

DUAL-AXIS TOURBILLON STRUCTURE WITH ADJUSTABLE ROTATIONAL INERTIA

TECHNICAL FIELD

[0001] The present application relates to the technical field of mechanical watch tourbillons, and in particular, to a dual-axis tourbillon structure with adjustable rotational inertia.

BACKGROUND ART

[0002] In the mechanical watch manufacturing industry, a tourbillon is a device for minimizing isochronal errors. The device is characterized by a balance gear and hairspring system along with an escapement mechanism disposed within a frame, which rotate along with the frame while in operation, minimizing timekeeping errors caused by gravitational forces, thereby improving accuracy. Traditional single-axis tourbillon has been developed for many years. However, with technological advancements and the diversification of consumer demands, the traditional single-axis tourbillon can no longer meet higher-level requirements. Particularly in complex and variable wearing conditions, more advanced tourbillon structures are needed to further improve performance.

[0003] To address this challenge, a dual-axis tourbillon structure is provided in the related technology, which is formed by adding a second rotational axis to an existing single-axis tourbillon, to further counteract gravitational influences from different directions. Although the dual-axis tourbillon in the existing technology can further reduce gravitational influences, it is still difficult to flexibly adjust the rotational inertia of the balance gear in practical applications, resulting in its limited adaptability to different conditions.

SUMMARY

[0004] In order to flexibly adjust the rotational inertia of the balance gear, the present

application provides a dual-axis tourbillon structure with adjustable rotational inertia.

[0005] The dual-axis tourbillon structure with adjustable rotational inertia provided by the present application adopts the following technical solution.

[0006] A dual-axis tourbillon structure with adjustable rotational inertia includes a frame plate, a first orientation shaft, an outer tourbillon, a second orientation shaft, an inner tourbillon, an escapement mechanism, and a transmission gear train, where the outer tourbillon is rotatably connected to the frame plate via the first orientation shaft, an axis of the outer tourbillon is perpendicular to the first orientation shaft, the inner tourbillon is rotatably connected to the outer tourbillon via the second orientation shaft, the axis of the outer tourbillon, an axis of the inner tourbillon, and the second orientation shaft are all arranged collinearly, the escapement mechanism is disposed on the inner tourbillon, the escapement mechanism includes an escapement wheel, a pallet fork, and a balance wheel with hairspring, a surface of the balance wheel with hairspring is provided with four adjustment posts equidistantly spaced along a circumference of the balance wheel with hairspring, a C-type weight is sleeved over each of the adjustment posts, the C-type weight is in an interference fit with a respective one adjustment post, and the transmission gear train is configured to drive the outer tourbillon to rotate about the first orientation shaft, while driving the inner tourbillon to rotate about the second orientation shaft, and driving the escapement wheel to rotate.

[0007] The dual-axis tourbillon structure of the aforementioned technical solution achieves rotational motion in two directions, improving the timekeeping accuracy and stability of a mechanical watch. The outer tourbillon and the inner tourbillon rotate about axes in two different directions, enabling the entire system to counteract gravitational influences in a plurality of directions. Additionally, four adjustment posts and C-type weights are provided on the surface of the balance wheel with hairspring of the escapement mechanism. The rotational inertia of the system can be varied by adjusting the angle of the C-type weights, thereby achieving precise time control. The design of the transmission gear train ensures coordinated movement among the

outer tourbillon, the inner tourbillon, and the escapement wheel, thereby further enhancing the stability and reliability of the system.

[0008] Optionally, the first orientation shaft includes a moving-side shaft and a stationary-side shaft arranged collinearly, where the moving-side shaft is configured to receive power, the stationary-side shaft is configured to provide support, the frame plate is provided with a moving-side stationary shaft frame and a stationary-side stationary shaft frame, the moving-side shaft is rotatably connected to the moving-side stationary shaft frame via a moving-side jewel bearing, the stationary-side shaft is rotatably connected to the stationary-side stationary shaft frame via a stationary-side jewel bearing, a moving-side movable shaft frame is fixedly connected to an outer periphery of the moving-side shaft, a stationary-side movable shaft frame is fixedly connected to an outer periphery of the stationary-side shaft, and both the moving-side movable shaft frame and the stationary-side movable shaft frame are fixedly connected to the outer tourbillon.

