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Increase of Efficiency for a Vertical Scroll Water Pump using Oldham Ring with Ball bearings.

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Abstract

In the past, the scroll water pump used Oldham ring without ball bearings which had the huge friction. Therefore, this scroll water pump consumes a high number of power for driven and also has low efficiency. This research presents new technique to reduce friction of a vertical scroll water pump by using Oldham ring with ball bearings. The comparison of efficiency of a vertical scroll water pump used Oldham ring with ball bearings and Oldham ring without ball bearing is measured by experiment.

The result shows that the efficiency of a vertical scroll water pump used Oldham ring with ball bearings have more efficiency than a vertical scroll water pump used Oldham ring without ball bearing. The increased efficiency is about 10% at the discharge pressure is 2.5 m. and about 20% at the discharge pressure is 5.0 m. comparing with a vertical scroll water pump used Oldham ring without ball bearings.

Keywords: Vertical Scroll water pump, Water pump efficiency, Scroll water pump.

INTRODUCTION

The scroll pump is classified as the displacement pump. At first, the scroll pump has been researched and designed for cooling the reactor of nuclear power plant. At that time, the researcher used the principal of the scroll compressor for designing the scroll water pump. The result showed that the scroll water pump can be able to use with the incompressible fluid [1]. In 2010, the scroll pump was developed and researched for pumping the water. The result showed that the scroll water pump had low efficiency and high shaking force if it was designed as the horizontal scroll water pump [2]. The shaking force of the scroll water pump can be able to reduce by the changing the arrangement from the horizontal to a vertical. This new model of scroll water pump is called a Vertical Scroll water pump but a vertical scroll water pump still has low efficiency [4]. In this research, the new technique is used to modify a vertical scroll water pump in order to increase the efficiency.

The efficiency of a vertical scroll water pump depends on the friction of parts of a vertical scroll water pump. From the experiment in the past, the friction can be visualized physical from the damage of the component parts of the scroll water pump. The significant damages of the component parts of the scroll water pump are at the Oldham ring and Orbiting scroll wrap. It is due to the contact surface between Oldham ring and Orbiting scroll wrap that is the sliding motion as shown in Fig. 1 (a), (b) [3].

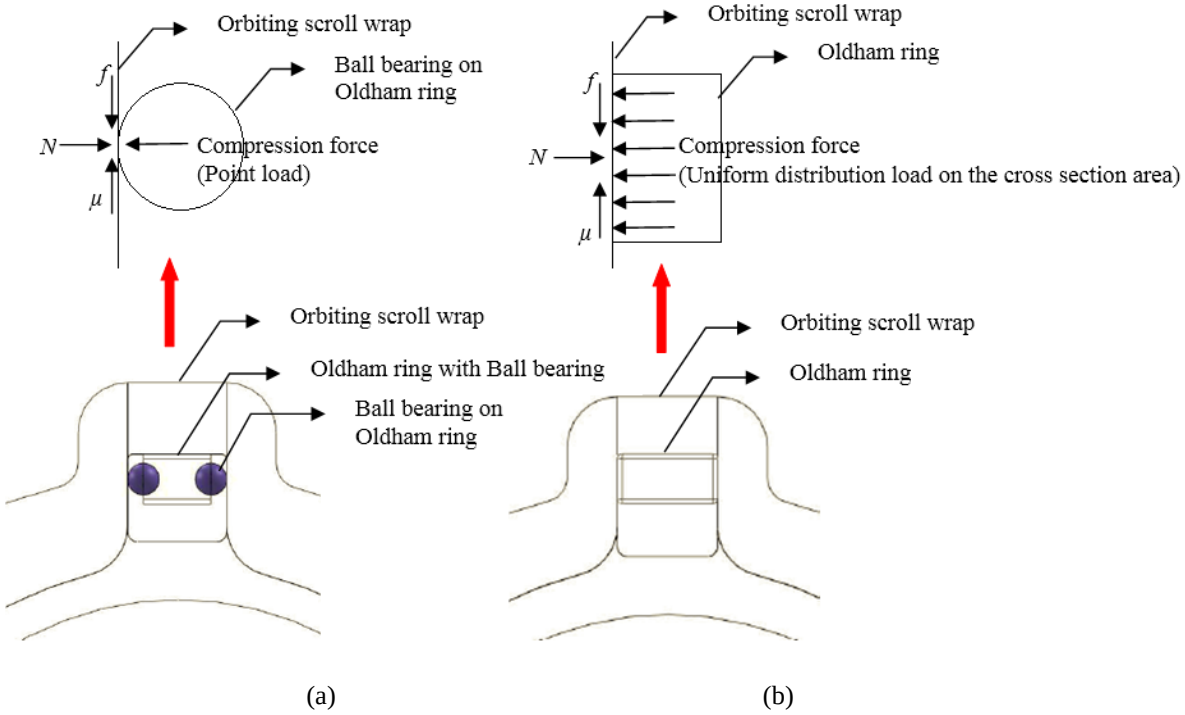
(a) (b)

