

# WINDOW BLOCK FOR BUILDINGS WITH AUTOMATED CONTROL

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## Abstract

The author presents an innovative solution for control of automatic window opening. The author presents a design solution as well as an automation circuit solution.

**Key words:** *automation, window opening, ventilation, applied mechatronics*

## 1 INTRODUCTION

The control of the movable doors can be manual<sup>8 9</sup>, but more often electrical control is required, in particular for automatic control systems ("smart house"). As a converter of electrical energy into a mechanical one, electric motors<sup>10</sup> with a rotating rotor of various designs, for example gear units, are usually used. The general block diagram of the electrically controllable window blocks comprises an electric power converter (electric motor), a transmission link, a wire, position locks of the movable leaf, an electric control unit<sup>11 12</sup>. A common disadvantage of the known electrically-controlled window units is their low energy efficiency.

## 2 PROBLEM SOLVING

The proposed window block comprises a frame 1 and a swinging flap 2 with a handle 3. The rotation of the flap is realized by means of hinges 4,5, installed in the usual manner at the corners of the leaf. The main elements of the kinematics are structurally designed as a single block of kinematics 6, which occupies a part of the frame volume. On the front side of the kinematics block 6 there are control elements - button 7 "open", button 8 "close" and electrical connector 9 for connection to the automatic system management. Inside the upper part of the frame there is an electromagnet for fixing the closed position of the flap, comprising a magnetic core 10 in the form of a bracket and an electric winding 11. A standard limit switch 12 having one normally closed contact S1 and one normally open contact S2 is fixed between the ends of the magnetic core 10. The mating part of the closed position of the casement is represented by an insert 13 in the form of a plate made of magnetically hard material with longitudinal magnetization - the magnetic poles are located at the ends of the lining. The lining is fixed to the leaf and faces toward the magnetic circuit 10. In the closed position of the flap, the ends of the lining coincide with the ends of the magnetic

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<sup>8</sup> Opening and closing device for liftable sliding doors and windows. Patent RU 2350 731 of the IPC E05D 15/06. / CEO Song Won (KR). Opubl. 27.03.2009.

<sup>9</sup> A folding swing window with a locking device. Patent RU 2404 346 of the IPC E05D 15/28. CEO Sonya Vaughn (Kr), CHOI Dong Hwan (KR). Opubl. 20.11.2010.

<sup>10</sup> Drive device. Patent RU 2418 145 IPC E05F 15/12. / Sommer franc (DE), Rövekamp Bernd (DE). Opubl. 10/05/2011.

<sup>11</sup> Window or door with the device. Patent RU 2420 644 IPC E05F 15/14. / Zičenija - Aubi Kr (DE). Opubl. 06/20/2011.

<sup>12</sup> Window block. Patent RU 129 137 IPC E05F 15/16. / A.Y. Kadrova, L.Y. Katkova, L.N.Sharygin. Opubl. 06/20/2013.

circuit, the resulting magnetic flux will hold the flap. In this position, the limit switch is pressed, the contacts S1 and S2 are switched.

Let us turn to the constructive scheme of Fig. Coaxial with the axial line of the hinges 4,5 is located the drive shaft 14. The hinge 4, which is attached to the drive shaft, has a lead pin 15 on its fixed element 4a on the flap, which is included in the pellet of the end flange 16 of the drive shaft. Thus, a clutch is formed. If you turn the pivoting wing by some angle  $\varphi$  from the vertical (g is the direction of gravity), then a torque appears that opens the flap and is attached to the drive shaft

$$M_c = mgd(1 - \cos\varphi), \quad (1)$$

where  $m$  - is the mass of the leaf;

$g$  - is the acceleration due to gravity;

$d$  - is the distance from the axis of rotation of the leaf to its center of mass.