[0009] By adopting the aforementioned technical solution, the separate design of the moving-side shaft and the stationary-side shaft not only effectively separates the power transmission and support functions, but also facilitates the grinding operations of shaft surfaces, thereby improving the surface finish. The application of the moving-side jewel bearing and the stationary-side jewel bearing further reduces frictional losses and extends the service life. Furthermore, the design of the moving-side movable shaft frame and the stationary-side movable shaft frame ensures a stable connection of the outer tourbillon, enhancing the rigidity and shock resistance of the overall structure.

[0010] Optionally, the transmission gear train includes an axial transmission train for driving the outer tourbillon to rotate about the first orientation shaft, where the axial transmission train includes a driving gear, an axial driving gear, and an axial driven gear, the axial driving gear is rotatably connected to the frame plate about its own axis, the driving gear is coaxially arranged with the axial driving gear and rotatable synchronously therewith, the axial driven gear is

coaxially arranged with the moving-side shaft and rotatable synchronously therewith, and the driving gear is meshed with the axial driven gear.

[0011] By adopting the aforementioned technical solution, the driving gear and the axial driving gear are coaxially arranged and rotatable synchronously. When the driving gear receives power, it transmits the power to the axial driving gear, causing the axial driving gear to rotate about its own axis. When the axial driving gear rotates, it transmits power to the axial driven gear via meshing relationship. Since the axial driven gear is coaxially arranged with the moving-side shaft and rotatable synchronously therewith, the rotation of the axial driven gear drives the moving-side shaft to rotate concurrently. When the moving-side shaft rotates, the moving-side movable shaft frame fixedly connected to its outer periphery also rotates. As the moving-side movable shaft frame is fixedly connected to the outer tourbillon, the rotation of the moving-side movable shaft frame drives the outer tourbillon to rotate about the first orientation shaft. The stationary-side shaft, serving as a support portion, is rotatably connected to the stationary-side stationary shaft frame via the stationary-side jewel bearing, ensuring the stability of the moving-side shaft during its rotation. The stationary-side movable shaft frame, fixedly connected to the outer periphery of the stationary-side shaft, is also fixedly connected to the outer tourbillon, further enhancing the stability of the outer tourbillon. Throughout the transmission process, the application of the moving-side jewel bearing and the stationary-side jewel bearing reduces frictional losses, improves transmission efficiency, and extends the service life. The separate design of the moving-side shaft and the stationary-side shaft facilitates the grinding operations of the shaft surfaces, improving the surface finish, thereby further enhancing the stability and reliability of transmission.

[0012] Optionally, the second orientation shaft is rotatably connected to the outer tourbillon about its own axis, where a first end of the second orientation shaft is integrally formed with a planet carrier while a second end thereof is configured to receive power, and the planet carrier is fixedly connected to the inner tourbillon.

[0013] By adopting the aforementioned technical solution, the second orientation shaft is rotatably connected to the outer tourbillon about its own axis, enabling the inner tourbillon to stably rotate around the second orientation shaft. The planet carrier, integrally formed at one end of the second orientation shaft, is fixedly connected to the inner tourbillon, ensuring reliable linkage between the inner tourbillon and the second orientation shaft, thereby improving the mechanical precision and stability of the entire system. The design of the other end for receiving power ensures effective power transmission, allowing the outer tourbillon and the inner tourbillon to work in coordination and achieve more complex motion patterns.

[0014] Optionally, the transmission gear train includes a circumferential transmission train for driving the inner tourbillon to rotate about the second orientation shaft, where the circumferential transmission train includes a circumferential driving gear, a circumferential driven gear, a steering synchronizing wheel, a steering movable wheel, and a steering stationary wheel, the circumferential driving gear is fixedly connected to the second end of the second orientation shaft away from the planet carrier, both the circumferential driven gear and the steering movable wheel are rotatably connected to the outer tourbillon about their own axes, the steering synchronizing wheel is coaxially connected to the steering movable wheel and rotatable synchronously with the steering movable wheel, the circumferential driven gear is meshed simultaneously with the steering synchronizing wheel and the circumferential driving gear, axes of the circumferential driving gear, the circumferential driven gear, and the steering movable wheel are parallel to each other, the steering stationary wheel is fixedly connected to the stationary-side stationary shaft frame and coaxially arranged with the first orientation shaft, and the steering stationary wheel is meshed with the steering movable wheel.

