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Calibre 3505 with Eterna Spherodrive

Ball bearing-mounted spring barrel design

for superior quality and longevity

Contents.

1. How a mechanical watch works.

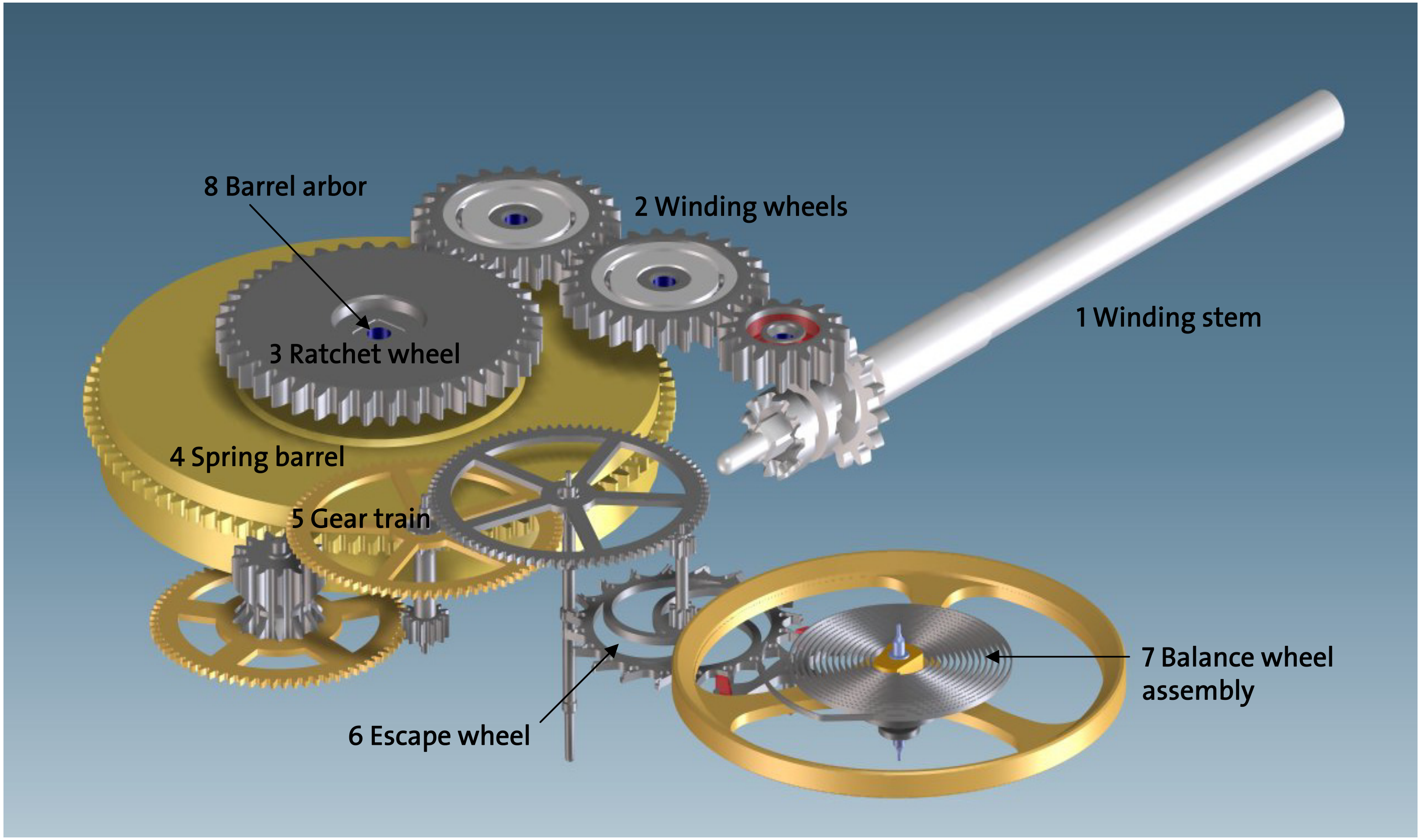

Fig. 1

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1. How a mechanical watch works.

