Electromechanics

High speed electric motor for agricultural power tools

Arkadi Rikrikadze – PhD,
Konstantin Tsereteli – PhD, Professor

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Abstract

The article discusses the prospect of using a high-frequency (200-500 Hz) induction motor in small-scale mechanization of agriculture, emphasizes its technical and economic advantages over existing commutator motors. Research was conducted on an innovative asynchronous electric motor in which the rotor is located cantilever relative to the stator housing, the rotor is a flexible shaft that allows it to overcome critical speeds and be more resistant to vibration. It also has an innovative bearing lubrication system in which the inner space of the rotor also acts as a reservoir for the liquid lubricant that cools the inner surface of the rotor.

An innovative method of obtaining a three-phase symmetric electrical system using a two-winding two-phase winding is shown, for which a Georgian patent for a utility model is obtained, which is new knowledge in electromechanics. Based on the results of the study, conclusions are drawn and areas of the possible use of an innovative electric motor are listed.

Introduction

In the first half of the 20th century, the basis for a new direction in agriculture was laid - small mechanization and in the second half its development began intensively. Electromechanical shearing machines for trimming animals were mastered and for pruning tea bushes. The main component of these power tools are high-speed collector motors. Accordingly, the technical level of these power tools is mainly determined by the reliability and technical characteristics of the electric motor. Their rated power is in the range of 70-750W.

These collector electric motors are powered from a single-phase electrical network with a voltage of 220V and a frequency of 50 Hz. Existing designs of this type of electric motors have exhausted their technical capabilities.

They have the following disadvantages:

1. Low reliability;
2. Increased noise;
3. They create TV and radio interference;
4. Low electrical safety;
5. Low work resource;
6. Cannot function in different climatic conditions.

Main part.

For almost 20 years there have been no major breakthroughs in the existing designs of electric motors used both in small agricultural mechanization and also in existing designs of electric motors used in power tools in general. These power tools often fail, and maintenance personnel spend a lot of time on their repair, which ultimately affects the production of workers. This has led us to take a fresh look at existing problems and to make cardinal changes to the construction of a built-in electric motor.

We have developed and manufactured a low-power (80–100 W) high-speed (12. 000–30. 000 rpm) innovative three-phase asynchronous electric motor with a short-circuited rotor of high current frequency (200–500 Hz) and low voltage (36–42 V) at level of sketch design, to drive electric scissors, designed for Haircuts animals. A general view of this electric motor in different positions is shown in photo 1.

Photo. 1. High-speed three-phase asynchronous electric motor with a cantilever squirrel cage rotor

Innovation is as follows. In existing designs of electric motors, the rotor core is mounted on the shaft and rotates with it. In our design, the rotor core is located on the bushings in which the bearings are mounted. An axle is mounted on the bearings that does not rotate. The rotor relative to the stator housing is located cantilever and is a flexible shaft, and therefore the rotor freely passes critical speeds compared to existing structures and is more stable from the point of view of vibration. The innovative rotor relative to existing ones additionally has a degree of freedom one more.

The space between the fixed axis and the bushings was used to create an original bearing lubrication system, which is expressed in making longitudinal and transverse holes in the fixed axis, with which the bearings are easily lubricated. Unlike existing electric motors, forced circulation lubrication of bearings was carried out, i.e. we have not come to use additional components and lubrication pumps. The space between the fixed axis and the bushings combined the function of a reservoir for a liquid substance. The overall view of the innovative rotor is shown in Photo 2.

Photo. 2. Flexible squirrel cage rotor.

As a result of theoretical research and analysis, we received an original wiring diagram for stator windings, for which we were granted a patent (Georgia) for utility model No. U 1926, entitled “Two-winding three-phase electric machine”. Such a connection of the windings increases the reliability of the motor and reduces the consumption of insulating materials, since with respect to three-phase asynchronous electric motors in the stator slots we place two single-phase windings (place three) offset by 900 degrees relative to each other. In this case, we get an innovative symmetrical three-phase winding.

Fig. Figure 3 shows an innovative connection scheme for a two-winding three-phase stator winding circuit of an asynchronous electric motor.

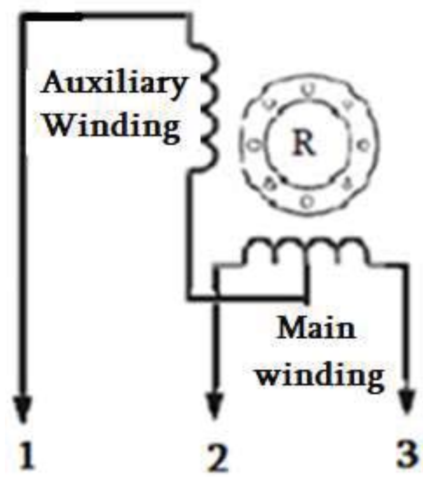

Fig.3 two winding three-phase electric machine (Patent № U 1926).