Figure 1: Damage of Oldham ring and the orbiting scroll wrap [3].

This research shows the new technique to reduce friction between Oldham ring and Orbiting scroll wrap by using the Oldham ring with the ball bearings that mounted at between the contact surface of the Oldham ring and the Orbiting scroll wrap.

DESIGN OLDHAM RING WITH BALL BEARING FOR A VERTICAL SCROLL WATER PUMP

Oldham Ring and Orbiting scroll wrap are sliding moving and has the compression force between Oldham Ring and Orbiting scroll wrap as shown in Fig 2 (a), (b)



(a) (b)

Figure 2: Compression force between Oldham Ring and Orbiting scroll wrap.

During to compression force, friction will create and occur at the contact surface between Oldham ring and Orbiting scroll wrap. The relationship between the compression force and the friction as shown equation 1, 2.

$$f = \mu N \quad (1)$$

$$N = PA \quad (2)$$

From equation 1, 2 shows that the friction caused by Oldham ring without ball bearing depends on the contact surface area between Oldham ring and Orbiting scroll wrap. In order to reduce the friction, the ball bearings are used. The ball bearings are mounted at the end of Oldham ring. From this principle, Oldham ring with ball bearing can be designed as shown in Fig.3.

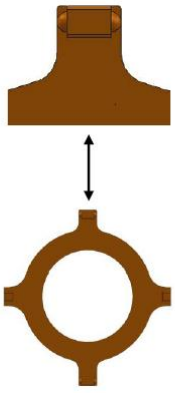


Figure 3: Oldham ring with Ball bearing

COMPARING OF THE TORQUE OF A VERTICAL SCROLL WATER PUMP USED THE OLDHAM RING BEARING AND THE OLDHAM RING WITHOUT A BEARING WITH MOTION SIMULATION IN SOLIDWORK PROGRAM.

Before Oldham ring with ball bearing was actually created, the torque of a vertical scroll water pump used Oldham ring with ball bearing and without ball bearing were simulated by the motion simulation in the Solidwork program. It is preliminarily evaluated to ensure that Oldham ring with ball bearing has less torque than Oldham ring without ball bearing.

To calculate of the torque of a vertical scroll water pump, the material of Oldham ring and Orbiting scroll wrap are Nitriding alloy (41CrMo4) and the material of ball bearing are stainless steel (AISI316L). The motion simulation of the rotation of a vertical scroll water pump is shown in Fig.4.

Comparison of torque using motion simulation in Solidwork program at 600 rpm to at 1500 rpm, as shown in Fig.5 shows that the values of a vertical scroll water pump used Oldham ring without ball bearing need more torque than a vertical scroll water pump used Oldham ring with ball bearing at all speed ranges. When the rotational speed is high, the torque of a vertical scroll water pump used Oldham ring without ball bearing is greater than a vertical scroll water pump used Oldham ring with ball bearing.

