Józef Hansel
Marian Wójcik
University of Mining and Metallurgy
in Kraków
Poland

FRICTION EMERGENCY ARRESTING SYSTEM FOR ELEVATORS AND HOISTS

1. Introduction

For more than ten years the causes and the consequences of the disastrous break downs in Polish mine shafts have been analysed. The most frequent reason for those break downs have been overwinds. This has given a stimulus for some works at the University of Mining and Metallurgy in Kraków which eventually led to the development of a friction emergency arresting system. The works leading to that development included all the steps of a research process namely theoretical analysis, laboratory tests, development of the structure and tests in situ, i.e. at a hoist in operation. The authors believe, that the test results are very interesting and could also be of interest for many designers and users of elevators.

2. Principle of operation and the structure of the friction emergency arresting system for elevators

The friction emergency arresting device can develop breaking forces in a range from a few hundred kN to a few thousand kN. Thus, the device can be used for braking the conveyances or cars with the payloads from a few Mg to 50 Mg running with the speed up to 20 m/sec. This system is capable to operate for more overwinds and can be set up for further operation in a very short time. The structure of the arrestor, due to its rather small dimensions can readily be installed in the existing structure of elevators. The device can be used independently of the guiding system of the cars and of the safety gear used with lifts. By an appropriate choice of the design parameters of the arrestor, the brakink force acting

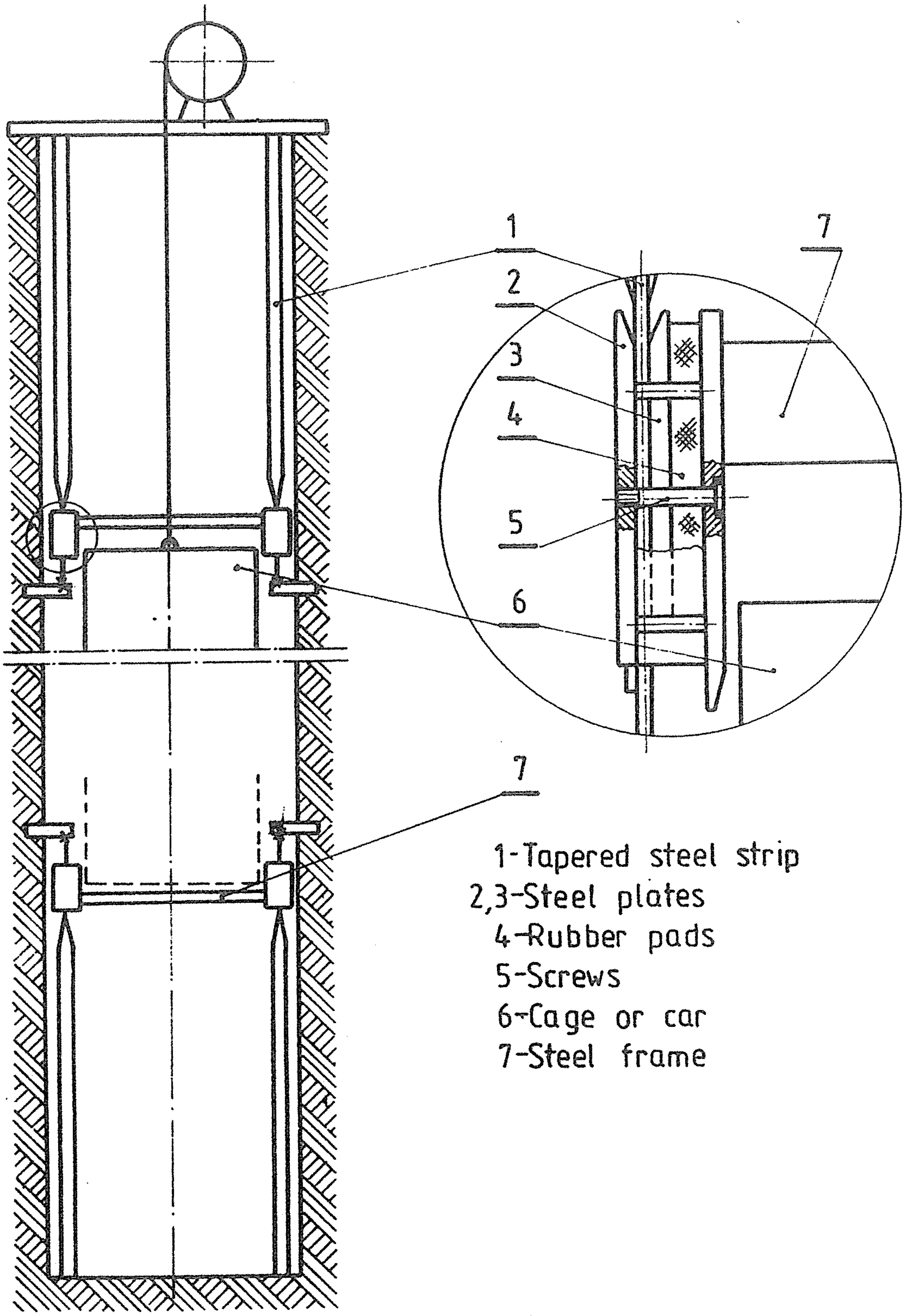

Fig.1. Friction arresting device.

