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(54) REDESIGNING OF THE MECHANICAL MOVEMENT OF A HAND-WOUND WATCH

(57) A method for manufacturing components having a light weight for achieving the mechanical movement of a hand-wound watch, comprising the steps of:
- designing the components so that a single component includes the functionalities and features of several components, so that the total number of components is smaller than the present mechanical movements;
- manufacturing the components with additive manufacturing technology so that a single component comprises several components already partially assembled together, so that the post-assembly step requires less time; and
- assembling together the aforesaid components obtained via additive manufacturing to obtain the mechanism of a hand-wound watch.

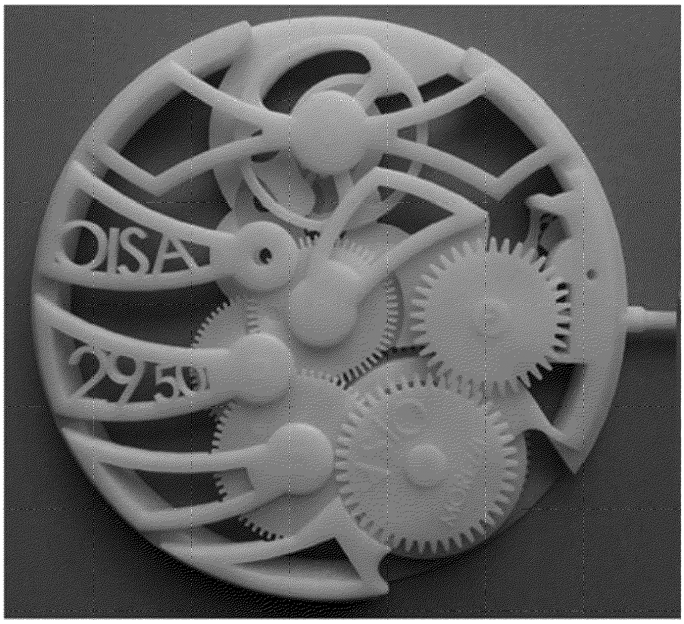

Fig. 16

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to the redesigning of the mechanical movement of a hand-wound watch.

[0002] In particular, the present invention relates to an additive manufacturing technique for manufacturing components for the mechanical movement of watches, more specifically, hand-wound watches.

KNOWN PRIOR ART

[0003] There are two macro families of movements for the operation of a watch: mechanical movements (the seconds ball moves continuously) and quartz movements (the seconds ball moves intermittently, one second at a time).

[0004] The first ones do not need a battery to operate, whereas the second ones need a battery.

[0005] The mechanical movements are divided, in turn, into manual and automatic movements. In manual winding movements, the winding is carried out manually by rotating the outer crown and the watch works until the spring runs completely flat. Whereas, automatic ones are provided with a rotor, which through a complex transmission, utilizes the movement of the wrist, in order to wind the spring and thus cause the watch to work.

[0006] Ideally, in this case, in automatic watches, the watch could work indefinitely provided that the movement thereof in space is ensured.

[0007] The model structure of a watch with a hand-wound mechanical movement is illustrated with reference to Figures 1-7.

[0008] The logic of the movement is based on the elastic energy released by a winding spring 33 (see Figure 6) housed inside a barrel 20 (see Figure 2).

[0009] The winding is given by rotating an endless screw known as a stem 9, onto which a crown is normally mounted (not shown in the drawings).

[0010] On a free end of the stem 9 (the end opposite to where the crown is mounted) a small wheel is mounted with a complex profile called a winding pinion 25 (see Figure 4), coupled to a crown wheel 10 (see Figure 1), which is connected, in turn, to a ratchet wheel 11.

[0011] The ratchet wheel 11 is integral with a barrel shaft 32, placed inside the barrel 20, onto which the winding spring 33 is mounted.

[0012] Once the winding spring 33 has been wound, it releases elastic energy to what is referred to as the "wheel train", see Figure 2, in which the wheel train consists of a large center wheel 12, a third wheel 13 and a central seconds wheel 19.

[0013] The central seconds wheel 19 is connected to an escapement wheel 14, which, through an anchor 15, transfers the impulse to a balance wheel 7, which can complete the oscillatory motion thereof (the angle between the two dead points of the balance wheel 7 during the movement is referred to as amplitude).

