purely mechanical design (without electronics).

Schemes of these solutions are shown in Fig. 1 a) and b). The third one will be a manually driven wheelchair using a chain transmission, but having an electronic gear shifting system. (Fig. 2). The planned solution is to be a modification kit to the already existing wheelchairs, and not a solution created from scratch (economic benefit).

The third solution will be based on one of the previously developed structures (a wheelchair with a chain transmission). The works planned to be carried out assume that the solution will be retrofitted with an electronic system, the task of which will be to enable automatic and semi-automatic operation. For this purpose, it will be necessary to use electric actuators to change the gear ratio and a microcontroller to control and supervise the system.

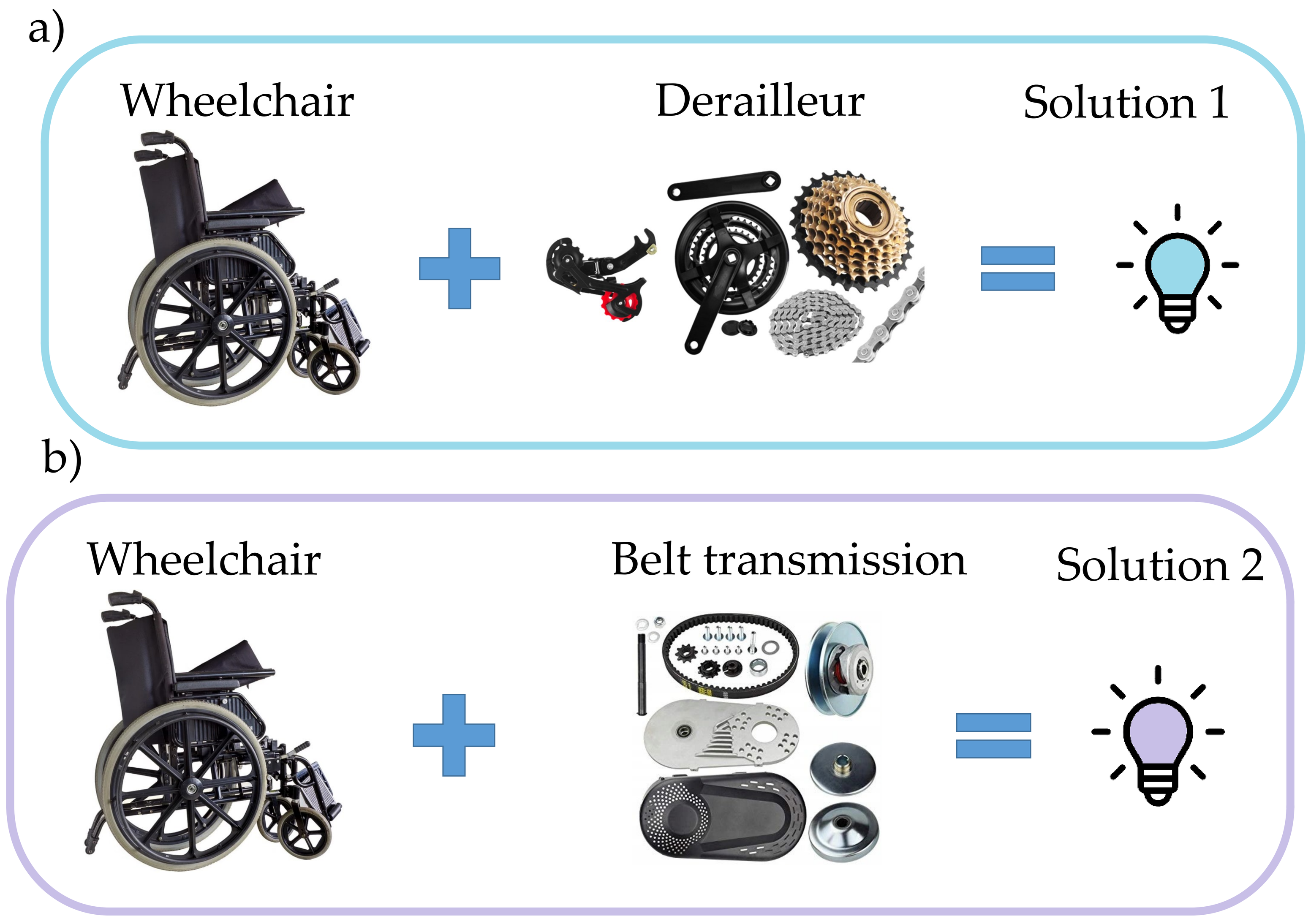

Fig. 1 Concepts of the solution according to the invention: a) with the use of a chain transmission, b) with the use of a belt transmission; Illustration made based on: [1-3]

