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V. Petrik, S. Trubachev, O. Alekseichuk

RELIABLE OF SLIDING CONTACTSOF POTENTCIOMETRIC SENSORS USED IN AVIATION

Introduction

In the early sixties in the classification of electrical contacts were appeared the low-current sliding contacts (LSC).This includes contacts in which the processes are occurring in the area of contact caused by friction and wear and predominating over all others, even the processes of current flow. Its including the season sensors, collectors, switches, and potentiometric transducers.

Of particular interest are the heat-resistant, precision potentiometers.

With a number of advantages such as a low weight, small size, simplicity of the scheme, a relatively small cost, the possibility of varying the output of functional dependence, they are widely used in aircraft, in control systems.

However, the presence of friction pairs leads to the most popular operational defects – small and unreliable contact life time. The using of a noble metals with a static-neutral to theenvironment, does not guarants the reliability of the LSC. Even in the party of potentiometers which are made by one technology of the precious metals have been surrendered to the contact near 10 – 20%. This is a confirmation that the reliability of the contact is depending from the friction and dynamic processes in the area of contact.

The problem's statement and solving

The complex physical chemical and mechanical processes take place in the surface layers, bordering with the contact surface, undergoing by friction these layers acquire a set of new properties different from properties of the source contact.

A necessary condition for solving the problem of improving the reliability of contact potentiometric sensors is the disclosure mechanism and the nature of these processes.

The working conditions of sensors are temporarily not in use and considered in studying of the reliability of the LSC. The work of the fixed contact in the closed state is no different from moving, so everything has been said about the fixed contact refers to rolling.

Feature of the sliding contact is that the sliding and the associated with it processes of elastic and plastic deformation causes changes in the real contact

area, which determines the conductivity of the surfaces and the contact resistance.

The chemical processes are activated in the surface layerand leading to theupdated by the surfaceand the real contact area, quality of the contact layer, they changing the mechanical and electrical properties of the contact surfaces after sliding friction. Changing the value of contact resistance is indicate the effect on the value of friction and wear.

Was proved [1, 2], that the reliability and durability of LSC is depends from the secondary structures which are arise on the contact surfaces during sliding.

The properties of the secondary structures are formed under the influence of dynamic factors arising after friction, impact brushes on the winding, type of machining contact surfaces and current. These factors are activate the interaction between the contact surfaces with the environment.

Thus, the secondary structures are define the contacting surfaces and wear, so to create a reliable and long potentiometric sensors is need to examine the processes which accompanying friction and wear of precious metals.

The main difficulty in resolving the issue of reliability potentiometric sensors is that the working environment of moisture and oxygen, the activation of the friction surfaces is accompanied by formation of the oxide.The oxide is a natural lubricant for the contact surfaces and hinders the process of conduction.

The opposite process of wear and contact-making isrequires mutually exclusive. The running and the further operation are the significant changes in surface condition in the process of friction.Source technological landscape is rapidly disappearing. The working relief of friction surfaces with different types of irregularities is develops.The quality of the surface is affects the conditions of the subsequent operation of the potentiometer.

Not all of the contact surface may be in the process of friction.On the surface, temporarily not in contact with the appearing oxide and sulfide films, as a result of the catalytic polymerization of the surrounding organic vapors, which are semiconductors with a large resistivity.

Oxygen environment promotes formation of adhesive films. Oxygen at the contact surface is deposited in the form of adsorbed molecules by binding to the surface by van der Waals forces.These molecules are dissociate with subsequent formation of atomic oxygen, which binds to the metal surface. At the contact surface is formed chemisorbed, covalently bound layer.It consists of molecules of oxygen and is physically associated with the metal surface, although poorly resists abrasion. Being destroyed by friction wear products formed and hindering the process of conduction.The adsorbed oxygen atoms, while at the contact surface, exchange electrons with the metal atoms and eventually form a negative layer. This layer prevents the evaporation of electrons and increases the work function.

The ability of the formation of oxide films indicates that the adsorbed oxygen atoms are able to extract the metal atoms and connect them to the lattice oxide. Thus, the oxygen atoms can extract electrons from the metal and form a negative

The process of rubbing activates the processes and a phenomena of the oxide with the formation of films is accelerating. [6].

Changes in surface quality and**,** especially, the state of thin surface layers during friction pair may be reversible, but it disappearing after removal of the load, and irreversible, residual.Therefore, the working condition of the surface is determined not only by residual characteristics after removing the load, but also the ongoing changes in the friction process.