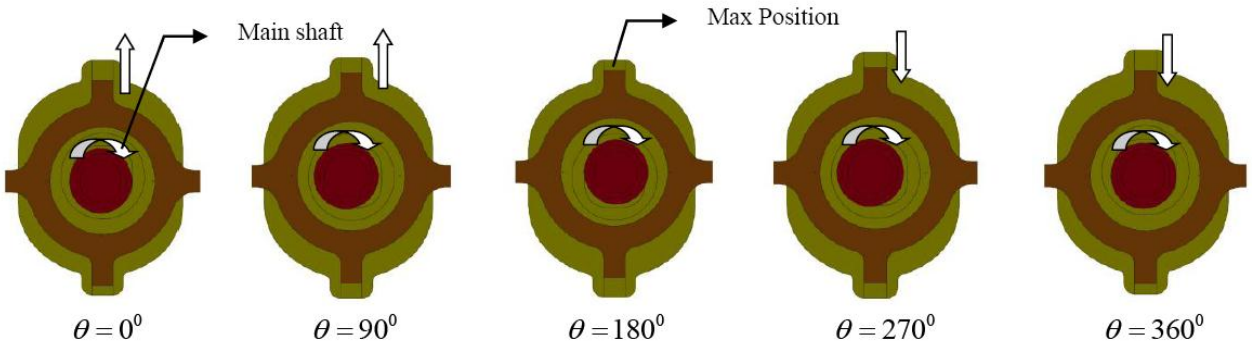


Figure 4: The motion simulation of the rotation of a vertical scroll water pump

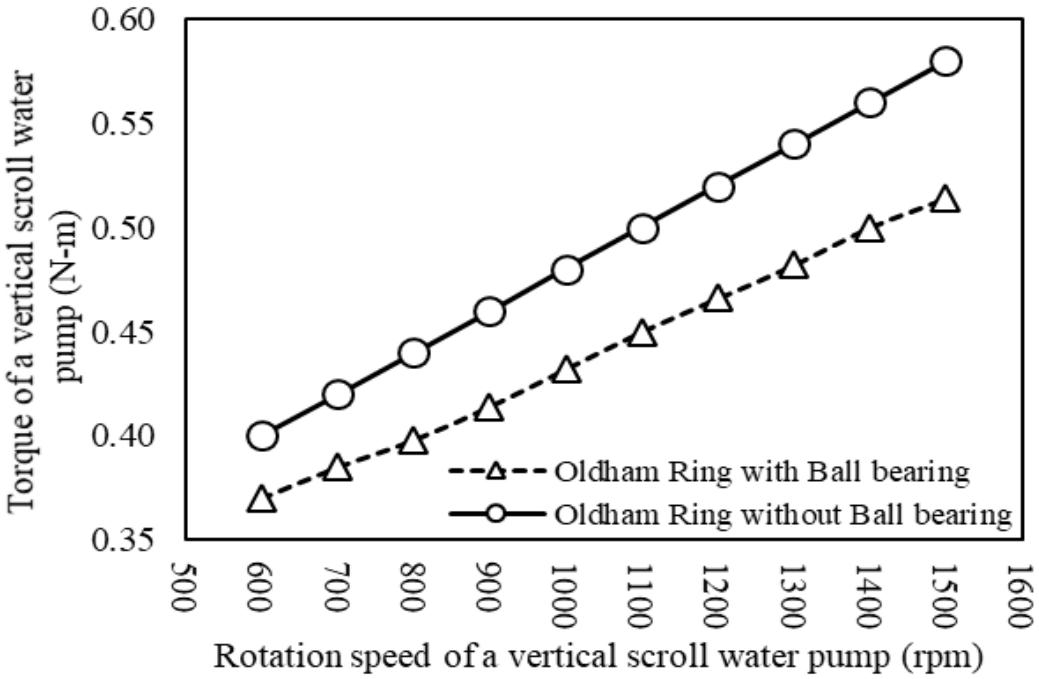
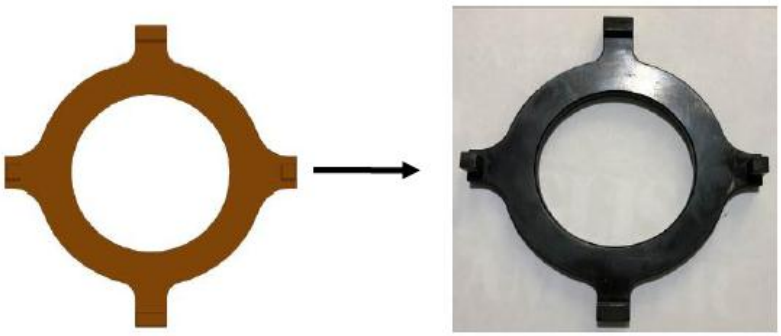


Figure 5: Comparison of the torque of a vertical scroll water pump used the Oldham ring