Fig. 2 Concepts of the solution according to the invention with electronic control system; Illustration made based on: [1-3]

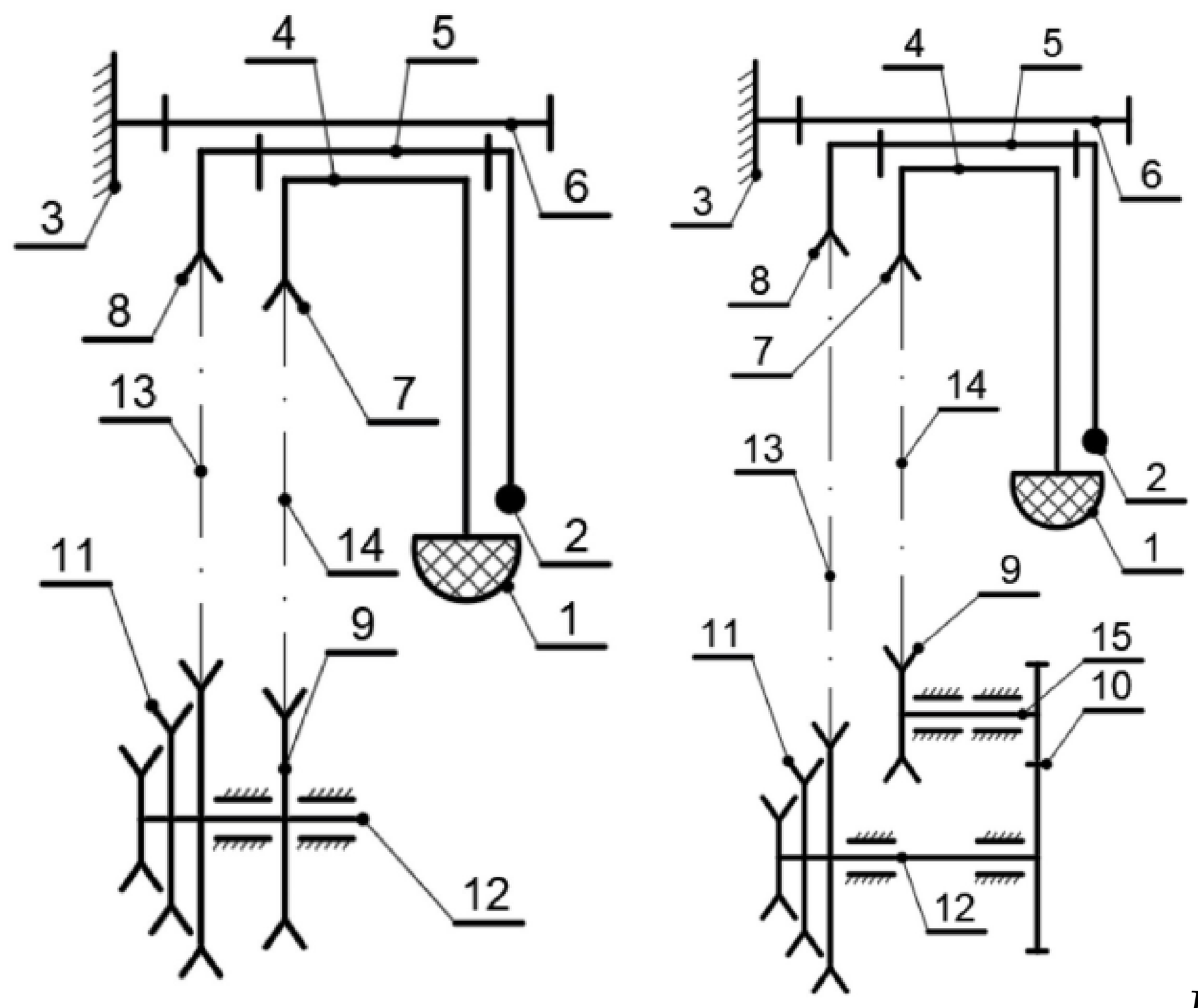

Fig. 3 Concepts of the solution according to the invention P.434936;