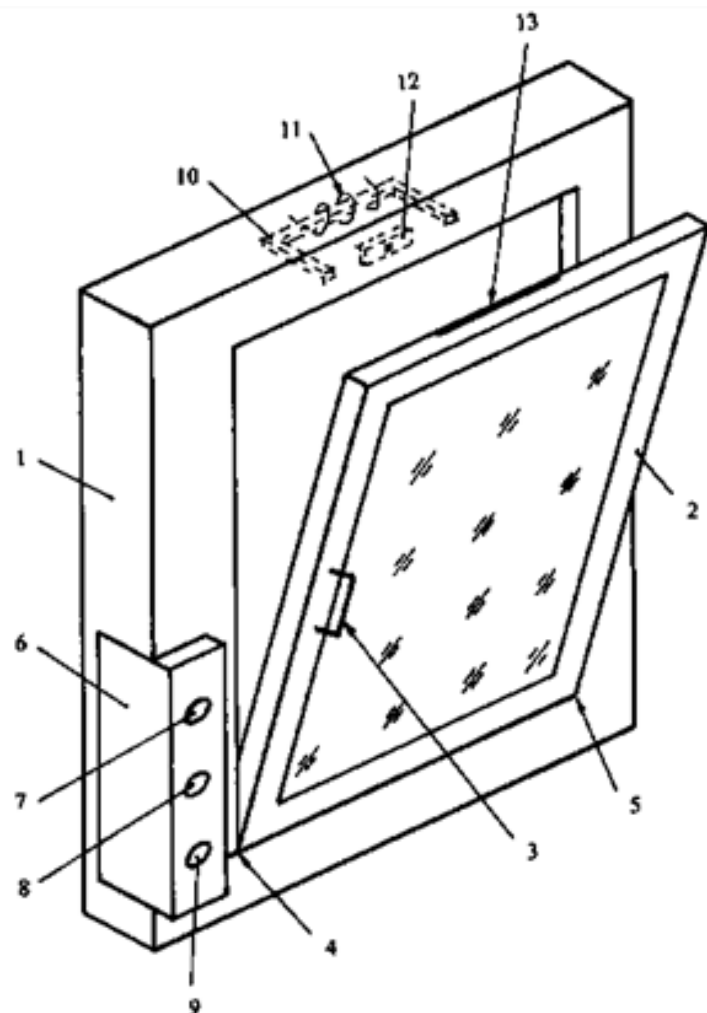


Fig.1. General view of the window

At the other end of the drive shaft, an energy storage device is mounted. It is represented in Fig. 2 by a spiral spring 17, a drum 18 with an outer toothed ring, a drum cover 19 and a corner of the angular position in the form of a spring-loaded arm 20 cooperating with the ring gear. The spring 17 is made of a flat elastic band and fixed

at one end on the inner surface of the drum, and the other on the drive shaft 14. The full moment characteristic of the spring is shown in Fig. In the initial position, the coils of the spring are pressed against the inner surface of the drum. As the drive shaft rotates (angle  $\alpha$ ), the coils of the spring are separated and the spring moment increases non-linearly to point A. Then all the turns are evenly distributed, the spring will work the entire length, we obtain a linear section AB. Then the spring begins to wind on the shaft and will work part of the length - the section of the aircraft. With the reverse rotation of the shaft (the lower branch of the characteristic), a mechanical hysteresis loop is formed. Thus, at the point C, further deformation of the spring is impossible. The energy accumulator at  $\alpha_{max}$  will act as a latching device for opening the sash. In this case the leaf is deflected from the vertical and the angle  $\varphi_{max}$ .