along the overrun travel can freely be set (its value and run). Thanks to that feature the car can be stopped along the existing overrun travel with a pre-determined deceleration. The friction arrestor can be coupled with a car safety catch device which would ensure full safety even in an event of breaking the winding ropes. In this device the arresting force of the car is the friction force developed between the steel plates pressed together by elastic forces of rubber elements. The friction arrestor consists of an even number of braking sets - fig.1. placed symmetrically to the car axis. Each arresting set consists of a stationary, tapered steel strip - 1, mounted along the overwind path. This strip is pushed into a casing containing elastic elements - 4. The elastic elements - 4, pressed by steel plates - 2 and 3 act on the tapered strips - 1 and produce friction force braking the car. A running car - 6, if passing the end of the travel i.e. beyond the highest or the lowest stop, hits the casings of the friction units and pushes them along the strips - 1, raising friction forces which brake the car. The casings can be coupled with each other by a frame. After the arresting has been completed the car can be pulled out of that zone immediately. The shifting of the casings to their initial (pre-overwind) position is obtained by loosening the friction surfaces which are held in an adequate position by means of a simple screw gear - 5.
One casing has usually more friction surfaces. The elastic segments - 4 can be made of e.g. rubber of an appropriate hardness. The friction arresting device, if adequately protected against corrosion and needs no maintenance during operation of the elevator. The material used for its construction is steel of average strength properties.

3. Laboratory and operational tests of the friction arrestor

At the University of Mining and Metallurgy in Kraków two kinds of tests of the friction arrestor were made. The dynamic tests were made in an experimental shaft, where the arrestor with the 1,5 m long tapered strips was mounted. The 3800 kG cage was moving at 6 m/s and 8 m/s. During the tests the deceleration of the cage was measured and accordingly the graphs of braking forces were drawn. At the laboratory, tests were made with an arrestor model. Experimenting with that model it was possible to vary such para-

meters like width of the friction surfaces, deflection of the rubber segments, hardness of rubber. It all aimed to study the relation between the friction force or the lateral forces raised in the system and the above mantioned parameters.
from the test results the area of the friction surfaces was calculated.
For the calculation the pressure of 4 to 5 MN/m^2 for rubber of 60^o to 65^o Shore hardness and 40% deflection were assumed.
The measurements of the lateral forces i.e. the reaction of the rubber elements, decided about the strength properties of the casing.
The above tests have proved the assumptions made at the designing stage of the arrestor. The tests greatly contributed to numerous designs of the friction emergency arrestor.
To verify the theoretical assumptions and the laboratory tests by which the calculation methods of the arrestor were developed the tests of the arrestor in situ were made.
An empty conveyance was accelerated to a certain speed and brought to a halt by the friction arrestor installed in the head frame.
In order to analyse the emergency arresting process along the overwind travel some measuring systems were developed which recorded the following quantities:

- loads in ropes
- deceleration of conveyances (cars)
- effective braking forces.

In figs.2 and 3 some graphs of those quantities are shown.

4. Conslusions

1. The friction emergency arrestor has a simple construction, can be used repeatedly for more overwinds and it can be suited to the value and the run of the braking force by a proper choice of its design parameters.
2. The tests of the arresting device, made in operation, could verify the theoretical assumptions and the laboratory tests. The test results have proved the assumptions for the design of the friction arrestor regarding those braking parameters like: braking force, deceleration of the car and the dynamic load of the rope.