Description of Fig. 1

In a manually wound movement, turning the **winding stem (1)** causes the **winding wheels (2)** to rotate. These serve to turn the **ratchet wheel (3)**, which is connected to the **barrel arbor (8)** on the shaft of the **spring barrel (4)**. This has the effect of tensioning the mainspring (not visible here) inside the barrel. The **spring barrel (4),** the mechanical energy reservoir and driving element, transmits the force of the mainspring to the **gear train (5)**, which in turn conveys it to the **escape wheel (6)**. The escapement transforms the rotational movement of the **gear train (5)** into a back-and-forth oscillating movement. The **balance wheel assembly (7)** acts as the timekeeping element of the watch.

2. The spring barrel design – present state of the art.

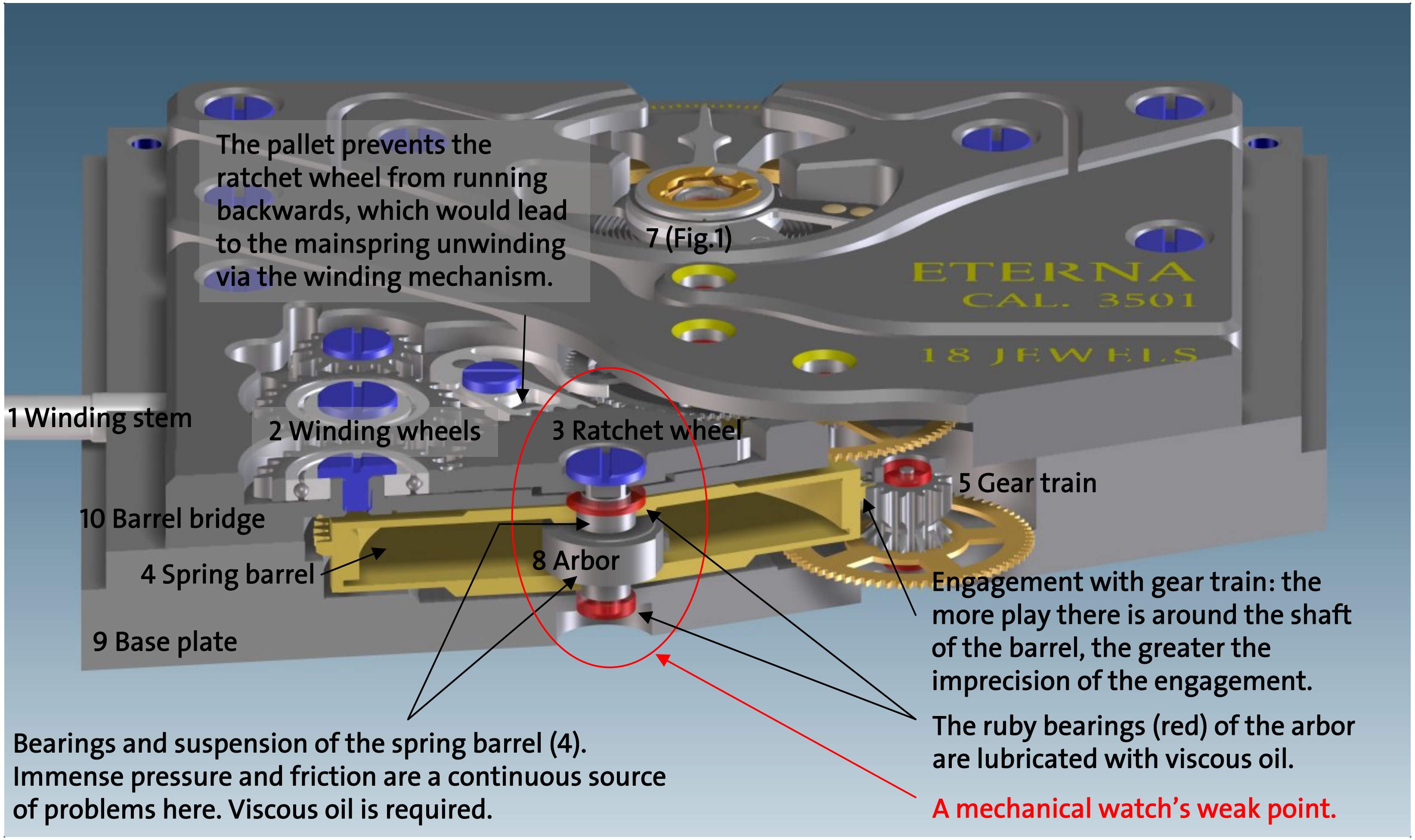

Fig. 2

Note: unlike Fig. 6, the mainspring in the spring barrel is not shown here.