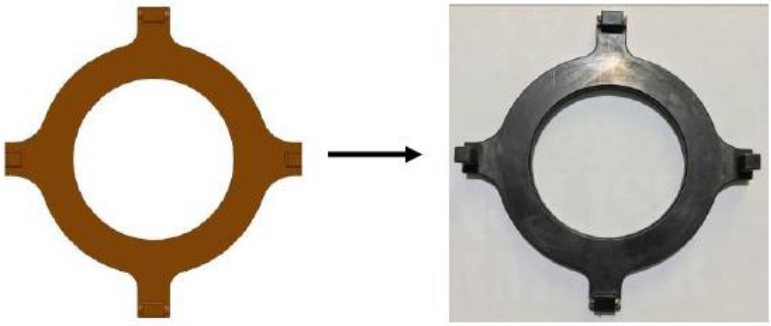
With bearings and the Oldham Ring without bearings by motion simulation in Solidwork

Program at 600 rpm to 1500 rpm.

From the result of the comparison of the torque above, the real Oldham ring without ball bearing and Oldham ring with ball bearing are created as shown Fig. 6 (a), (b) in order to find out real pump efficiency by experiment.



(a) Oldham ring without Ball bearing

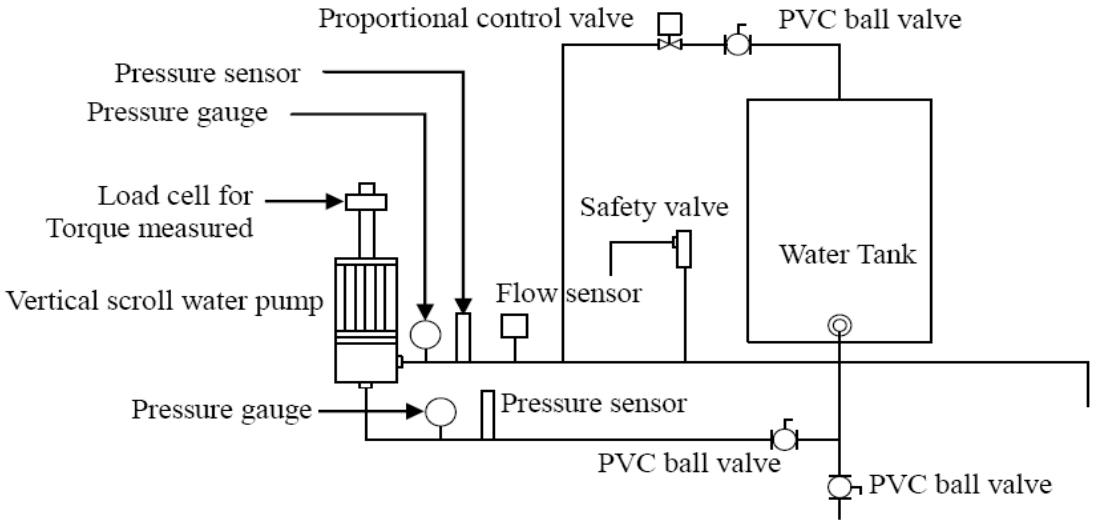


(b) Oldham ring with Ball bearing

Figure 6: Oldham ring of a vertical scroll water pump actually created for experiment

EXPERIMENTAL STUDY

Because a vertical scroll water pump is a new type of water pump, there is not the standard for testing of the efficiency. Therefore, the British Standard (BS EN 143343) which is testing of the efficiency of Rotary Positive displacement pump is used for testing the efficiency of a vertical scroll water pump. The measuring instrument for the experiment can be installed as shown Fig.7 (a), (b) [5].