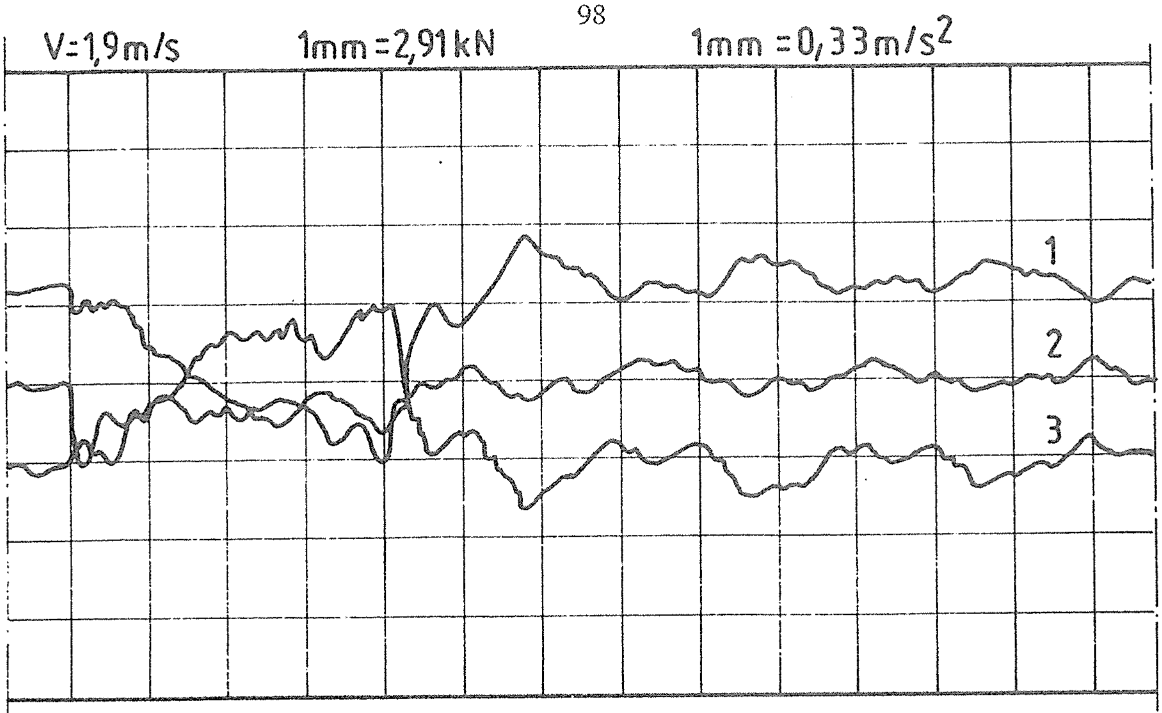

Fig. 2. 1-Load in rope 1, 2-Deceleration of conveyance, 3-Load in rope 2.

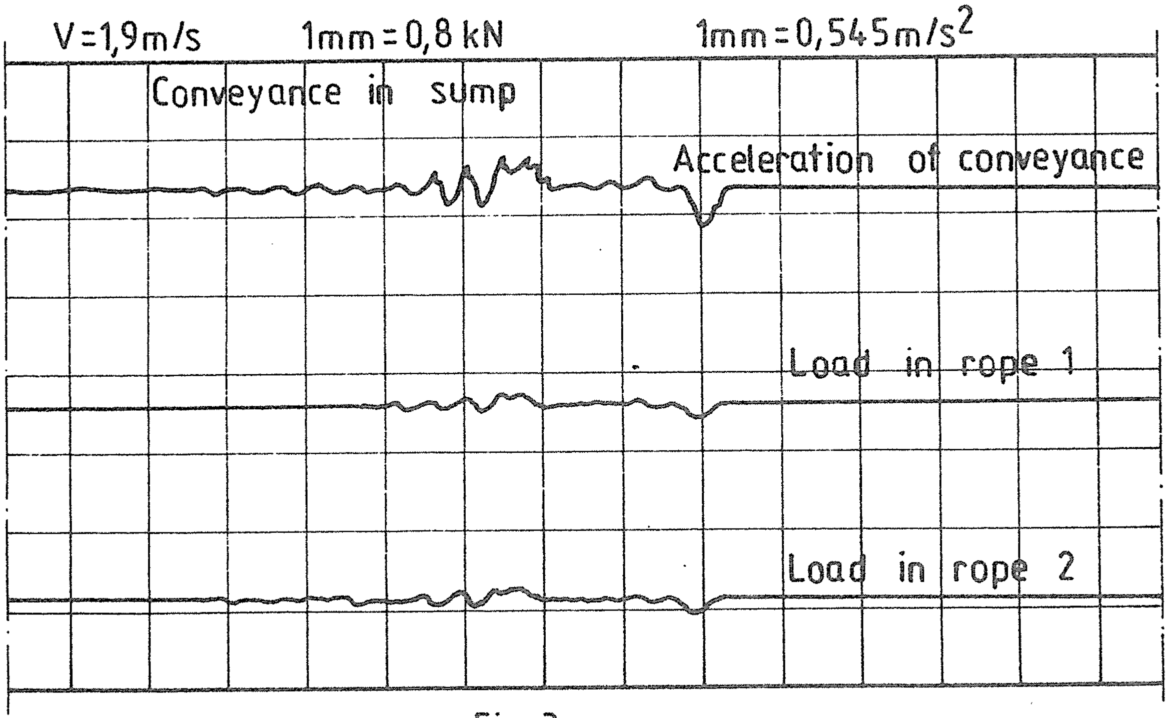

Fig. 3.

3. The use of the friction emergency arrestor in elevators can raise reliability and safety of operation.

References

1. J.Hansel, M.Wójcik: A Conveyance Friction Overwind Arresting System. Kwartalnik AGH, Mechanika, Tom 4, Z.2. Kraków 1985.
2. Urządzenie do awaryjnego hamowania naczyń wydobywczych w szybach na wolnych drogach przejazdu. Patent PRL nr 139894. (European Patent Application 84 109 827.0.).
3. J.Hansel, M.Wójcik: Reibungs-Bremssystem zum Stillsetzen von Förderkörben beim Übertreiben. Bergbau 10/87.