2. The spring barrel design – present state of the art.

Description of Fig. 2

The **winding wheels (2)** and **ratchet wheel (3)** cause the **arbor (8)** to turn the mainspring (not shown in Fig. 2) in the **spring barrel (4)**. The arbor fulfils two functions in this conventional design: it acts as the mainspring's winding axis and serves as the suspension/bearing of the **spring barrel (4)** (shown in yellow).

2. The spring barrel design – present state of the art.

Description of Fig. 2

This dual function of the arbor is also the biggest drawback of a conventional system. When the watch is wound, the **arbor (8)** rotates about its own axis to tension the mainspring. As the mainspring unwinds, however, the **arbor (8)** remains static while the **spring barrel (4)** rotates around it, which transmits the rotary movement to the **gear train (5)**. This design, where the steel **arbor (8)** meets the brass **spring barrel (4)**, exerts a torque of around 1 Nmm on the bearing when fully wound, generating immense friction and resulting in loss of power. The two materials wear each other out despite lubrication, and the **spring barrel (4)** becomes increasingly unstable over time. Potential consequences include a loss of torque, engagement defects with the **gear train (5)**, and contact between the spring barrel and the **supporting elements (9, 10)**. All this negatively impacts the power reserve autonomy, precision and service life of the watch.

2. The spring barrel design – present state of the art.

Description of Fig. 2

Care must also be taken to ensure that there is no pinching between the **arbor (8)** and its **supporting elements (9, 10)**, or between the **arbor (8)** and the **spring barrel (4)**. Also, too much play in those areas causes the entire barrel assembly (the driving element) to become unstable. Conventional mechanisms comprising these elements are subject to labour-intensive adjustments.

When assembling the parts, once the **barrel bridge (10)** is in place and has been lubricated, it can no longer be removed without dismantling the entire watch mechanism and cleaning it again. This is because removal of the **supporting elements (9, 10)** causes the oil to run into the ruby bearings (shown in red) and contaminate the mechanism.

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2. The spring barrel design – present state of the art.

Drawbacks of a conventional design

- Labour-intensive adjustments and settings.
- Need for lubricant.
- Mechanical wear and tear of spring barrel and arbor.
- Instability of the barrel assembly.
- Loss of power and torque.
- Cost: the barrel assembly and arbor almost always need replacing during a service intervention.
- Once the barrel bridge has been assembled and the bearing oiled, it can no longer be removed without dismantling the entire watch mechanism and cleaning it again.

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3. Innovation: the double ball bearing.

Prompted by the issues referred to above, a team of engineers, designers and watchmakers has developed an ultra-precise miniature ball bearing serving two functions.

- **Ring A: arbor (8)** bearing
- **Ring B**: bearing mount (screwed to **base plate (9)**)
- **Ring C: spring barrel (4)** bearing (to which the barrel is screwed)