[0014] Figure 3 shows the mechanism, which allows the movement of the minute hand and the hour hand, as well as the system, which allows the time on the watch to be adjusted.

[0015] All of the components, which are shown in Figure 3 are connected to those present in the front view (shown in Figure 1 and in Figure 2) by means of a particular and ingenious component called a clutch 27 (see Figure 4), which performs a simple, but necessary function: that of making the system for adjusting the time independent of the watch motor system (as in cars, the clutch decouples the drive shaft from the wheels).

[0016] The clutch 27 consists of two wheels, which, when it is desired to adjust the time of the watch, must be independent, but when they are not in the position of adjusting the time, they must be integral so that the elastic energy released by the barrel 20 can be transferred to a minute wheel 28 and then to an hour wheel 29 and to a canon wheel 31 (Figure 5) onto which the hour hand and the minute hand are mounted, respectively.

[0017] Figure 7 shows a detail of the mechanical movement of the watch referring to the process of adjusting the time.

[0018] The setting of the hour on the watch is carried out thus: take the winding crown (not shown in the Figures), screwed onto the stem 9, and pull it outwards in the direction of the arrow F.

[0019] In the stem 9 there is a groove inside which is a foot of a draw rod 22 (see Figure 3), which moves integrally with the stem 9. On moving, the foot of the draw rod 22 pushes a weighbridge 23, which is conveniently connected to what is called a sliding pinion 26. The sliding pinion 26 is a component, which is free to slide on the stem 9 and which will engage with the clutch 27 so as to adjust the time. Once the winding crown is pushed inwards, everything returns to the initial position, corresponding to what is referred to as the winding position.

[0020] To-date, such components are produced individually by traditional technologies, such as the removal of swarf and successively mounted together during the assembly step.

[0021] From Figure 1 it is possible to note the presence of numerous elements, which do not take an active part in the operation of the mechanism, such as the entire bridge system, comprising a barrel bridge 1, a center wheel bridge

2, a central bridge 3, an escapement bridge 5, a balance wheel bridge 6, and an anchor bridge 17.

[0022] All of these elements serve to keep the wheels in axis.

[0023] Furthermore, other elements, which do not an active part in the operation of the mechanism are the slot screws 8, which serve to fasten the bridges to a platen 4.

[0024] It is also possible to note how the design of the platen 4 requires different processings to obtain the seats needed for positioning the various members forming the movement mechanism.

[0025] Thus, to-date in order to ensure the correct working of the watch's movement mechanism, the traditional processing processes, such as the removal of swarf, require additional mechanical components, which result in an increased weight of the component, an increased production time due to the assembly step, a greater probability of discrepancy due to the phenomenon referred to as tolerance chain (set of consecutive tolerated amounts for elements of the pieces assembled in a group or overall).

[0026] Finally, a limit of the design freedom of the components is evidenced in keeping with the removal processes of swarf determined by the constraints of accessibility or collisions, which prevent the tool from accessing the surface to be worked.

[0027] Therefore, the need is felt to find and suggest solutions capable of overcoming and solving the problems of the solutions, which are currently available, and eliminating the drawbacks present in the current solutions.

SUMMARY OF THE INVENTION

[0028] The present invention relates to solutions aimed at solving the aforesaid problems and drawbacks.

[0029] It is an object of the suggested solution to use processes for producing alternatives to the traditional ones, aiming at being able to redesign the traditional geometry of the mechanical movement, trying to minimize the previously described limits.

[0030] In particular, to-date, additive manufacturing stands as a real alternative solution to traditional processes for producing components characterized by elevated added value, utilizing the design freedom, which is typical of the process.

[0031] Thus, by utilizing the advantages resulting from additive manufacturing, the mechanical movement of a hand-wound watch has been redesigned aiming at reducing the overall weight thereof, the number of parts and the production time, significantly reducing the assembly step since most of the components have already been produced interconnected to one another.