The energy storage device is configured in the following sequence. Dismount the swing flap to the design angle  $\varphi_{max}$ . By releasing the stopper 20, the drum 18 rotates until the spring 17 is tightened (point C of the characteristic). Stop the drum. When the leaf is turned to the closed position, the angle of twist of the spring 17 will correspond to the value of  $\alpha_H$  (point D of the characteristic).

$$\alpha_{max} - \alpha_H = \varphi_{max}. \quad (2)$$

During operation, the spring 17 will operate on a private hysteresis loop from point D to point C. Accordingly, the amount of energy stored in the drive will be:

for open sash position

$$E = \int_0^{\alpha_{max}} M_{\Pi} d\alpha, \quad (3)$$

for the closed position of the sash

$$E = \int_0^{\alpha_H} M_{\Pi} d\alpha, \quad (4)$$

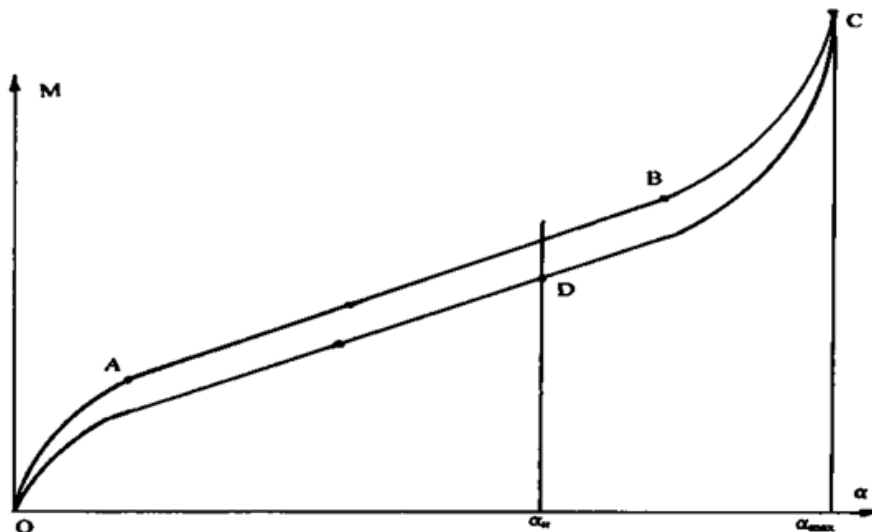


Fig.5. Momentary characteristic of the energy store

The electric motor that converts electric energy into mechanical one is the electromagnet of the drive comprising a housing 21, a solenoidal coil 22 wound on a frame 23 which is connected to the housing 21 by screws 24. With a small gap, a rod anchor 25 is included in the opening of the carcass. To ensure the initial position of the armature, a corrugated membrane 26 is used which is wrapped around the outer

contour into the ring 27, the latter by screws 28 attached to the body 23. Attachment of the anchor in the central hole of the membrane is also a typical rolling. A coaxial opening 29 is formed under the armature in the housing 21. A movable shutter 30 is provided that can turn around the pin 31 and be fixed by the screw 32.

When the anchor moves upwards (orientation of the drawing), air pressure (piston effect) is created under it, proportional to the relative change in volume. When air flows through the hole 29, an armature resistance force arises

$$F_b = h\dot{x}, \quad (5)$$

where  $\dot{x}$  - is the speed of the anchor motion;

$$h = \rho(S_{25} - S_{29}) \quad (6)$$

$\rho$  - is the density of air;

$S_{29}$  - is the cross-section of the opening 29;

$S_{25}$  - section of the anchor 25.

Thus, the higher the anchor rises in accordance with Fig. 2 (the closer the leaf to the closed position), the greater the force (5) of viscous friction. By adjusting the size of the cross-section  $S$  of the opening 29, it is possible to reduce the speed at which the pivoting flap is inserted into the "closed".

