11 *PMI* Ballscrew With Hollow Cooling System

PMI's design of hollow cooling system is especially good for high speed Ballscrews. It shall well dissipate heat generated by friction between balls and grooves during Ballscrew running, and then to minimize thermal deformation as to ensure positioning accuracy.

11.1 Introduction to Hollow Cooling Screw Shaft

The hollow cooling system is designed by *PMI* (Fig.11.1) It uses a coolant pipe through the hollow hole of Ballscrew. The hollow hole is through all of the Ballscrew, and one end is clogged with the oil seal by *PMI* patent. The coolant is pumped into coolant pipe and flow to the end of coolant pipe. Coolant then flow reversely along the hollow hole back into the coolant collector. It can cool down the Ballscrew. The coolant is then sucked back to the cooling unit to drop coolant temperature and pumped again to the coolant pipe to complete circulation.

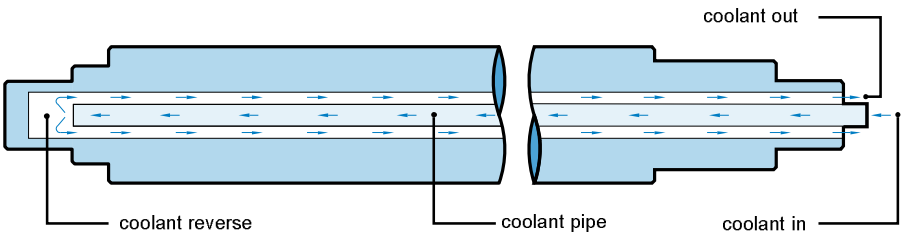


Fig.11.1 Hollow cooling diagram

11.2 Patent of Hollow Cooling Screw Shaft

11.2.1 Hollow cooling system

Features:

(i) Well and effectively control Ballscrew thermal expansion.

(ii) Simple design and structure to save cost.

Fig.11.2 Hollow cooling system

11.2.2 Cooling entrance

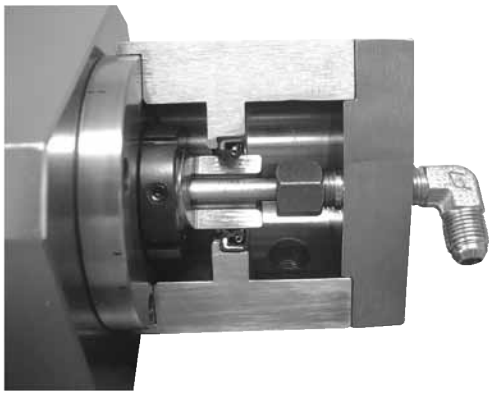


Fig.11.3 Cooling entrance

11.2.3 End sealing

Features:Easy for installing, disassembling and maintenance.

11.2.4 Coolant pipe support installation

Supported the coolant pipe. Let it don't touch Ballscrew.

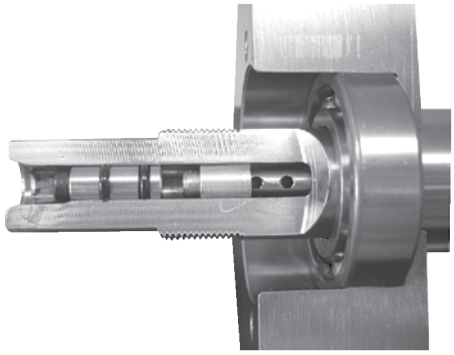


Fig 11.4 End sealing structure

11.2.5 Thermal control system test equipment

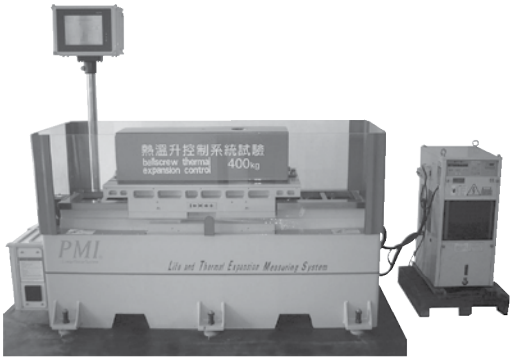


Fig.11.5 Thermal control system test equipment

11.3 Thermal control experiment

11.3.1 Test condition

Screw nominal O.D. :	Ø40 *mm*
Lead:	10 *mm*
Rotation speed:	1000 *rpm*
Speed:	10 *m/min*
Load:	400 *kgf*
Slideways:	Hardened ways

11.3.2 The results of experiment

As per the results by experiment, ***PMI***'s design of hollow cooling system proves an effective way for controlling the thermal expansion on the Ballscrew. Hence it is a very helpful design to high precision machine tools.