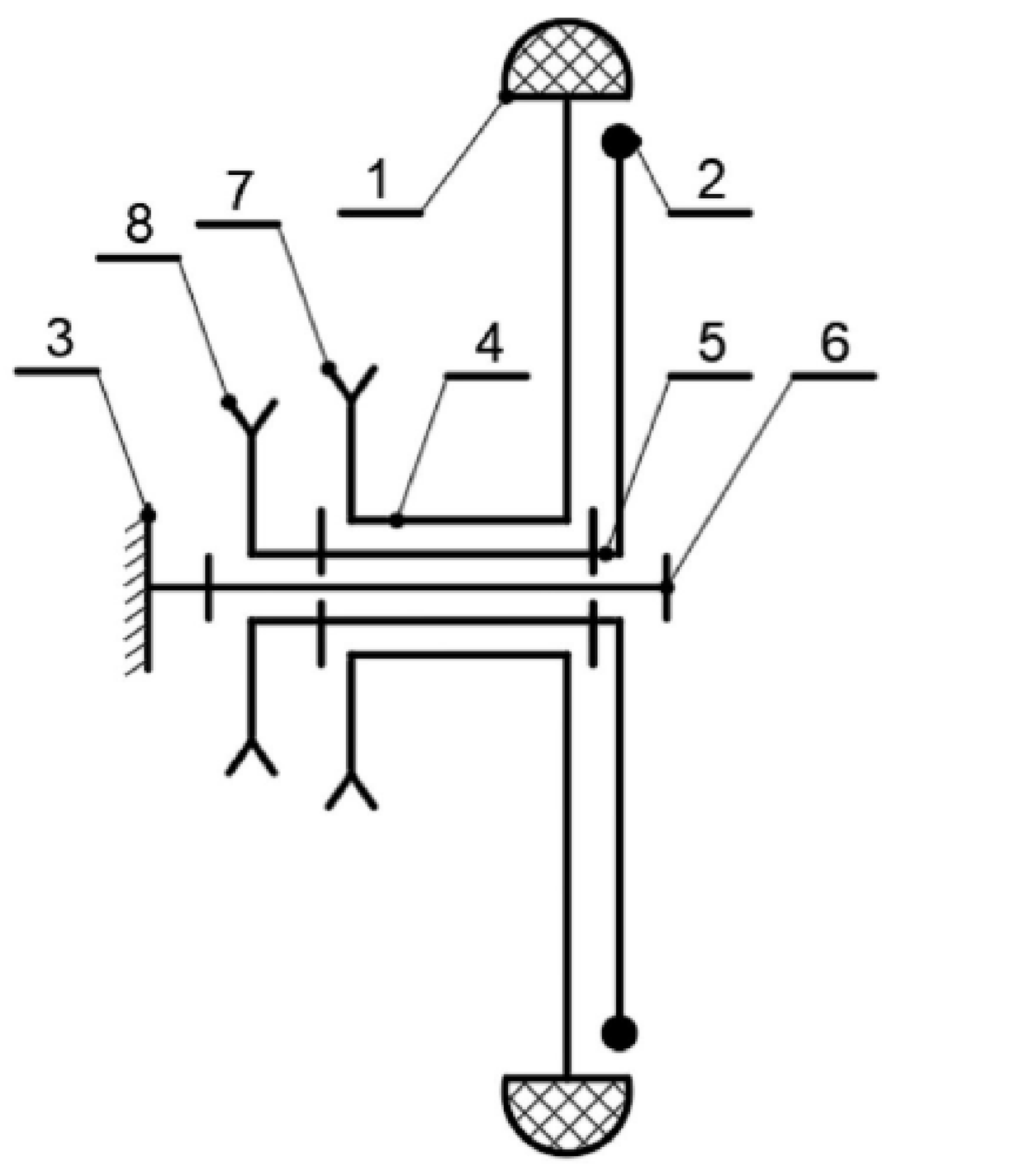

Fig. 4 Scheme of the rotating handrims

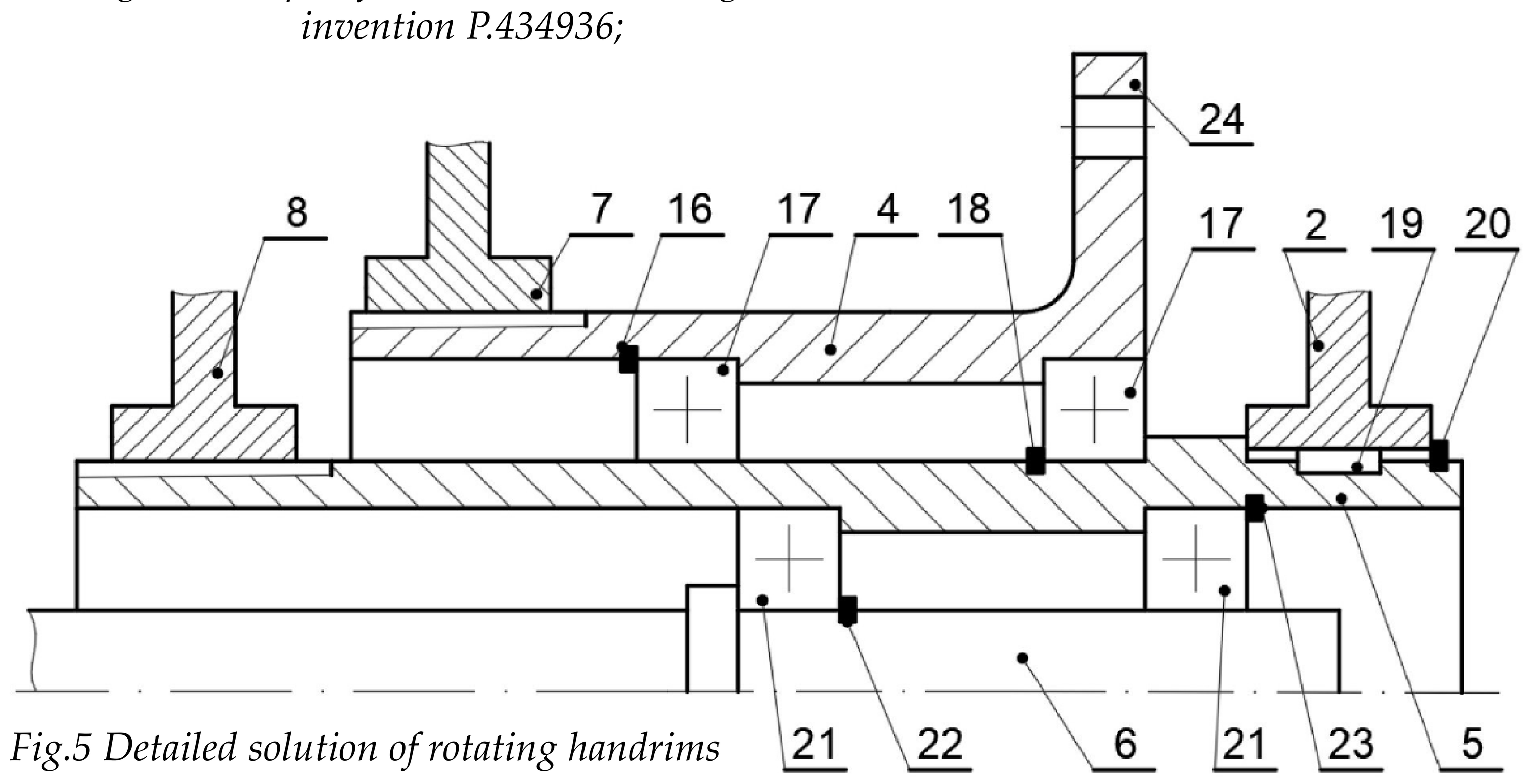

Fig.5 Detailed solution of rotating handrims

The essence of the invention is a set of cable gears for a wheelchair with manual drive. The unit has a fixed main axle which connects permanently, preferably releasably, to the frame. The stand is a load-bearing element of the wheelchair or is rigidly attached to it by a suitable adapter.