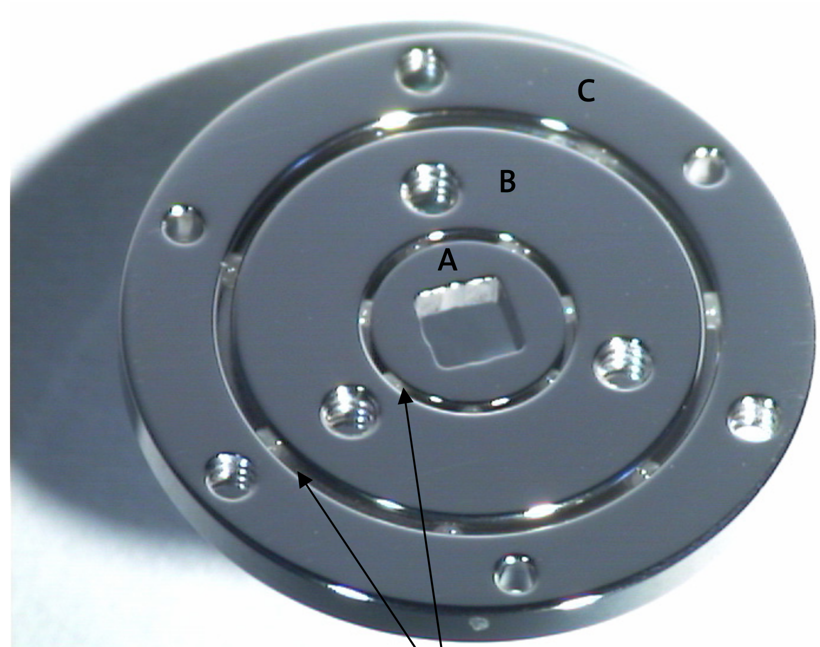

Fig. 3

The zirconium oxide balls require no lubrication/oil whatsoever. To ensure the system's long-term resilience, manufacturer MPS Micro Precision Systems AG conducted ageing tests: 20 years of simulated service resulted in barely any wear.

3. Innovation: the double ball bearing.

This picture shows the ball bearing **(ABC)** screwed to **the base plate** (9) from below: note the ends of the blued screws, which are just visible in the middle ring **B**. The outer ring **C** and inner ring **A** can now rotate freely as they are 1/10 mm thinner than ring **B**.

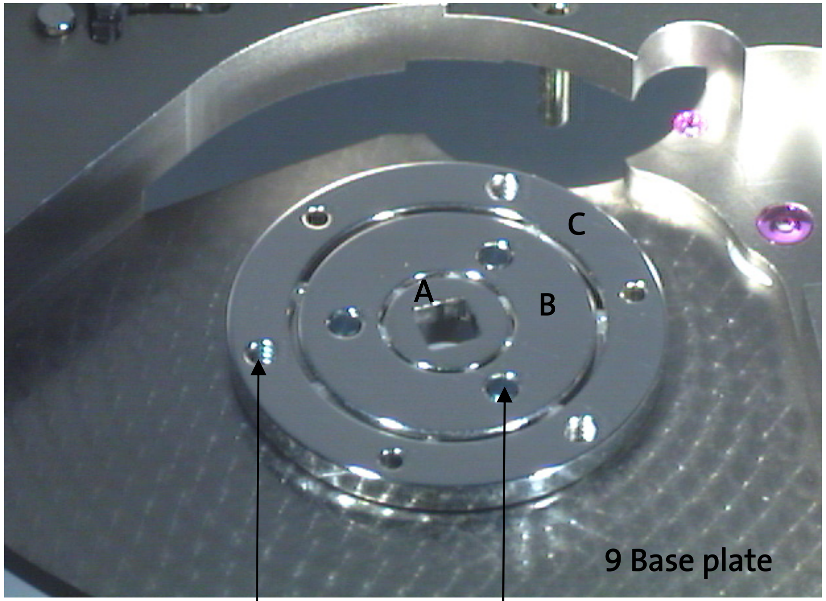

Fig. 4

Thread for mounting spring barrel (4)

Screwed to base plate from below

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3. Innovation: the double ball bearing.

In Fig. 5, note how the **spring barrel (4)** has been screwed to ring **C** of the double ball bearing **(ABC)**. The mainspring and **arbor (8)** can now be placed in the **spring barrel (4)**. The barrel cover is then placed on top.

Note that the amount of play afforded by the free-turning rings **A** and **C** – and therefore of the **arbor (8)** and **spring barrel (4)** – is in the order of 6-10/1’000 mm. This is 5-10 times more precise than the conventional approach.