BRIEF DESCRIPTION OF THE DRAWINGS

[0032] Further features and advantages of the invention will become apparent from the following description provided by way of example and not by way of limitation, with the aid of the figures shown in the accompanying drawings, in which:

- Figure 1 shows a front view of the model structure of a watch with a hand-wound mechanical movement,
- Figure 2 shows a front view without bridges of the model structure of a watch with a hand-wound mechanical movement,
- Figure 3 shows a rear view of the model structure of a watch with a hand-wound mechanical movement,
- Figure 4 shows an enlargement of a portion of the rear view in Figure 3 of the model structure of a watch with a hand-wound mechanical movement,
- Figure 5 shows an enlargement of a portion of the rear view in Figure 3 of the model structure of a watch with a hand-wound mechanical movement,
- Figure 6 shows a side section of the barrel of the model structure of a watch with a hand-wound mechanical movement,
- Figure 7 shows an enlargement of a portion of the rear view in Figure 3 relative to the mechanism for adjusting the time,
- Figure 8 and Figure 9 show a front view and a rear view of the original geometry of the structure of the platen and the bridges as separate components,
- Figure 10 and Figure 11 show a front view and a rear view of the modified geometry of the structure, in which the platen and bridges are obtained in a single piece,
- Figure 12 shows the original geometry of the barrel consisting of different components,
- Figure 13 shows the modified geometry of the barrel consisting of a single component,
- Figure 14 shows the original geometry of the system of adjusting the time and the winding,
- Figure 15 shows the modified geometry of the system of adjusting the time and the winding, and
- Figure 16 and Figure 17 show a front view and a rear view of a prototype, true to scale, of the new mechanical movement of a hand-wound watch according to the present invention.

[0033] The parts according to the present description have been depicted in the drawings, where appropriate, with conventional symbols, showing only those specific details which are pertinent to the understanding of the embodiments of the present invention, so as not to highlight details, which will be immediately apparent to those skilled in the art, with reference to the description provided below.

DETAILED DESCRIPTION OF THE INVENTION

[0034] The modifications made in the suggested redesigning in the mechanical movement of a hand-wound watch are shown in the table below.

[0035] In particular, it is reported whether the specific component has been eliminated or redesigned in the "Modification" column. The components, which are not present in the table, do not appear to have been modified.

TABLE 1

#	COMPONENT DESCRIPTION	QUANTITY	MODIFICATION
1	BARREL BRIDGE	1	ELIMINATED (NOW IT IS A COMPONENT PART OF THE PLATEN)
2	CENTER WHEEL BRIDGE	1	ELIMINATED (NOW IT IS A COMPONENT PART OF THE PLATEN)
3	CENTRAL BRIDGE	1	ELIMINATED (NOW IT IS A COMPONENT PART OF THE PLATEN)
4	PLATEN	1	PLATEN AND BRIDGES HAVE NOW BECOME A SINGLE COMPONENT (IN FACT, THEY ARE 7 DIFFERENT COMPONENTS)
5	ESCAPEMENT BRIDGE	1	ELIMINATED (NOW IT IS A COMPONENT PART OF THE PLATEN)
6	BALANCE WHEEL BRIDGE	1	ELIMINATED (NOW IT IS A COMPONENT PART OF THE PLATEN)
7	BALANCE WHEEL AND COIL	1	COMPONENTS SEEN AS A UNIT (IN FACT THEY ARE TWO DIFFERENT COMPONENTS)
8	SLOT SCREWS	17	ELIMINATED
17	ANCHOR BRIDGE	1	ELIMINATED (NOW IT IS A COMPONENT PART OF THE PLATEN)
18	RUBIES	12	ELIMINATED
20	BARREL	1	COMPLETELY REVISITED (IT ACTUALLY CONSISTS OF 4 DIFFERENT COMPONENTS, NOW IT ONLY APPEARS TO BE ONE COMPONENT)
23	WEIGHBRIDGE	1	ELIMINATED/COMPLETELY REVISITED (NOW IT IS A COMPONENT PART OF THE PLATEN)
24	DRAW ROD COVER	1	ELIMINATED/COMPLETELY REVISITED (NOW IT IS A COMPONENT PART OF THE PLATEN)
30	SMALL METAL COMPONENTS STUD	1	NOW IT IS A COMPONENT PART OF THE PLATEN

[0036] From Table 1 it is apparent that many components (such as the screws, which, in the original movement are seventeen in number and the rubies, which in the original movement, are twelve in number) have been eliminated because, since the additive production process is capable of producing components already assembled, they were no longer necessary for the correct operation of the movement.