The main axis cooperates by means of bearings with a hollow internal shaft, the use of which allows to achieve the fact that the axis of rotation of the strings and the axis of rotation of the wheel coincide. Thanks to this, it is possible to use the already existing wheel and set of strings. The inner shaft, on the other hand, cooperates with a hollow outer shaft by means of bearings. The outer shaft cooperates with a flange with holes and a gear wheel. The flange with holes is attached to the spokes, which are rigidly attached to the tire rim. Moreover, the inner shaft works with the gear wheel and with the strings. The gear wheel cooperates by means of a cable with the gear wheel. The gear wheel is mounted on the shaft of the set with bearings or on an additional gear shaft. In the option of mounting on an additional gear shaft, the gear wheel and one of the auxiliary gear wheels are also mounted on the additional gear shaft. The second wheel of the auxiliary gear is mounted on the bearing-mounted shaft of the set. A set of gear wheels is placed on the bearing-mounted shaft of the set, which cooperates with the gear wheel via a cable. It is obvious that, depending on the design solution used, in the presented mechanism, the set of gear wheels can be placed in different places of the system, i.e. interchangeably with the gear wheel or the gear wheel or the gear wheel. The principle of operation of the system will not change. However, the geometry of the solution will be modified, because in such cases the gear wheel set will be associated with the external shaft, or the internal shaft, or the bearing-mounted shaft of the set, respectively.

It is obvious that the inner shaft bearings and the outer shaft bearings may, depending on the chosen design solution, take the form of rolling or plain bearings. The bearings are preferably secured against displacement in the shafts by means of circlips. The gear wheel set allows the choice of different gear wheel diameters. This selection is carried out by an additional mechanism, preferably electrically controlled by means of an additional drive or mechanically controlled, for example by means of a lever, as is the case in the classic solution known from bicycles.

The pull-gear assembly of the pull-drive wheelchair in the exemplary embodiment is shown in the drawing with the aid of the kinematic diagram in Fig. 5 and in detail in the section in Fig. 5. Fig. 3 shows a first and a second variant of the solution. Fig. 6 shows a kinematic diagram of one possible modification of the invention. The pull-drive assembly of a pull-drive wheelchair consists of several assemblies of parts, the most important of which is the axle and shaft assembly. The central part of the system is a fixed main axis 6 rigidly connected to the frame 3. The frame 3 is a support element of the wheelchair or is rigidly attached to it by a suitable adapter. A hollow internal shaft 5 cooperates with the main axis 6, and the external hollow shaft 4 cooperates with it. The whole is supported on two bearings 17 and two bearings 21 in such a way that the internal shaft 5 can rotate independently of the main axis 6 and the outer shaft. 4. Likewise, the outer shaft 4 is able to rotate freely with respect to the inner shaft 5.