[0015] By adopting the aforementioned technical solution, the steering movable wheel, being rotatably connected to the outer tourbillon, may revolve about the first orientation shaft along with the outer tourbillon. The steering stationary wheel, being fixedly connected to the stationary-side stationary shaft frame and coaxially arranged with the first orientation shaft,

remains stationary relative to the outer tourbillon and the steering movable wheel, that is, its position does not change with the rotation of the outer tourbillon. Consequently, when the steering movable wheel revolves following the rotation of the outer tourbillon, power transmission is achieved between the steering movable wheel and the steering stationary wheel through their meshing relationship, that is, the steering stationary wheel drives the steering movable wheel to rotate about its own axis. Since the steering synchronizing wheel is coaxially connected to the steering movable wheel and can rotate synchronously with the steering movable wheel, and the steering synchronizing wheel is meshed with the circumferential driven gear, after the steering movable wheel begins to rotate about its axis, the circumferential driven gear also rotates accordingly. The circumferential driven gear is meshed with the circumferential driving gear, and the circumferential driving gear is fixedly connected to the end of the second orientation shaft away from the planet carrier, therefore the circumferential driving gear and the second orientation shaft also rotate along with the circumferential driven gear. Simultaneously, the rotation of the second orientation shaft drives the planet carrier and the inner tourbillon to rotate together about the second orientation shaft. The fixed connection between the planet carrier and the inner tourbillon ensures reliable linkage between the inner tourbillon and the second orientation shaft.

[0016] Optionally, the escapement mechanism further includes an escapement frame, where the escapement wheel, the pallet fork, and the balance wheel with hairspring are all disposed on the escapement frame, and the escapement frame is fixedly connected to the inner tourbillon.

[0017] By adopting the aforementioned technical solution, the escapement wheel, the pallet fork, and the balance wheel with hairspring are connected to the escapement frame, allowing these components to operate stably under the constraint of the escapement frame. Additionally, the fixed connection between the escapement frame and the inner tourbillon ensures that the escapement mechanism may move along with the inner tourbillon, thereby achieving a precise time regulation function.

[0018] Optionally, the transmission gear train further includes an escapement transmission train for driving the escapement wheel to rotate, where the escapement transmission train includes a sun gear and an escapement input wheel, the sun gear is fixedly disposed on a side of the outer tourbillon facing the first orientation shaft, the sun gear is coaxially arranged with the second orientation shaft and is rotatably connected to the second orientation shaft via a central jewel bearing, the escapement wheel is coaxially and fixedly connected with the escapement input wheel, and the escapement input wheel is meshed with the sun gear.

[0019] By adopting the aforementioned technical solution, when the circumferential driving gear receives power and begins to rotate, it drives the second orientation shaft to rotate concurrently. Since the planet carrier is integrally formed with the second orientation shaft and fixedly connected to the inner tourbillon, the inner tourbillon also rotates along with the rotation of the second orientation shaft. The escapement transmission train includes a sun gear and an escapement input wheel. Since the sun gear is fixedly disposed on the side of the outer tourbillon proximate to the first orientation shaft, is coaxially arranged with the second orientation shaft, and is rotatably connected to the second orientation shaft via the central jewel bearing, the sun gear remains stationary relative to the inner tourbillon, that is, its position does not change with the rotation of the inner tourbillon. The escapement wheel is disposed on the escapement frame, and the escapement frame is fixedly connected to the inner tourbillon, and the escapement wheel is coaxially fixed with the escapement input wheel. Consequently, when the inner tourbillon rotates, both the escapement wheel and the escapement input wheel will revolve around the sun gear, which is coaxially arranged with the second orientation shaft. The escapement input wheel is meshed with the sun gear, therefore when the escapement input wheel revolves around the sun gear, it also rotates about its own axis due to the meshing action, thereby driving the escapement wheel to rotate concurrently. When the escapement wheel rotates, it drives the escapement mechanism including the pallet fork and the balance wheel with hairspring to start operating.