(a)

(b)

Figure 7: The experimental facility of a vertical scroll water pump efficiency testing

The values of the water flow rate, the pressure head and the torque at a rotational speed of 600 rpm to 1500 rpm of a vertical scroll water pump used Oldham ring with ball bearing and without ball bearing are collected experimentally. The pump efficiency is calculated in order to comparing between a vertical scroll water pump used Oldham ring with ball bearings and without ball bearing. The proportional control valve is used to control the discharge pressure of a vertical scroll water pump and the inverter device is used to control the rotation speed of a vertical scroll water pump. In the experiment, the efficiency is controlled by the discharge pressure head of a vertical scroll water pump at 2.5, 4 and 5 m. and the experimental room temperature is controlled at 25°C. The efficiency of a vertical scroll water pump can calculate by.

$$\eta = \frac{Power_{output}}{Power_{input}} \tag{3}$$

$$Power_{output} = \rho g Q H_P \tag{4}$$

$$Power_{input} = 2\pi n \frac{T}{60} \tag{5}$$

RESULTS AND DISCUSSIONS

At the discharge pressures head are 2.5, 4.0 and 5.0 m., the results of the comparison of the pump efficient and rotational speed between 600 rpm to 1500 rpm of a vertical scroll water pump used Oldham ring with ball bearing and without ball bearing as shown in Fig.8, 9, 10.

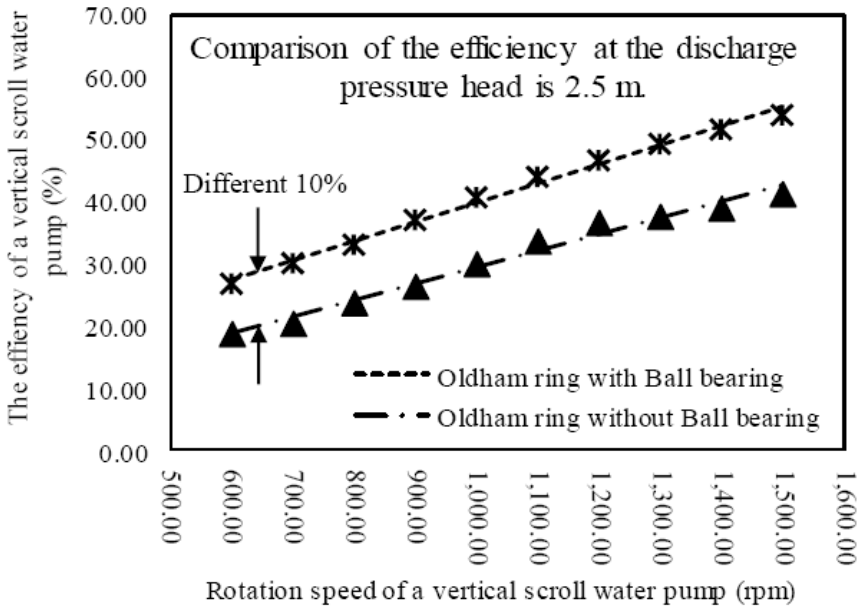


Figure 8: Comparison of the efficiency of a vertical scroll water pump at the discharge pressure head is 2.5 m.

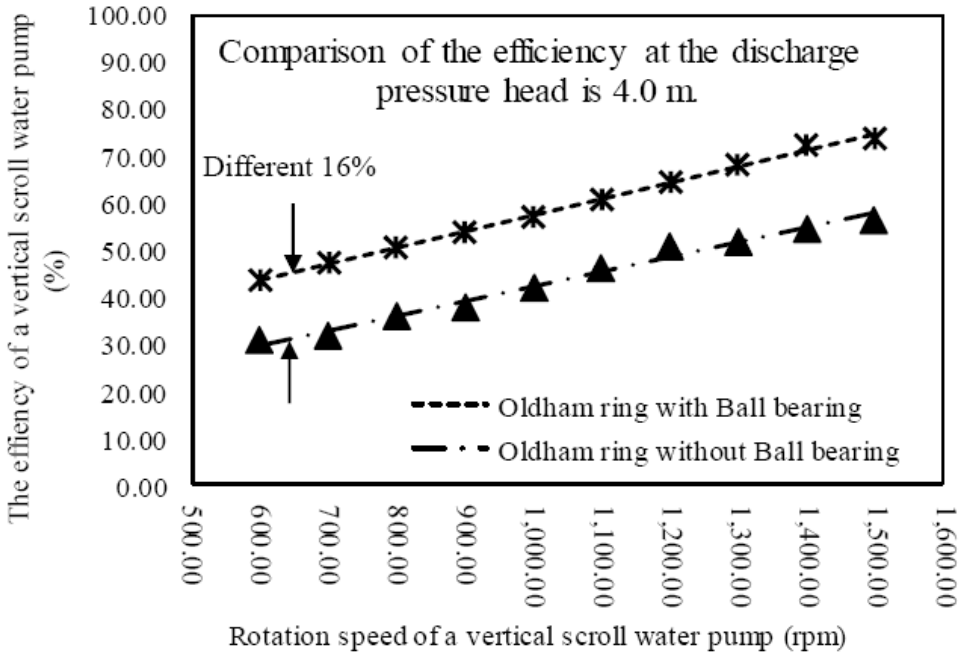


Figure 9: Comparison of the efficiency of a vertical scroll water pump at the discharge pressure head is 4.0 m.