[0037] Figures 8-17 show the substantial changes made on a geometrical level, aiming at reducing the weight of the movement of the watch and aiming at reducing the overall number of components. Furthermore, some components have been completely redesigned with a view to Additive Manufacturing.

[0038] Note that, by analyzing Figures 8,9,10, and 11, the platen 4 and the bridges 1,2,3,5,6, and 17 have been redrawn/redesigned aiming at lightening the weight of the mechanical movement (furthermore, they are now a single component).

[0039] The platen 4 is the component, which has undergone the most changes: the geometry thereof was significantly modified following the redesigning.

[0040] Now, following on from what was said in the previous lines, the bridges 1,2,3,4,5,6 and 17 appear to be a component part of the platen, thus, already assembled without having to use screws for the coupling. Furthermore, all of these components have been modified in order to reduce the weight thereof, and in the field of watchmaking this is a great advantage.

[0041] However, the most important modification is the one made to the winding system (and the time setting): now, the weighbridge 23 and the setting cap 24 have been completely redesigned so they can be considered as one with the Platen 4, while, at present, they are three different components joined to one another by means of screws.

[0042] This substantial modification can be seen in Figures 14 and 15, where the system is shown before and after the redesigning, respectively. It should be pointed out that this modification has been made possible by additive technology, and is impossible to achieve using the conventional production techniques. Here too, we have considerable advantages: a reduction in the number of components, a reduction in the overall weight and elimination of the post-assembly step.

[0043] A further redesigning made possible by additive manufacturing, is the redesigning carried out on the barrel 20. In the original movement it consists of four components: central shaft, drum, cover, and winding spring. After the redesigning, these four components appear already assembled and independent of one another (thus, free to rotate), also modified in geometrical terms so as to reduce the weight thereof.

[0044] Thus, the advantages of this modification are a reduction in the number of components, a reduction in the overall weight and elimination of the post-assembly step.

[0045] Alternatively, the weighbridge 23 and the setting cap 24 have been completely redrawn, to redesign the operation of the time-setting and watch- winding system (these are now also a part of the platen). Figure 14 shows the original system and Figure 15 shows the modified one according to the present invention.

[0046] Figures 16 and 17 show a prototype made by means of additive manufacturing of the solution suggested on a scale of 4:1.

[0047] The additive manufacturing technology used is MATERIAL JETTING. The operating principle on which these processes are based is very similar to that of common ink jet printers. Thus, the material is jetted onto the construction platform with a continuous or Drop-on-Demand approach (jetted upon specific request).

[0048] The material is deposited onto the platform through a nozzle which moves in the space along the axes XY in order to create, layer by layer, the layers which will form the final piece. Naturally, there is a gradual solidification of the individual layers, which are hardened by means of UV light. The machines used vary in complexity and in the methods of controlling the deposition of the material. Polymers and waxes are the most suitable materials for this type of processes due to the viscous nature thereof and to the capacity thereof to form drops.

[0049] In particular, the material used to construct the new prototypes following the redesigning is VISIJET M2R-WT developed by 3D SYSTEMS.

[0050] The printer used was developed again by 3D SYSTEMS, and it is the MJP2500. It is an advanced machine, which utilizes the principle of Material Jetting, conceived to ensure an elevated professional level at a convenient price, with a compact size and simple man/machine interface.

[0051] The Additive Manufacturing processes involve a series of steps, which start from the description of the CAD and end with the manufacturing of the piece. Different types of products can utilize the Additive Manufacturing in different ways and to a different extent: relatively simple and small products can use the Additive Manufacturing with the purpose of visualization, while more complex components with a high engineering content can utilize the Additive Manufacturing to carry out technical and functional checks of the component.

[0052] In general, regardless of the object and the process selected for producing the component, the manufacturing process is always the same and consists of eight steps.