[0020] Optionally, the axial driving gear, the axial driven gear, the steering movable wheel,

and the steering stationary wheel are all bevel gears.

[0021] By adopting the aforementioned technical solution, the design of the bevel gears makes the power transmission of the transmission gear train smoother and more efficient in multiaxial directions, reduces power losses, and improves the operational stability and precision of the entire dual-axis tourbillon structure.

[0022] In summary, the present application has the following beneficial effects:

[0023] 1. By arranging four adjustment posts on the surface of the balance wheel with hairspring and sleeving C-type weights thereon, flexible adjustment of the rotational inertia is achieved, thereby enhancing the adaptability and the stability of the dual-axis tourbillon structure under different wearing conditions.

[0024] 2. The outer tourbillon is rotatably connected to the frame plate via the first orientation shaft, and the inner tourbillon is rotatably connected to the outer tourbillon via the second orientation shaft, ensuring precise linkage between the outer tourbillon and the inner tourbillon, further enhancing the timekeeping accuracy and reliability of the entire system.

[0025] 3. The design of the transmission gear train enables the outer tourbillon to rotate about the first orientation shaft while allowing the inner tourbillon to rotate about the second orientation shaft and drive the escapement wheel to rotate. This multi-level power transmission mechanism effectively reduces the gravitational influence on the movement and enhances the overall anti-interference capability.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] FIG. 1 is a schematic plan view of a dual-axis tourbillon structure with adjustable rotational inertia according to the present application;

[0027] FIG. 2 is a schematic three-dimensional view of the dual-axis tourbillon structure with adjustable rotational inertia according to the present application;

[0028] FIG. 3 is a schematic three-dimensional view of the dual-axis tourbillon structure with

adjustable rotational inertia according to the present application from another perspective;

[0029] FIG. 4 is an exploded view of a moving-side shaft and a moving-side movable shaft frame according to the present application;

[0030] FIG. 5 is an exploded view of the cooperative relationship between a second orientation shaft and a sun gear according to the present application.

Reference sign list

101 moving-side shaft

102 stationary-side shaft

2 outer tourbillon

201 outer support plate

3 second orientation shaft

301 planet carrier

4 inner tourbillon

5 adjustment post

6 C-type weight

7 driving gear

8 axial driving gear

9 axial driven gear

10 circumferential driving gear

11 circumferential driven gear

12 steering movable wheel

1201 steering synchronizing wheel

13 steering stationary wheel

14 sun gear

15 escapement input wheel

16 moving-side stationary shaft frame

- 17 stationary-side stationary shaft frame
- 18 moving-side jewel bearing
- 19 stationary-side jewel bearing
- 20 moving-side movable shaft frame
- 21 stationary-side movable shaft frame
- 22 escapement wheel
- 23 pallet fork
- 24 balance wheel with hairspring
- 25 escapement frame
- 26 central jewel bearing

DETAILED DESCRIPTION

[0031] The present application is described in further detail with reference to FIGS. 1-5 as following.

[0032] The embodiments of the present application disclose a dual-axis tourbillon structure with adjustable rotational inertia.

[0033] Referring to FIGS. 1-3, the dual-axis tourbillon structure with adjustable rotational inertia includes a frame plate, a first orientation shaft, an outer tourbillon 2, a second orientation shaft 3, an inner tourbillon 4, an escapement mechanism, and a transmission gear train. The outer tourbillon 2 is rotatably connected to the frame plate via the first orientation shaft, and an axis of the outer tourbillon 2 is perpendicular to the first orientation shaft. The inner tourbillon 4 is rotatably connected to the outer tourbillon 2 via the second orientation shaft 3, and the axis of the outer tourbillon 2, an axis of the inner tourbillon 4, and the second orientation shaft 3 are arranged collinearly. The escapement mechanism is disposed on the inner tourbillon 4, and the escapement mechanism includes an escapement wheel 22, a pallet fork 23, and a balance wheel with hairspring 24. A surface of the balance wheel with hairspring 24 is provided with four