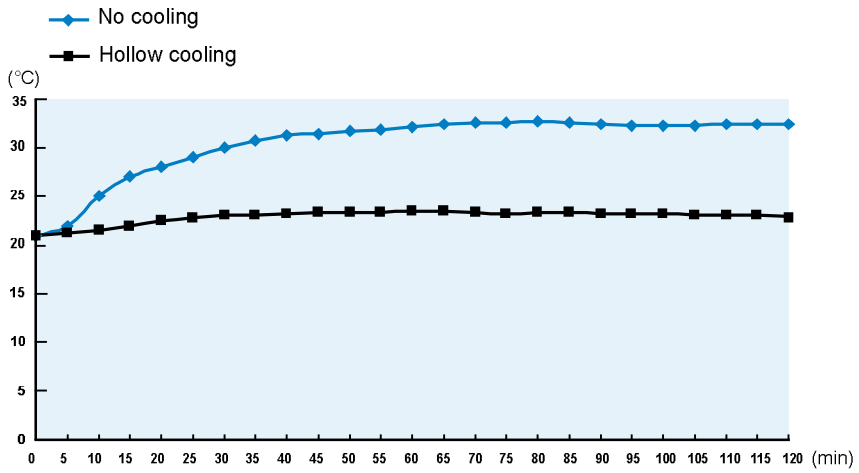


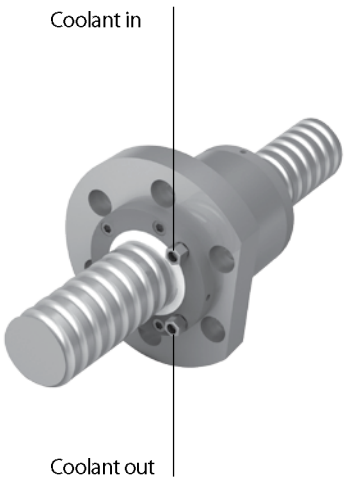
Fig.11.6 The results of experiment

11.4 Nut Cooling

（1）The principle of design

Cool liquid is able to control the heat generation and thermal expansion by creating circulating cooling channel in the nut.

Single Nut Cooling



Double Nut Cooling

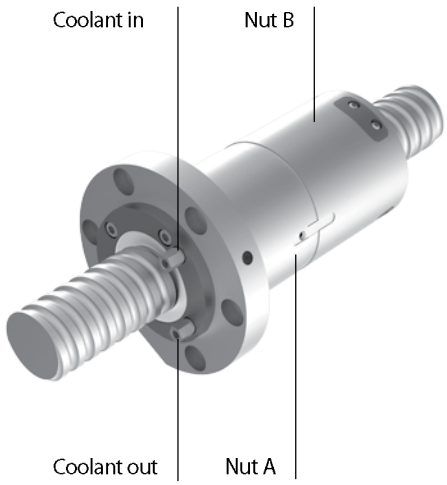


Fig.11.7 Single nut cooling and Double nut cooling diagram

（2）Characteristics:

1. **Increase the positioning accuracy and the stability**
   Control the temperature rise of the ballscrew and reduced the heat deformation. The high velocity and accuracy of the machine will be reached.
2. **Decrease the warm-up time of machine**
   The stable temperature of the ballscrew be quickly, so the warm-up time of the machine could be shortened.
3. **Maintain capability of the lubrication oil**
   When the temperature of the ballscrew is stabilized, it is able to avoid the deterioration of the lubrication caused by high temperature.

Table11.1 Testing Parameters

Model no.	R45-12T5-FDDC-1274-1569-0.018
Operation travel(mm)	690
Feed speed(m/min)	7.2
Mean rotation (rpm)	523.3
Acceleration (m/s2)	5
Preload (kgf)	392
Table weight (kgf)	200
Mounting method	fixed-supported
Coolant	Mobil Velocite oil no.3 (ISO VG 2)
Coolant flow (L/min)	3.1
Coolant Temperature (℃)	Room temperature ±0.5

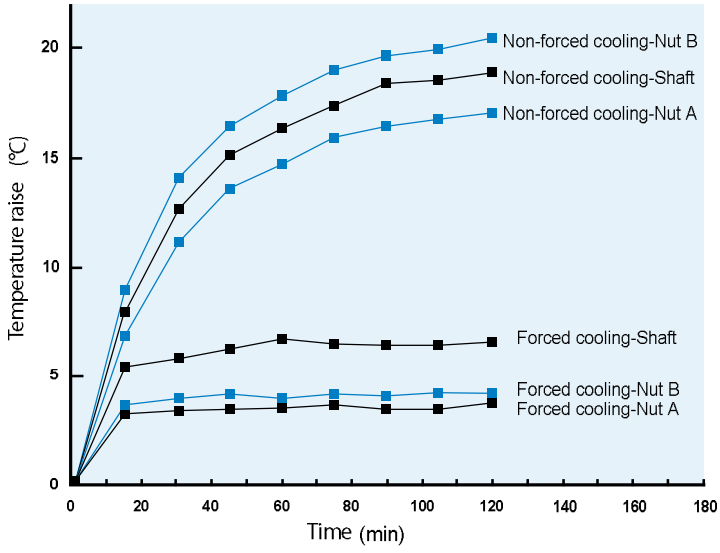


Fig.11.8 The results of experiment