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B2 Overhead lines
PS1 Challenges & new solutions in design and construction of new overhead lines

Development of lifting device for raising height of existing towers of overhead lines

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SUMMARY

The growing demand for electricity makes it necessary to build new and modernize the existing power lines. Many of existing power lines were built long time ago and need to be refurbished, some of them are very important in power system and it is difficult or even not possible to turned them off during maintenance. This in turn, combined with the growing costs of human labor, makes it necessary to look for new solutions in the construction and operation of overhead lines. This paper presents innovative device which can be used to build new lines and maintain existing lines. This device can be used to uplift existing towers of overhead lines without outages. It also can be used to erect new towers especially in areas with difficult access.

Device is made up of four independent self-transported lifts. All the four lifts are transported to the tower station independently and they are attached on one side to the top of foundation which are above ground and on the other side to tower legs. Each of these independent lifts are connected to each other by a special frame and computer-coupled so that the lifting of each leg of the tower is even. There is also small crane inside this device which helps workers to build tower elements. The device is designed and manufactured under European Union funding by Enprom specialists. It is possible to raise towers up to 400kV double circuit tower suspension and tension with conductors. Maximum height of increasing insert is up to 5m. Application limit is related to the forces acting on the tower from conductors. Before device is operated the special calculation is to be made to check possibility in the case. If the special safety procedures are introduced, it is possible to uplift tower while the line is operated.

Uplifting of existing towers is done by preparing additional extension. Usually for towers uplifting at least one crane must be involved. Conductors are disconnected from clamps and put to rollers. In some cases, ex. tension towers, it is even necessary to disconnect conductors from tower before operation is being done. These are the reasons that before tower is raised the line must be turned off. With this device it is possible to do that without putting conductors to rollers on suspension towers, and even without disconnecting conductors for tension tower. In special cases it is possible to do it when the line is energized.

It can also be used for erecting new towers. Each part of tower is being assembled on ground, and then using the device those parts might be connected to each other. This is not a very quick solution, but in some cases – the only one.

Existing and new overhead lines are in different areas, some of them are easy to access, the others are placed in area where cranes are not possible to transfer. In those situations, presented device might be a good solution.

The paper presents examples of practical application of this device.

KEYWORDS

Tower uplifting, Crane, Device.

Introduction

During the operation of power lines, it is sometimes necessary to increase the capacity of the lines. This can be done by replacing the conductors with HTLS wires, it can also be done by increasing the operating temperature of the conductors. In both cases, it may be necessary to raise the towers. If it is necessary to increase the suspension height of the conductors above the ground and objects located under the line, the towers are raised by installing an additional raising structure with an average height of 2 to 5 meters. This structure is installed between the foundations and the existing column structure. The works are carried out in a technology that usually requires disconnecting the power supply to the line, disassembling the conductors in a short section of the line, and disassembling the tower. Subsequently, an elevating structure is installed. Later, the tower and conductors are reassembled. The process is not very complicated, but the basic problem is that it is necessary to disconnect the power supply to the line. Meanwhile, in some cases, certain lines are critical energy transmission, and their possible shutdown is very troublesome or even impossible. To meet these practical needs, in 2018 we initiated a research project aimed at developing and implementing a new technology that would allow the implementation of tower elevations without outages of the line or switching it off for a short time, or with a very short time of readiness for connection. The key element of this technology is an innovative device for lifting entire tower together with live working conductors. This device was designed as part of the research project from the NCBIR pool no. POIR.01.01.01-00-0257 / 18 entitled: Development of an innovative mechanical device for lifting the entire power pole. The project, completed in 2021, was an interdisciplinary undertaking involving research and development in the field of construction, mechanics, power hydraulics, automation, and electrics. The manufactured device, hereinafter referred to as a jack, received its own trade name.

Construction details

As part of the project, 4 types of devices were designed and built, adapted to the specifics of the basic support structures of power lines that are encountered in practice. The devices differ in load capacities and parameters adapted to the suspension towers "P" and tension towers "M" straight poles. Depending on the required load capacities, related not so much to the weight of the columns being lifted, but also to the reactions generated in the supports, light "1" and heavy "2" types were built. The entire range of devices is presented in Figure 1.