adjustment posts 5 equidistantly spaced along its circumference, a C-type weight 6 is sleeved over each adjustment post 5, and the C-type weight 6 is in an interference fit with the corresponding adjustment post 5. The transmission gear train is configured to drive the outer tourbillon 2 to rotate about the first orientation shaft while driving the inner tourbillon 4 to rotate about the second orientation shaft 3, and simultaneously driving the escapement wheel 22 to rotate.

[0034] The dual-axis tourbillon structure of the present embodiment achieves bidirectional rotational motion, significantly enhancing the timekeeping accuracy and stability of a mechanical watch. The outer tourbillon 2 and the inner tourbillon 4 rotate about two different orientation shafts respectively, enabling the entire system to counteract gravitational effects in a plurality of dimensions. Concurrently, the balance wheel with hairspring 24 of the escapement mechanism is configured with four adjustment posts 5 and C-type weights 6 on its surface. By adjusting the angle of the C-type weights 6, the rotational inertia of the system may be varied, thereby achieving precise time control. The design of the transmission gear train ensures coordinated movement among the outer tourbillon 2, the inner tourbillon 4, and the escapement wheel 22, further enhancing the stability and reliability of the system.

[0035] Referring to FIGS. 1-3, the transmission gear train includes a driving gear 7, an axial driving gear 8, an axial driven gear 9, a circumferential driving gear 10, a circumferential driven gear 11, a steering movable wheel 12, a steering synchronizing wheel 1201, a steering stationary wheel 13, a sun gear 14, and an escapement input wheel 15. The axial driving gear 8, the axial driven gear 9, the steering movable wheel 12, and the steering stationary wheel 13 are all bevel gears.

[0036] Referring to FIGS. 1-3, the first orientation shaft includes a moving-side shaft 101 and a stationary-side shaft 102 arranged collinearly, where the moving-side shaft 101 is configured to receive power, and the stationary-side shaft 102 is configured to provide support. The frame plate is provided with a moving-side stationary shaft frame 16 and a stationary-side stationary

shaft frame 17. The moving-side shaft 101 is rotatably connected to the moving-side stationary shaft frame 16 via a moving-side jewel bearing 18, and the stationary-side shaft 102 is rotatably connected to the stationary-side stationary shaft frame 17 via a stationary-side jewel bearing 19. A moving-side movable shaft frame 20 is fixedly connected to an outer periphery of the moving-side shaft 101, and a stationary-side movable shaft frame 21 is fixedly connected to an outer periphery of the stationary-side shaft 102. Both the moving-side movable shaft frame 20 and the stationary-side movable shaft frame 21 are fixedly connected to the outer tourbillon 2. The axial driving gear 8 is rotatably connected to the frame plate about its own axis, the driving gear 7 is coaxially arranged with the axial driving gear 8 and is rotatable synchronously therewith. The axial driven gear 9 is coaxially arranged with the moving-side shaft 101 and is rotatable synchronously therewith. The driving gear 7 is meshed with the axial driven gear 9.

[0037] The stationary-side shaft 102, serving as a support portion, is rotatably connected to the stationary-side stationary shaft frame 17 via the stationary-side jewel bearing 19, ensuring the stability of the moving-side shaft 101 during its rotation. The stationary-side movable shaft frame 21, fixedly connected to the outer periphery of the stationary-side shaft 102, is also fixedly connected to the outer tourbillon 2, further enhancing the stability of the outer tourbillon 2. Throughout the entire transmission process, the moving-side jewel bearing 18 and the stationary-side jewel bearing 19 reduces frictional losses, thereby improving transmission efficiency, and extending the service life.

[0038] Referring to FIG. 4, the separate design of the moving-side shaft 101 and the stationary-side shaft 102 facilitates the grinding operations of the shaft surfaces, improving the surface finish of the shafts, thereby further enhancing the stability and reliability of the transmission.