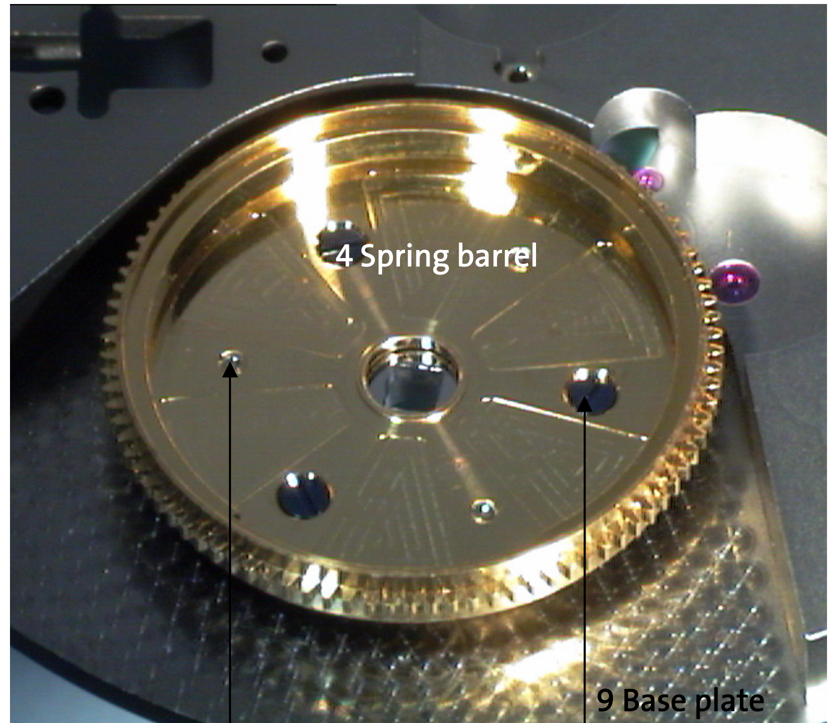

Fig. 5

Centring pin to guarantee concentricity

Screws securing the spring barrel (4) to the ball bearing (ABC)

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4. The new double ball bearing mounted in the mechanism.