Bearings 17 or 21 may, depending on the selected design solution, take the form of rolling or plain bearings. The bearings are secured against displacement by circlips 16, 18, 22 and 23. The outer shaft 4 cooperates with a flange with holes 24 and a gear wheel 7. The flange with holes 24 is associated with spokes which are rigidly attached to the rim of the tire 1. The inner shaft 5 cooperates with the gear wheel 8 and with the strings 2. The inner shaft 5 is connected with the strings 2 by means of the key 19. The stationary position of the strings is ensured: on the one hand, thanks to the appropriate geometry of the inner shaft 5, and on the other hand, thanks to the groove ring 20 The system may have two basic variants. In the first variant, the gear wheel 7 cooperates by means of a pull rod 14 with a gear wheel 9. The gear wheel 9 is mounted on a bearing mounted shaft of the set 12, which in turn is associated with a set of gear wheels 11. The set of gear wheels 11 cooperates by means of a link 13 with a gear wheel. 8. The whole is constructed in such a way that the wheelchair user drives the system by means of strings 2. The torque is transmitted by means of the internal shaft 5 to the gear wheel 8, and then through the cable 13 to the gear wheel set 11. Due to the bearing shaft of the set 12, the torque is the rotation is transmitted to the gear wheel 9 and then via the cable 14 to the gear wheel 7. The outer shaft 4 allows the torque to be transferred between the gear wheel 7 and the tire 1. In this way, the user drives the wheelchair. The change of the torque demand is realized by changing the mating diameters by means of the cable 13 or the cable 14 of the gear wheels. As shown in Fig. 3, these may be, for example: a gear wheel 8 and a gear wheel set 11. The gear wheel set 11 allows the choice of different diameters of the gear wheels. This selection is made through an additional mechanism: electrically controlled by means of an additional drive or mechanically controlled by, for example, a lever, as is the case in the classic solution known from bicycles. In the second variant, the system is additionally equipped with a gear shaft 15, on which the gear wheel 9 and one of the wheels of the auxiliary gear 10 are mounted. The other wheel of the auxiliary gear 10 is mounted on the bearing shaft of the set 12. The task of the system of parts: the additional gear shaft 15 and the gear auxiliary 10 is to change the rotational direction. In the first variant of the solution, the strings and wheels rotate in the same direction, in the second variant - in the opposite. The application of the variant may depend on the personal preferences of the user. It is obvious that depending on the design solution used, in the presented mechanism, the set of gear wheels 11 may be in different places of the system interchangeably with the gear wheel 7, or the gear wheel 8, or the gear wheel 9. The operating principle of the system will not change. On the other hand, the geometry of the solution will be modified, because in such cases the gear wheel set 11 will have to be associated with the outer shaft 4 and the inner shaft 5, respectively. The possibility of modification consisting in the use of various types of cable gears in the discussed invention should be obvious. In the presented solution the focus is on a chain transmission using a set of gear wheels 11. For technically skilled people it will be obvious that it can be used interchangeably with a chain transmission implemented in Fig. 2 by means of a cable 13, for example a belt transmission using a flat belt as a cable 27, yes as shown in Fig. 6. In this case, the gear wheel set 11 and, for example, the gear wheel will need to be replaced by a conical belt variator using a bevel gear 26 and a bevel gear 27. Various cable gears and combinations thereof may be used in place of the gear wheel set 11 and gear wheels 7, gear wheels 8 or gear wheels 9. Different types of cable gears have their own unique advantages and disadvantages. Various ways of using them and combining them into one mechanism may result in more favorable characteristics of the resulting drive system. An important utility benefit is also the fact that the chain, wheels and most of the elements together fit under the seat of the stroller. Thanks to this, the dimensions of the wheelchair will not increase, but only its weight.

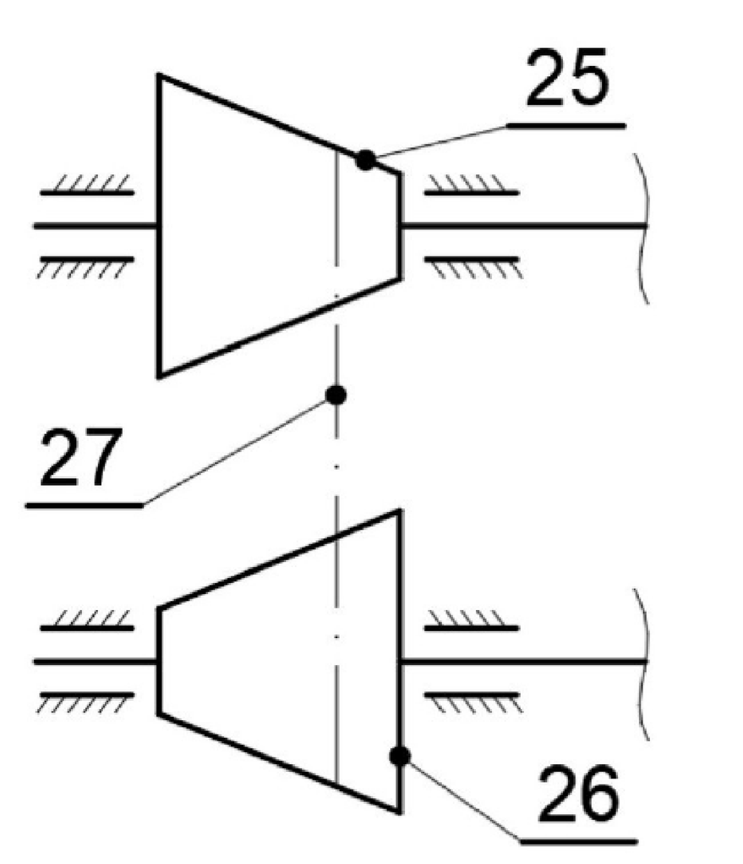

Fig. 6 Scheme of variable belt transmission

Work carried out under the project entitled "Innovative Drive Systems for Wheelchair - Design, Prototype, Research. Project number: Rzeczy są dla ludzi/0004/2020. (Eng. Things are for people). National Centre for Research and Development.

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