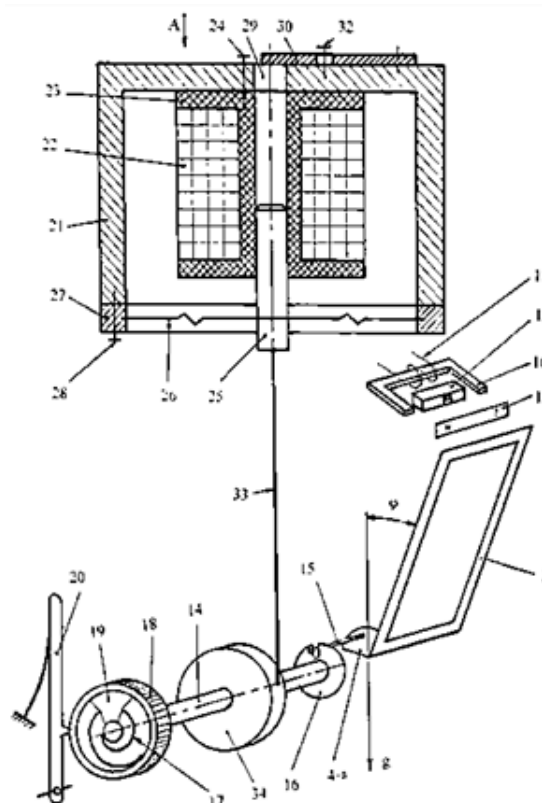


Fig.2. Structural scheme

The movement of the armature 25 to the drive shaft 14 is effected by means of a flexible cable 33. The flexible cable is fixed at one end to the armature, the other to the cylindrical surface of the pulley 34 connected to the drive shaft 14.

Window box operation. We take as initial the closed position of the swing flap 2. In this case, the lining plate 13 is pressed against the ends of the fixing magnetic circuit 10, the magnetic flux keeps the flap, the limit switch throws its contacts: S1 is open, S2 is closed. By pressing the "open" button 7, the winding circuit 14 of the locking electromagnet closes. The ends of the magnetic core 10 are polarized in opposition to the poles of the patch. There is a mechanical impulse in the direction of opening the leaf. The leaf will begin open and the driving torque (1) will appear. During the opening, the drive shaft 14 rotates and the washing spring 17 turns. At the end of the movement, the moment of the spring rapidly increases, and the opening speed accordingly decreases. Thus, the leaf approaches the position "open" at a low speed, without impact. The work of gravity has been transformed into the potential energy (3) of the energy store. After the start of the movement, there is a transfer of the contacts of the limit switch 12.

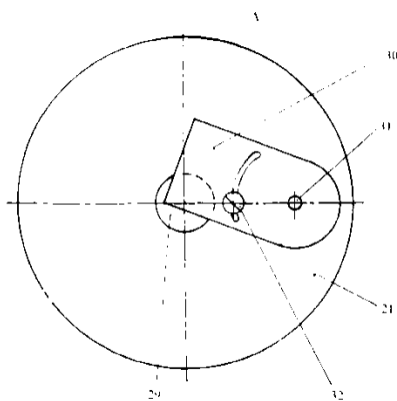


Fig.3. View A of fig. 2

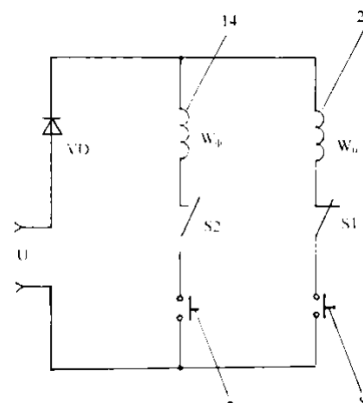


Fig.4. Electrical circuit

Pressing the "close" button 8 closes the coil circuit 22 of the drive electromagnet. Anchor 25 through flexible cable 33 over pulley 34 rotates drive shaft 14, respectively, through the drive clutch, motion is transferred to the valve 2. During closing, energy is consumed (3) stored in the energy storage device, which reduces the current consumed by the drive electromagnet from power supply U.

Thus, in the proposed window block in the energy store, energy is stored from the work of gravity, then this energy returns to the system on another cycle of motion. The energy consumption from the source is practically equal to the consumption of frictional forces in kinematic pairs. There is a simple manual control.

## References

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