The surface friction without lubrication, which corresponds to the case of potentiometric sensors, oxide films are formed more rapidly.When the relative motion of the contact surfaces are formed movable secondary structures are moving across the friction surface and fill all the surface roughness.

Thus, the contact surface of the LSC is the topography with irregularities, roughness, covered with a film of oxides. Such a surface, as part of the electrical contact has a certain resistance to the passage of current, which is called the contact resistance. Its value is largely determined by the height and thickness of the insulating micro-roughness of the oxide layer.

Consequently, the value of contact resistance is the main parameter which is characterizing the state of the surface conductivity of the mating surfaces, the real contact area.

For attaching the wires to the frame is held adhesives impregnation insulation composition. To implement the possibility of electrical contact with the brush, the contact surface of the wires is cleaned (polished). This machining treadmill isnecessary to remove the wire insulation and cleaning insulation of the space of an adhesive composition.

Insulating layer is usually cleaned by hand on lap, using different abrasives. This is accompanied by non-uniform sampling depth of the insulation along the length of the treadmill and lifting of the surface layer of wires.

When stripping the wire exposed to mechanical stress, which is accompanied by plastic deformation of the metal in the surface layer and changing its structure. At the same time to identify and somehow evaluate the role of uniform residual stresses, which was generated during processing, is quite difficult.

One thing is clear, machining the contact surface is leads to an increased activation of the surface, the flow of oxygen into the metal .In this case, the diffusion of oxygen into the metal is occurs in two stages: simultaneously with the deformation (treatment), aided by emerging at the time of deformation of the crystal lattice defects, and deformation after removal of the load [3].

It is known that the flow of oxygen into the metal is increases with increasing of velocity of polishing, the specific pressure and hardness of the abrasive used [4].

Thus, every mechanical action on the contact surface helps to change its properties, which directly affects the quality of contact and wear of friction surfaces.

According to [5], the sliding electrical contacts interaction of contacting surfaces is discrete and has the character of the instantaneous (10 – 5 sec.) strike (1100 kg/mm^2), which is localized at the microscopic area (1,3?10^{-6} cm^2). This energy is the cause of the electrical, thermal, acoustic and other physical phenomena which are accompanying the friction. As the friction surface may be acceptable and unacceptable [4].

Allowable state is corresponds to the oxidative deterioration which is based on a dynamic balance of processes of destruction and reconstruction of secondary structures formed during sliding.

Invalid state of the surface is occurs only when it is damaged. This only happens when the process of destruction of the secondary structures are prevails over the process of recovery.At the same time contacting surfaces are occurs without separating medium on a clean surface and are accompanied by a juvenile is increased wear and tear, the phenomena of grasping surfaces.

The presence of secondary protective structures on friction surfaces are natural and absolutely necessary condition of normal operation of the rubbing surfaces.

And so, the complex of physical and chemical processes is occurring in the area of contact and can be viewed as consisting of two parts:

- Process, which is providing machining the contact surface of the plastic deformation of the surface with the intense absorption of oxygen atoms (the environment) and then returns the friction and the formation of secondary structures;
- The complex processes that are occur only when the friction and wear of contact surfaces.

To eliminate the influence of technological processes for cleaning, the treadmill experiments were carried out by the winding of the potentiometer "bare" wire without insulation. Winding, which is carried on the frame, is covered with an insulating material with a partial polymerization. Wire pushes himself a groove in the insulating material and, thus, was mounted on the frame.Were followed by three operations: – partial, not the entire height of the

frame, impregnation is adhesives wire insulation material is complete polymerization of adhesive material – ultra-sonic cleaning in petrol.

We get the opportunity to explore complex physical and chemical processes only as a result of friction.

Experiments are confirmed that when the oxidative wear, no scratches on the level of the tunneling conductance of the film, the life of the potentiometers, with a reliable contact of increased several times.

Under these conditions, opening up the possibility of finding and establishing the conditions for a special kind of friction – selective transfer.

This type of friction will further extend the life of potentiometric sensors for reliable contact.

Conclusions

To increase the durability and reliability necessary to contact the LSC:

1. To achieve a minimum mechanical action on the treadmill in the preparation of the contact surface;
2. To operate only in LSC oxidative deterioration, which reach the dynamic equilibrium of destruction and reconstruction of secondary structures at the level of the tunneling conductance of the films.

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