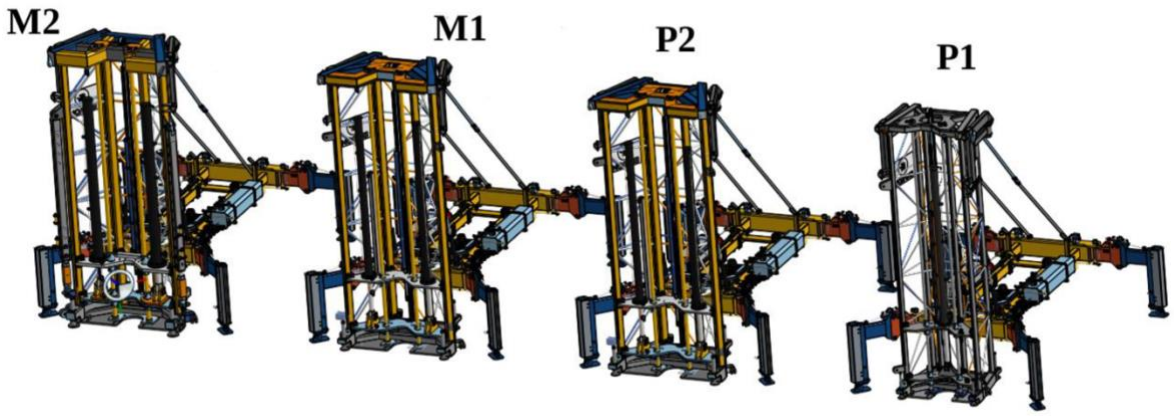

Figure 1. The different series of presented device.

Devicewas designed to service the highest voltage lines in the range from 110kV to 400kV. Under certain conditions, it is possible to use them even on 750kV lines. They can also lift other tower structures, incl. telecommunications, observation, four-legged and three-legged towers.

The construction of the devices is modular, and their design, which differs in components, has been standardized.
Each of the devices consists of four independent steel columns. designed as frame and lattice structures with working platforms. They constitute the skeleton for running the column lifting systems. The columns are mounted on frames, which are equipped with supports that stabilize the lifts during operation. The supports are unfolded by actuators, and during transport they are folded to the transport position. The diagram of the frame in the transport and working position is shown in Figure 2.

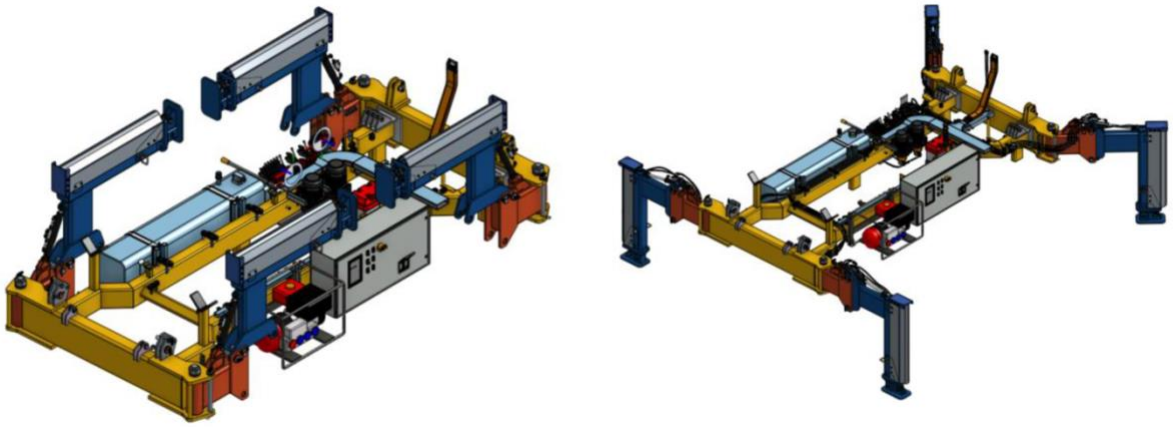

Figure 2. Frame in transport position (left) and in operational position (right)

The complete segment in working position is shown in Figure 3. The lifts unfold automatically from transport to working position. The devices are designed so that they can be optimally transported without the use of special trailers. An example of the loading configuration on standard truck trailers is shown in Figure 4.

Figure 3. Operation position.

Figure 4. Two modules on a semitrailer.

After being delivered to the tower position, the jacks are positioned at the members of the pole and attached to the foundations and to the pole structure. The view of the finished set placed next to the pole is shown in the photos Fig. 5. and Fig. 6.