[0039] Referring to FIGS. 1-3 and 5, the second orientation shaft 3 is rotatably connected to the outer tourbillon 2 while rotating about its own axis. One end of the second orientation shaft 3 is integrally formed with a planet carrier 301, and the other end thereof is fixedly connected to a

circumferential driving gear 10. The planet carrier 301 is fixedly connected to the inner tourbillon 4. To provide better support, an outer support plate 201 may be provided on a side of the circumferential driving gear 10 away from the outer tourbillon 2, and the outer support plate 201 is fixedly connected to the outer tourbillon 2. The circumferential driving gear 10, the circumferential driven gear 11, and the steering movable wheel 12 are all rotatably connected to the outer tourbillon 2 and the outer support plate 201 while rotating about their own axes. The steering synchronizing wheel 1201 is coaxially connected to the steering movable wheel 12 and rotatable synchronously with the steering movable wheel 12. The circumferential driven gear 11 is meshed simultaneously with the steering synchronizing wheel 1201 and the circumferential driving gear 10. The axes of the circumferential driving gear 10, the circumferential driven gear 11, and the steering movable wheel 12 are parallel to each other. The steering stationary wheel 13 is fixedly connected to the stationary-side stationary shaft frame 17 and is coaxially arranged with the first orientation shaft, and the steering stationary wheel 13 is meshed with the steering movable wheel 12.

[0040] Referring to FIGS. 1-3, the escapement mechanism further includes an escapement frame 25. The escapement wheel 22, the pallet fork 23, and the balance wheel with hairspring 24 are all disposed on the escapement frame 25. The escapement frame 25 is fixedly connected to the inner tourbillon 4. The sun gear 14 is fixedly disposed on a side of the outer tourbillon 2 proximate to the first orientation shaft, and the sun gear 14 is coaxially arranged with the second orientation shaft 3 and is rotatably connected to the second orientation shaft 3 via a central jewel bearing 26. The escapement wheel 22 is coaxially fixed with an escapement input wheel 15, and the escapement input wheel 15 is meshed with the sun gear 14. The escapement mechanism is a conventional technical means in the field, and therefore the cooperative relationships among the escapement wheel 22, the pallet fork 23, the balance wheel with hairspring 24, and the escapement frame 25 are not elaborated herein.

[0041] The implementation principle of the dual-axis tourbillon structure with adjustable

rotational inertia according to the present application is as follows.

[0042] The driving gear 7 and the axial driving gear 8 are coaxially arranged and rotatable synchronously. When the driving gear 7 receives power, it transmits the power to the axial driving gear 8, causing the axial driving gear 8 to rotate about its own axis. When the axial driving gear 8 rotates, it transmits power to the axial driven gear 9 via meshing engagement. Since the axial driven gear 9 is coaxially arranged with the moving-side shaft 101 and rotatable synchronously therewith, when the axial driven gear 9 rotates, it drives the moving-side shaft 101 to rotate together. When the moving-side shaft 101 rotates, the moving-side movable shaft frame 20 fixedly connected to the outer periphery thereof also rotates accordingly. As the moving-side movable shaft frame 20 is fixedly connected to the outer tourbillon 2, the rotation of the moving-side movable shaft frame 20 drives the outer tourbillon 2 to rotate about the first orientation shaft.

[0043] When the outer tourbillon 2 rotates about the first orientation shaft, by virtue of its rotatable connection to the outer tourbillon 2, the steering movable wheel 12 revolves about the first orientation shaft along with the outer tourbillon 2. By virtue of being fixedly connected to the stationary-side stationary shaft frame 17 and coaxially arranged with the first orientation shaft, the steering stationary wheel 13 remains stationary relative to the outer tourbillon 2 and the steering movable wheel 12, that is, its position does not change with the rotation of the outer tourbillon 2. Consequently, when the steering movable wheel 12 revolves following the rotation of the outer tourbillon 2, power transmission is achieved between the steering movable wheel 12 and the steering stationary wheel 13 through their meshing relationship, that is, the steering stationary wheel 13 drives the steering movable wheel 12 to rotate about its own axis. Since the steering synchronizing wheel 1201 is coaxially connected to the steering movable wheel 12 and can rotate synchronously with the steering movable wheel 12, and the steering synchronizing wheel 1201 is meshed with the circumferential driven gear 11, after the steering movable wheel 12 begins to rotate about its own axis, the circumferential driven gear 11 also rotates accordingly.