- Step 1: CAD. All of the products, which are desired to be manufactured by Additive Manufacturing must start from a model generated by software, which completely describes the outer geometry of the piece. Such solid modeling is ensured by the use of a professional CAD, but on output there is a solid representation or a 3D surface. Reverse Engineering techniques can be used to create the point cloud, which will then represent the surface of the piece.
- Step 2: Conversion into STL file. Almost every Additive Manufacturing machine accepts the STL format, which has now become the format par excellence for CAD systems applied to additive. This file describes the outer surfaces of the original CAD model and forms the basis for the calculation of the layering of the component.
- Step 3: Manipulation of the STL file. The STL file, which describes the component, is transferred to the machine for Additive Manufacturing. On the machine the file can be conveniently manipulated so as to ensure the desired scale,

a correct positioning, and a correct orientation for the production thereof.

- Step 4: Machine setup. The machine for Additive Manufacturing is set correctly before the production process. Such settings regard the parameters for construction, materials, energy source, layer thickness, timing, etc.
- Step 5: Production. Construction of the part is basically an automated process and the machine does not require supervision during operation. Only a small initial inspection is needed at the beginning to ensure an absence of errors due to a lack of material in the machine, a power failure or problems relating to the positioning of the piece.
- Step 6: Removal of the piece. Once the machine has completed the processing of the component, it must be removed. Since removal requires interaction between the operator and the machine, safety blocks can be present to ensure that the operating temperatures are low enough, for example, or that there are no moving parts.
- Step 7: Post treatments. Once the parts have been removed from the machine, they may require a post-treatment before they are ready for use. This step needs time and operator experience.
- Step 8: Application. The parts can now be used, however further treatments may also be necessary before they are ready for use. For example, they may require a painting step rather than other surface finishing operations. These treatments are as long and laborious as the finishing constraints are demanding. Furthermore, the parts can also be assembled to other mechanical or electronic components to form the finished product.

[0053] Given below are the advantages of the suggested solution with respect to the original geometry utilizing the advantages of additive manufacturing:

- a reduction in the number of components from 53 to 27 (reduction of 50%);
- components made simultaneously, reducing the post-assembly step;
- reduction of 50% in the weight of the component with respect to the original geometry;
- overall production time equal to about 6 hours.

[0054] Of course, without prejudice to the principle of the invention, the construction details and embodiments may vary widely with respect to the description disclosed merely by way of example, without departing from the scope of the present invention.

Claims

1. A method for manufacturing components having a light weight for achieving the mechanical movement of a hand-wound watch, comprising the steps of:

- designing the components so that a single component includes the functionalities and features of several components, so that the total number of components is smaller than the present mechanical movements;
- manufacturing the components with additive manufacturing technology so that a single component comprises several components already partially assembled together, so that the post-assembly step requires less time; and
- assembling together the aforesaid components obtained via additive manufacturing to obtain the mechanism of a hand-wound watch.

2. The method according to claim 1, wherein the additive manufacturing technology used is the MATERIAL JETTING.

3. The method according to claim 2, the material is jetted onto the construction platform with a continuous or Drop-on-Demand approach.

4. The method according to claim 2 or claim 3, wherein the material is deposited onto the platform through a nozzle which moves in the space along the axes XY in order to create, layer by layer, the layers which will form the final piece.

5. The method according to one or more of the claims 2 to 4, wherein there is a solidification of the single layers by means of UV light between one layer and the other.

6. The method according to one or more of the claims 2 to 5, wherein the materials used are selected from polymers and waxes due to the capacity thereof to form drops.

7. The method according to one or more of the claims 2 to 6, wherein the material used is VISIJET M2R-WT.

8. The method according to one or more of the preceding claims, wherein the manufacturing process comprises the steps of:

- generating a CAD model by means of a software, which completely describes the outer geometry of the piece;
- converting the model into STL file which describes the outer surfaces of the CAD model and forms the basis for the calculation of the layering of the component; and
- manipulating the STL file to ensure the desired scale, a correct positioning and a correct orientation for the production thereof.

9. The method according to claim 8, wherein the manufacturing process comprises the steps of:

- setting up the machine before the process of producing the construction parameters, materials, energy source, layer thickness, timing, etc.;
- producing the piece;
- removing the piece;
- carrying out the operations of post-treatment of the piece; and
- applying or assembling the piece with other mechanical or electronic components to form the final product.