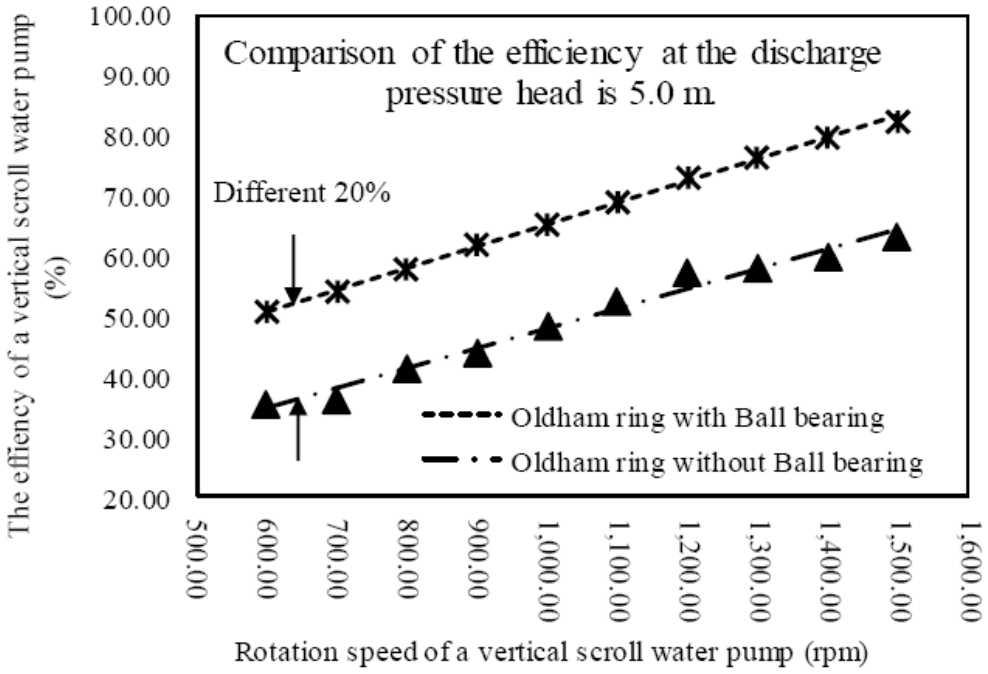


Figure 10: Comparison of the efficiency of a vertical scroll water pump at the discharge pressure head is 5.0 m.

The results of a vertical scroll water pump used Oldham ring with ball bearings have more efficiency than a vertical scroll water pump used Oldham ring without ball bearing about 10% at the discharge pressure head is 2.5 m, 16% at the discharge pressure head is 4 m and 20% at the discharge pressure head is 5 m. As the result of the friction between Oldham ring and Orbiting scroll wrap, a vertical scroll water pump used Oldham ring with ball bearing have less the friction than a vertical scroll water pump used Oldham ring without ball bearing.

CONCLUSIONS

The new technique to reduce the friction between Oldham ring and Orbiting scroll wrap is installation of the ball bearing into the Oldham ring. The ball bearings is mounted on Oldham ring can reduce the friction between Oldham ring and Orbiting scroll wrap which is the new principle of the efficiency increase of a vertical scroll water pump.

NOMENCLATURE

f Friction on the surface [N]
μ Kinetic frictional coefficient
N Normal force [N]
P Compression force [N/m^2]
A Cross-Section Area [m^2]
H_P The discharge pressure head [m]
g Gravitational acceleration [m/s^2]
n Rotation speed [rpm]
T Torque [$N.m$]
η Efficiency of a vertical scroll water pump[$\%$]
ρ Water Density [kg/m^3]
Q Water flow rate [m^3/s]
θ Clank angle of the main shaft [$Degree$]

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