Since the circumferential driven gear 11 is meshed with the circumferential driving gear 10, and the circumferential driving gear 10 is fixedly connected to an end of the second orientation shaft 3 away from the planet carrier 301, the circumferential driving gear 10 and the second orientation shaft 3 also rotate along with the circumferential driven gear 11. At the same time, the rotation of the second orientation shaft 3 drives the planet carrier 301 and the inner tourbillon 4 to rotate together about the second orientation shaft 3.

[0044] Since the sun gear 14 is fixedly disposed on the side of the outer tourbillon 2 proximate to the first orientation shaft, is coaxially arranged with the second orientation shaft 3, and is rotatably connected to the second orientation shaft 3 via the central jewel bearing 26, the sun gear 14 remains stationary relative to the inner tourbillon 4, that is, its position does not change with the rotation of the inner tourbillon 4. The escapement wheel 22 is disposed on the escapement frame 25, the escapement frame 25 is fixedly connected to the inner tourbillon 4, and the escapement wheel 22 is coaxially fixed with the escapement input wheel 15. Consequently, when the inner tourbillon 4 rotates, both the escapement wheel 22 and the escapement input wheel 15 revolve around the sun gear 14, which is coaxially arranged with the second orientation shaft 3. The escapement input wheel 15 is meshed with the sun gear 14, therefore when the escapement input wheel 15 revolves around the sun gear 14, it also rotates about its own axis due to the meshing action, thereby driving the escapement wheel 22 to rotate concurrently. When the escapement wheel 22 rotates, it drives the escapement mechanism including the pallet fork 23 and the balance wheel with hairspring 24 to start operating.

[0045] The above are all preferred embodiments of the present application and are not intended to limit the protection scope of the present application. Therefore, any equivalent modifications made in accordance with the structure, shape, and principle of the present application shall fall within the protection scope of the present application.

WHAT IS CLAIMED IS:

1. A dual-axis tourbillon structure with adjustable rotational inertia, characterized by comprising a frame plate, a first orientation shaft, an outer tourbillon (2), a second orientation shaft (3), an inner tourbillon (4), an escapement mechanism, and a transmission gear train, wherein the outer tourbillon (2) is rotatably connected to the frame plate via the first orientation shaft, an axis of the outer tourbillon (2) is perpendicular to the first orientation shaft, the inner tourbillon (4) is rotatably connected to the outer tourbillon (2) via the second orientation shaft (3), the axis of the outer tourbillon (2), an axis of the inner tourbillon (4), and the second orientation shaft (3) are all arranged collinearly, the escapement mechanism is disposed on the inner tourbillon (4), the escapement mechanism comprises an escapement wheel (22), a pallet fork (23), and a balance wheel with hairspring (24), a surface of the balance wheel with hairspring (24) is provided with four adjustment posts (5) equidistantly spaced along a circumference of the balance wheel with hairspring (24), a C-type weight (6) is sleeved over each of the adjustment posts (5), the C-type weight (6) is in an interference fit with a respective one adjustment post (5), and the transmission gear train is configured to drive the outer tourbillon (2) to rotate about the first orientation shaft, while driving the inner tourbillon (4) to rotate about the second orientation shaft (3), and driving the escapement wheel (22) to rotate.