10. A hand-wound watch, wherein the components are obtained according to one or more of the claims 1 to 9.

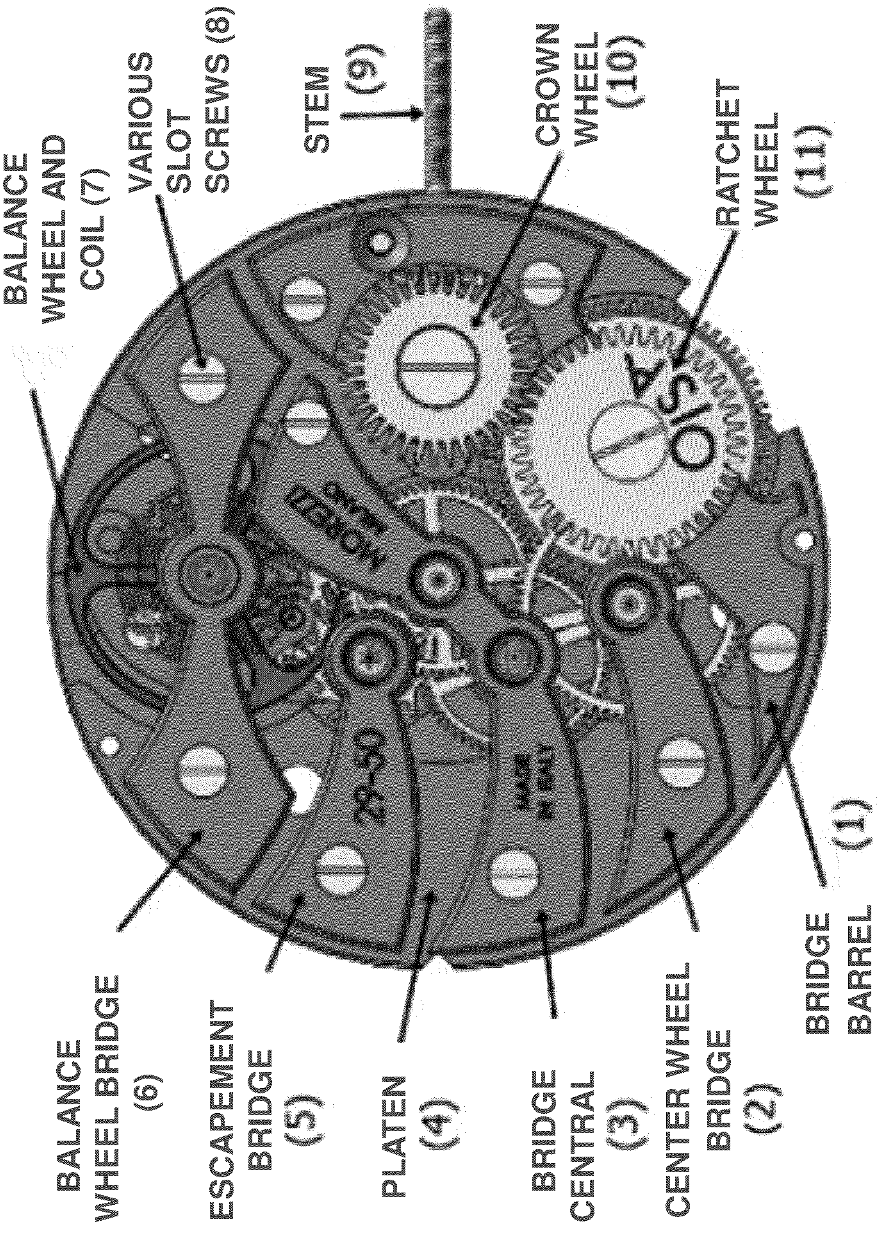
BALANCE WHEEL AND COIL (7)
VARIOUS SLOT SCREWS (8)
STEM (9)
CROWN WHEEL (10)
RATCHET WHEEL (11)
BALANCE WHEEL BRIDGE (6)
ESCAPEMENT BRIDGE (5)
PLATEN (4)
BRIDGE CENTRAL (3)
CENTER WHEEL BRIDGE (2)
BRIDGE BARREL (1)
MOREZZI MILANO
29-50
MADE IN ITALY