Figure 5. Device implemented to a tower

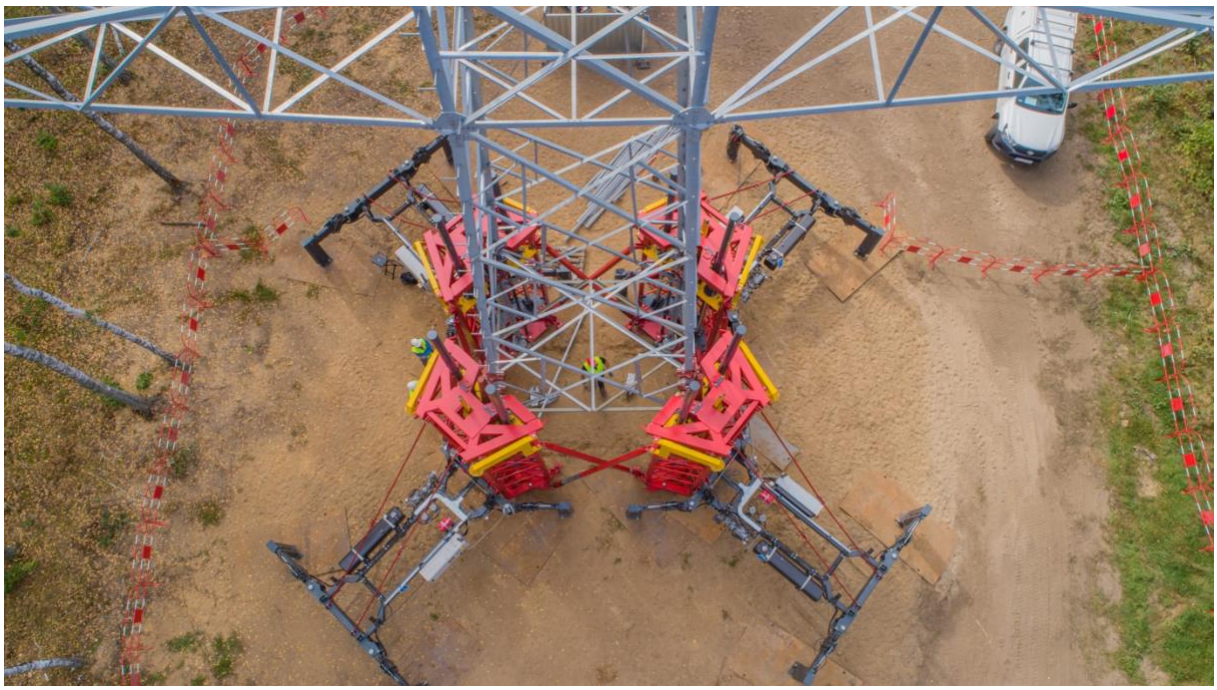

Figure 6. Device implemented to a tower.

The lifting mechanism consists of hydraulic cylinders mounted to the movable base of the cylinder piston rod and the movable platform to which the pole structure is attached. Movable base and platform can be mechanically locked in any position with special nuts. The view of the lifting system with the raised pole is shown in Fig. 7. The photo shows a grey, movable base for mounting the piston rod and a yellow, movable base for mounting the pillar structure. The hydraulic system of the lifts is powered by electric pumps.
The lifts are electrically controlled from a desktop equipped with an automated system. All the lift segments can be controlled from any control panel on which each of the four lift segments is equipped. A computer can be connected to the control system. It is also possible to control manually by means of levers at the manifolds. This solution allows to work with damaged electric control.
The standard and simplest version of the column lifting technology assumes the connection of all lifts to one control panel and the introduction of boundary conditions consisting in limiting the difference in the current lifting height between the individual legs of the column. The control is then reduced to "pressing a button" responsible for smooth, even, simultaneous lifting of all legs. Automation smooths the pace of lifting and makes sure that the set forces in the lifts are not exceeded. The panel displays the lifting height and force values for each jack individually.
A key component of this device are special holders for securing the lifting device to the column foundations. Figure 8 shows an example of a clamping system securing the device to the foundation. The mounting bracket itself, the so-called griper, is produced in various variants adapted to particular types of foundations.

Figure 7. Upraise system.

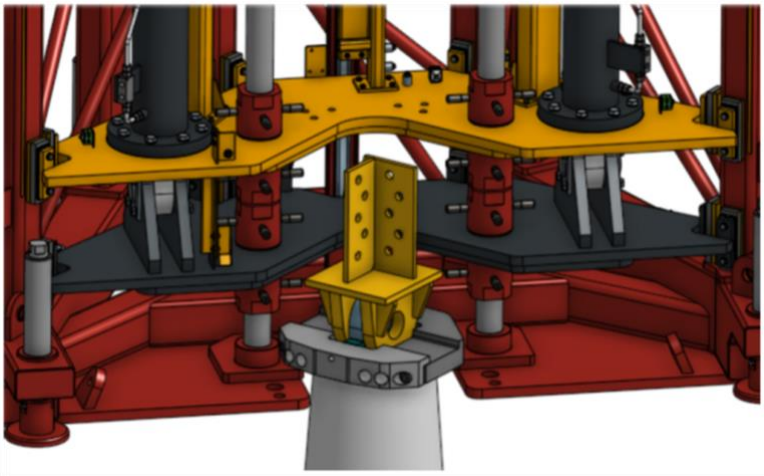

Figure 8. Foundation attachment.

Summary

The presented innovative device for lifting entire poles is a unique solution. The presented device opens new possibilities in the field of technology for modernization works on overhead power lines. Its main advantage is the possibility of carrying out works related to raising towers on active lines (without outages) or with a very short time of switching them off.

The photo (Photo 4) shows from the left the pole on the elevating insert, the lift in the working position and the lift in the storage position.

Figure 9. Tower after installation of extension, Device in both position operational and transporting.

The developed technology ensures the stability of the system through the simultaneous and corrected operation of all four lift segments with the simultaneous possibility of manual adjustment of the lifting height of each of them, the possibility of mechanical locking of any height of lifting the structure and the possibility of manual and safe lowering of the pole in the event of a power cut.

Technology to ensure health and safety to all employees involved in the assembly work when lifting and lowering the pole and during the assembly of the increasing structure

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