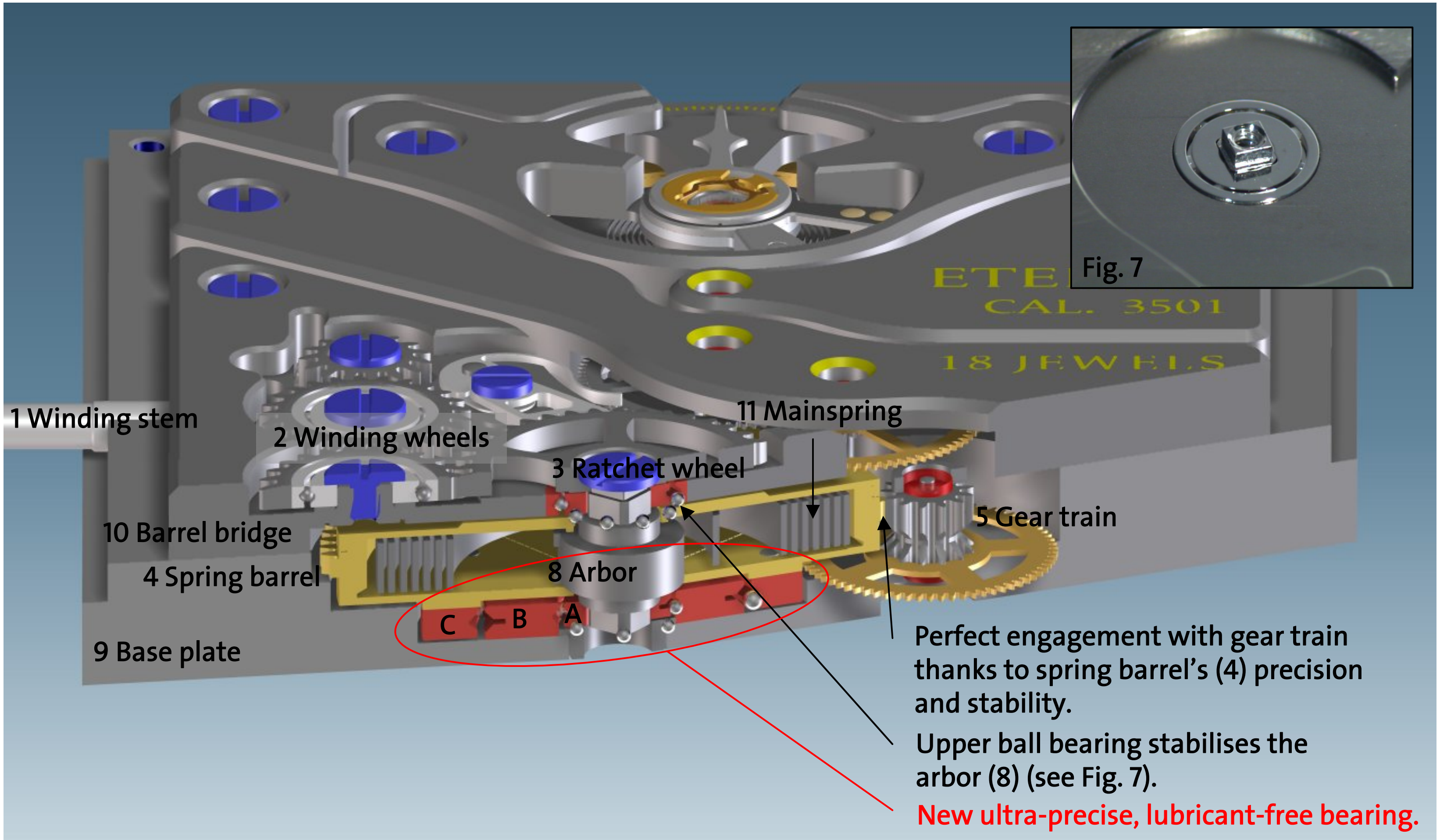

Fig. 6

4. The new double ball bearing mounted in the mechanism.

Description of Fig. 6

The computer-aided design (CAD) drawing shows the bearing (circled in red) mounted in the watch mechanism. The **base plate (9)** bears the **double ball bearing (ABC)**, which in turn bears the **spring barrel (4)** and its **arbor (8)**. The arbor serves to tension the **mainspring (11)** via the **winding mechanism (2, 3)**. Fig. 7 shows the upper ball bearing which supports the top of the **arbor (8)**. The **spring barrel (4)** is subject to up to 10 times less play than a conventional design, and canting instability at the point where it engages with the **gear train (5)** is reduced by a factor of 4-6.

This system requires no lubrication, and the **spring barrel (4)** is floated, i.e. it is secured at one end only through being screwed to the **double ball bearing (ABC)**. This gives it unmatched stability – and the **barrel bridge (10)** can be removed and replaced without causing secondary problems.

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4. The new double ball bearing mounted in the mechanism.

The benefits of this innovation

- Longer life thanks to the rolling movement which helps mitigate the immense pressures in the watch movement, as well as friction and wear.
- The stability of the spring barrel affords optimum engagement with the gear train and improves energy transfer.
- No lubricant (oil) needed due to bearing's lubricant-free zirconium oxide balls.
- Increased power reserve thanks to use of thinner mainspring.
- Assembly and service are much simplified and less prone to error, since the bearing requires no adjustment or calibration.
- Less labour-intensive service work: the spring barrel is subject to far less wear and tear than conventional systems, and no longer needs routine replacement after three to five years. 20 years of simulated ageing resulted in barely any wear.

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5. Summary.

This invention is as efficient as its concept is simple. It provides the mechanical watch's core element – its energy reservoir – with a straightforward, lubricant-free and ultra-efficient method of mounting. This eliminates virtually all the drawbacks watchmakers have had to contend with for decades.

The bearing mounting is not only a technical innovation; it also significantly improves the quality of a mechanical watch. The bearing is virtually maintenance-free since it is not subject to friction, but instead exhibits a rolling motion that requires no lubrication. The watch's extended service intervals and service life, reliability and long-term accuracy will clearly be of major interest to consumers – quite apart from the fact that they will be wearing what is currently the most cutting-edge technology on their wrists.

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