2. The dual-axis tourbillon structure with adjustable rotational inertia according to claim 1, characterized in that the first orientation shaft comprises a moving-side shaft (101) and a stationary-side shaft (102) arranged collinearly, wherein the moving-side shaft (101) is configured to receive power, the stationary-side shaft (102) is configured to provide support, the frame plate is provided with a moving-side stationary shaft frame (16) and a stationary-side stationary shaft frame (17), the moving-side shaft (101) is rotatably connected to the moving-side stationary shaft frame (16) via a moving-side jewel bearing (18), the stationary-side shaft (102) is rotatably connected to the stationary-side stationary shaft frame (17) via a

stationary-side jewel bearing (19), a moving-side movable shaft frame (20) is fixedly connected to an outer periphery of the moving-side shaft (101), a stationary-side movable shaft frame (21) is fixedly connected to an outer periphery of the stationary-side shaft (102), and both the moving-side movable shaft frame (20) and the stationary-side movable shaft frame (21) are fixedly connected to the outer tourbillon (2).

3. The dual-axis tourbillon structure with adjustable rotational inertia according to claim 2, characterized in that the transmission gear train comprises an axial transmission train for driving the outer tourbillon (2) to rotate about the first orientation shaft, wherein the axial transmission train comprises a driving gear (7), an axial driving gear (8), and an axial driven gear (9), the axial driving gear (8) is rotatably connected to the frame plate about its own axis, the driving gear (7) is coaxially arranged with the axial driving gear (8) and rotatable synchronously therewith, the axial driven gear (9) is coaxially arranged with the moving-side shaft (101) and rotatable synchronously therewith, and the driving gear (7) is meshed with the axial driven gear (9).

4. The dual-axis tourbillon structure with adjustable rotational inertia according to claim 3, characterized in that the second orientation shaft (3) is rotatably connected to the outer tourbillon (2) about its own axis, wherein a first end of the second orientation shaft (3) is integrally formed with a planet carrier (301) while a second end thereof is configured to receive power, and the planet carrier (301) is fixedly connected to the inner tourbillon (4).

5. The dual-axis tourbillon structure with adjustable rotational inertia according to claim 4, characterized in that the transmission gear train comprises a circumferential transmission train for driving the inner tourbillon (4) to rotate about the second orientation shaft (3), wherein the circumferential transmission train comprises a circumferential driving gear (10), a

circumferential driven gear (11), a steering synchronizing wheel (1201), a steering movable wheel (12), and a steering stationary wheel (13), the circumferential driving gear (10) is fixedly connected to the second end of the second orientation shaft (3) away from the planet carrier (301), both the circumferential driven gear (11) and the steering movable wheel (12) are rotatably connected to the outer tourbillon (2) about their own axes, the steering synchronizing wheel (1201) is coaxially connected to the steering movable wheel (12) and rotatable synchronously with the steering movable wheel (12), the circumferential driven gear (11) is meshed simultaneously with the steering synchronizing wheel (1201) and the circumferential driving gear (10), axes of the circumferential driving gear (10), the circumferential driven gear (11), and the steering movable wheel (12) are parallel to each other, the steering stationary wheel (13) is fixedly connected to the stationary-side stationary shaft frame (17) and coaxially arranged with the first orientation shaft, and the steering stationary wheel (13) is meshed with the steering movable wheel (12).

6. The dual-axis tourbillon structure with adjustable rotational inertia according to claim 5, characterized in that the escapement mechanism further comprises an escapement frame (25), wherein the escapement wheel (22), the pallet fork (23), and the balance wheel with hairspring (24) are all disposed on the escapement frame (25), and the escapement frame (25) is fixedly connected to the inner tourbillon (4).

7. The dual-axis tourbillon structure with adjustable rotational inertia according to claim 6, characterized in that the transmission gear train further comprises an escapement transmission train for driving the escapement wheel (22) to rotate, wherein the escapement transmission train comprises a sun gear (14) and an escapement input wheel (15), the sun gear (14) is fixedly disposed on a side of the outer tourbillon (2) facing the first orientation shaft, the sun gear (14) is coaxially arranged with the second orientation shaft (3) and is rotatably connected to the second

orientation shaft (3) via a central jewel bearing (26), the escapement wheel (22) is coaxially and fixedly connected with the escapement input wheel (15), and the escapement input wheel (15) is meshed with the sun gear (14).

8. The dual-axis tourbillon structure with adjustable rotational inertia according to claim 5, characterized in that the axial driving gear (8), the axial driven gear (9), the steering movable wheel (12), and the steering stationary wheel (13) are all bevel gears.