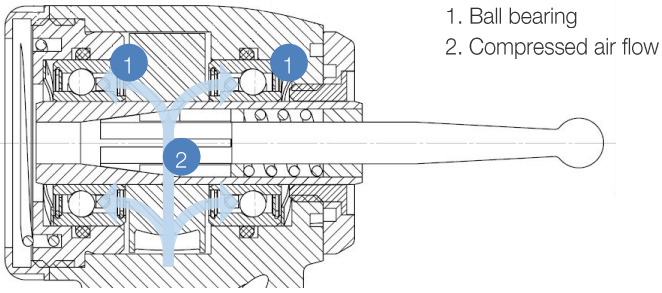
High-Precision Ball Bearings

BRAKING DEVICE IN GRW DENTAL BALL BEARINGS

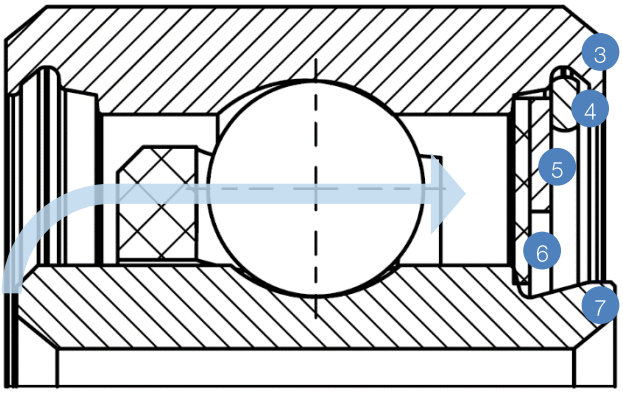
Pneumatically driven hand pieces are state of the art in the dental and medical industry. In this case, an applied air pressure drives a rotor mounted on two ball bearings (1) up to speeds of 500,000 rpm. The compressed air (2) flowing through the rotor is discharged via an exhaust duct in the hand piece and through the two ball bearings. The main criterion here is that the ball bearings run as evenly as possible with as little friction as possible.



1. Ball bearing
2. Compressed air flow

Figure 1: Head of a pneumatically driven dental hand piece

When the compressed air is switched off, a problem arises for which GRW offers a solution that has already proven itself many times in the field. The overrun of the rotor in the absence of compressed air flowing through it generates a vacuum in the hand piece head, which results in the so-called back suction effect. This causes the vacuum in the hand piece to draw air from the outside into the hand piece head, which can also cause dirt to enter the interior through the ball bearings. This must be avoided at all costs to ensure the highest standards of hygiene and a long service life for the ball bearings. In order to reduce or completely avoid this suck-back effect, it is necessary to limit the overrun of the rotor, by reducing the stopping time to a minimum and so stopping the ball bearings as quickly as possible.



3. Outer ring
4. Snap ring
5. Z-disk (metal, optional)
6. Polymer disk
7. Inner ring

Figure 2: Detail drawing, GRW solution for deceleration of an air turbine.

GRW uses a simple but effective solution for this, which significantly shortens the run-down time of the hand piece and prevents the suck-back effect. A sealing system as shown in Figure 2, consisting of a simple cylindrical washer (6), snap ring (4) and a metal washer (5), ensures reliable braking of the inner ring (7).

The snap ring secures the cylindrical washer in the outer ring (3) of the ball bearing, while the latter rests against a specially matched step on the inner ring of the ball bearing and thus achieves a force-fit sealing and braking effect. When the airflow is present from the inside to the outside (left to right, Fig. 2), the disc can lift off due to the air pressure and thus does not generate any additional friction while the assembly

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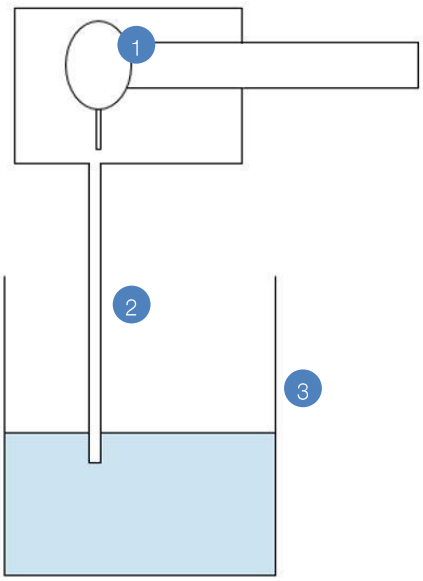
rotates freely. In the absence of air pressure, the disc rests against the inner ring, or is pressed against the inner ring by the suck-back effect / negative pressure in the bearing, effectively braking the inner ring. To increase the pressure of the disc on the inner ring, an additional metal disc is inserted between the plastic disc and the snap ring.

For a reliable braking function over the entire service life of the ball bearings, the material of the plastic washer is critical.



1. Hand piece in chamber connected to pipette generates negative pressure during discharge.
2. Pipette with level indicator, back suction volume is measured [mm^3].
3. Container with liquid

Figure 3: Measuring device for the back suction volume and measured values

This must simultaneously exhibit low wear in contact with the inner ring, sufficient deflection for lift-off, and a high coefficient of friction for braking. GRW uses a stamped or injection-molded high-performance polymer with fiber reinforcement for higher wear resistance.

Tests have shown that the suck-back effect can be massively reduced by using this system. This was measured based on the volume of water sucked in by the hand piece due to the vacuum during deceleration. The volume sucked in was reduced by 74% on average, and by as much as 95% at the peak. GRW thus offers an effective solution to the problem of the suck-back effect in pneumatically operated dental hand pieces.

Intake volume without seal (open bearings):
V (avg.) = 1204 mm^3
V (max.) = 1491 mm^3
V (min.) = 1107 mm^3
n (avg.) = 414,000 rpm
Corresponds to 100% back suction volume

Suction volume with cover (Z-disc):
V (avg.) = 1094 mm^3
V (max.) = 1423 mm^3
V (min.) = 956 mm^3
n (avg.) = 410,000 rpm
Improvement to 91%

Intake volume with GRW seal:
V (avg.) = 310 mm^3
V (max.) = 644 mm^3
V (min.) = 56 mm^3
n (avg.) = 397,000 rpm
Improvement to 26%