In operation, the innovative electric motor is easy to maintain. Its application is possible not only in agriculture, but also where technological processes require not only high speeds (in the food industry, in the production of power tools, in transport - in electric vehicles, in aviation, in electric spindles, etc.), but also where high reliability is required, which is ensured by two windings, in contrast to three-phase asynchronous electric motors of the classical type.

The above design also differs from the existing one in that it has one bearing shield (place two), due to which its assembly is extremely simple. As a result, a compact high-speed electric motor with a mass of not more than 0.70 kg and a nominal power of at least 80 W was obtained. The innovative electric motor, unlike the existing ones, does not require a fan for cooling, which also contributes to the reduction of aerodynamic noise. The motor can be powered using compact semiconductor frequency converters (200-500 Hz), the mass of which does not exceed 2.0 kg.The question is relevant, since A need has emerged to research and design an innovative high-speed asynchronous electric motor, which is promising, more reliable, electrically safe, does not create television and radio interference, can work in different climatic conditions. Has small dimensions and mass.

Our goal is to develop at the technical level and master the production of an innovative high-speed asynchronous electric motor, which can also be used in the food industry (in spray dryers) for the production of condensed milk, instant tea, etc.

Today, Switzerland for trimming shrubs produces electric shears based on a classical three-phase asynchronous electric motor with a short-circuited rotor of increased frequency (200 Hz), 120W power and a rotor frequency of 12,000 rpm. Russia for the construction industry produces power tools that incorporate classic three-phase asynchronous electric motors with a short-circuited rotor with a power of 120–750 W, current frequency (200 Hz), 42V supply voltage and rotor frequency of 12,000 rpm. These electric motors are less compact, have a relatively low specific power and assembly technology as compared with an innovative electric motor is more complex. The resource of work is limited as they have disposable greasing for bearings. In our version, the lubricant is liquid and automatic, depending on the frequency of rotation of the rotor.Construction power tools are mainly powered by machine frequency converters. The generated frequency of the current in them should be 200 Hz, but in fact they generate 185–190 Hz. This current frequency mismatch is not valid. Their mass is high (35–60 kg). Based on the foregoing, their use is not recommended.

The results of the study and their applicability

As a result of research, new knowledge in the field of electromechanics was obtained. In particular, the two windings, which are electrically offset relative to each other by 90^0, give a symmetric three-phase system and, unlike a three-winding three-phase system in generator mode under asymmetric loads, do not create a zero sequence of currents and voltages, therefore, energy losses will be less. At the same time, the consumption of insulating material for the stator winding will be less, because in our system instead of three we use two windings.

A potential consumer of the project under study is animal husbandry, tea growing, the food industry, the construction industry, electric spindles, electric transport - electric cars, aviation, etc.

Conclusion:

1. In power tools of small-scale mechanization of agriculture, two-winding three-phase asynchronous high-frequency electric motors with a cantilever arrangement of a squirrel-cage rotor should be used.
2. lubrication of the bearings of high-speed electric motors should be carried out with a liquid substance.
3. The rotor of a high-speed squirrel-cage induction motor should be a cantilever version.
4. As a result of research, new knowledge in electromechanics was obtained, namely, two single-phase windings, which are electrically shifted from each other in 90^0 stator slots, create a symmetric three-phase system.

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დიდჩქარული ელექტროძრავა სოფლის მეურნეობის ელექტროიარაღებისათვის

არკადი რიკრიკაძე-ტექნიკის აკადემიური დოქტორი,
კონსტანტინე წერეთელი-ტექნიკის მეცნიერებათა კანდიდატი, პროფესორი

საკვანძო სიტყვები: დიდჩქარული ელექტროძრავა; ელექტროიარაღები.

რეფერატი:

სტატიაში განხილულია მოკლედშერთული როტორიანი დიდჩქარული ასინქრონული ელექტროძრავას სოფლის მეურნეობის მცირე მექანიზაციაში გამოყენების პერსპექტივა, რომელიც არის ინოვაციური, კერძოდ როტორი კონსოლურად განლაგებულია სტატორის მიმართ და როტორი წარმოადგენს მოქნილ ლილვს, რაც საშუალებას იძლევა მან განავითაროს დიდი სიჩქარეები და ვიბრაციების მიმართ იყოს უფრო მდგრადი. გააჩნია საკისრების ინოვაციური შეზეთვის სისტემა, რომელშიც როტორის შიგა სივრცე ამავდროულად ითავსებს თხევადი საზეთი ნივთიერების რეზერვუარის ფუნქციასაც. აღნიშნულ ელექტროძრავაში ნაჩვენებია ორი ერთფაზა გრაგნილით სამფაზა სიმეტრიული სისტემის მიღების ელექტრული შეერთების სქემა.