Fig. 1

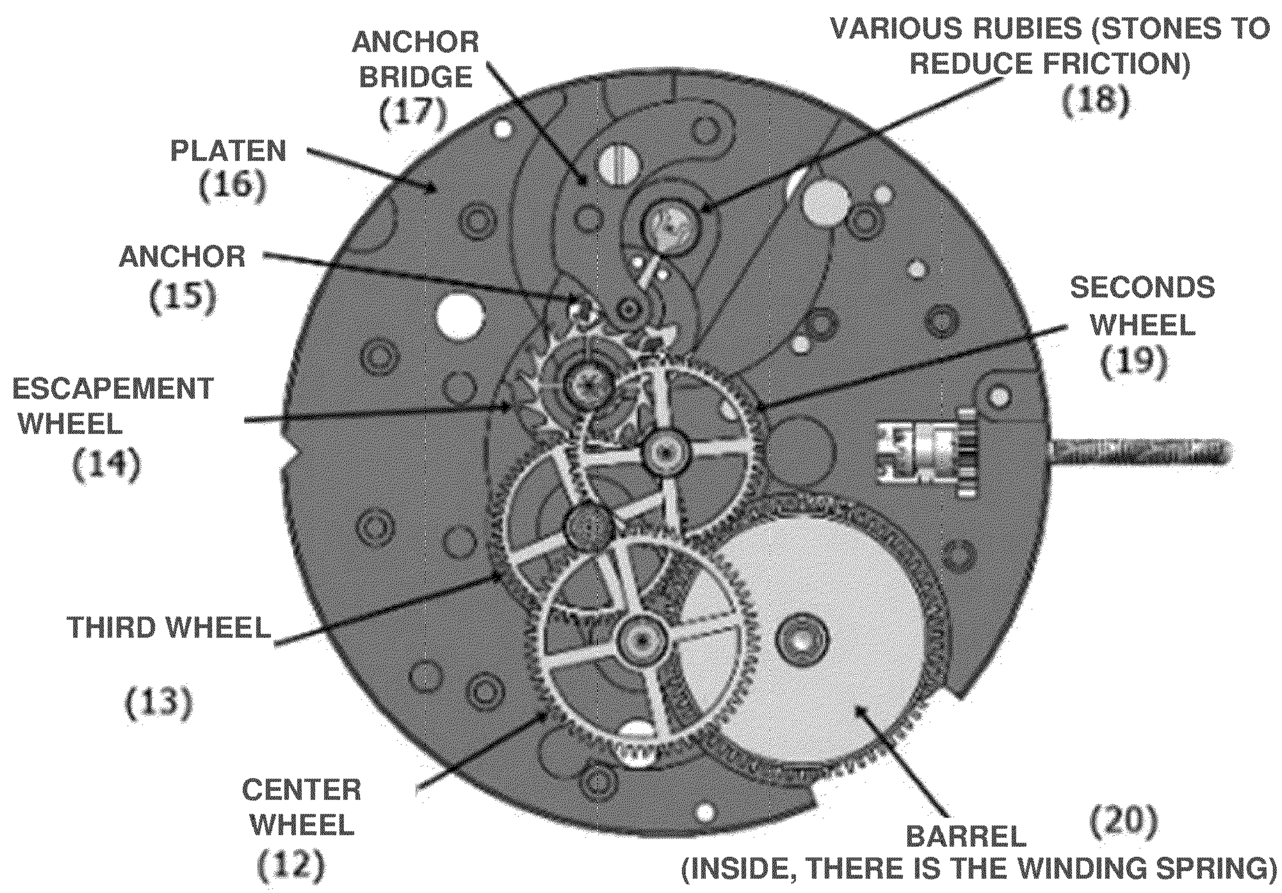
ANCHOR BRIDGE (17)
VARIOUS RUBIES (STONES TO REDUCE FRICTION) (18)
PLATEN (16)
ANCHOR (15)
SECONDS WHEEL (19)
ESCAPEMENT WHEEL (14)
THIRD WHEEL
(13)
CENTER WHEEL (12)
(20)
BARREL
(INSIDE, THERE IS THE WINDING SPRING)

Fig. 2

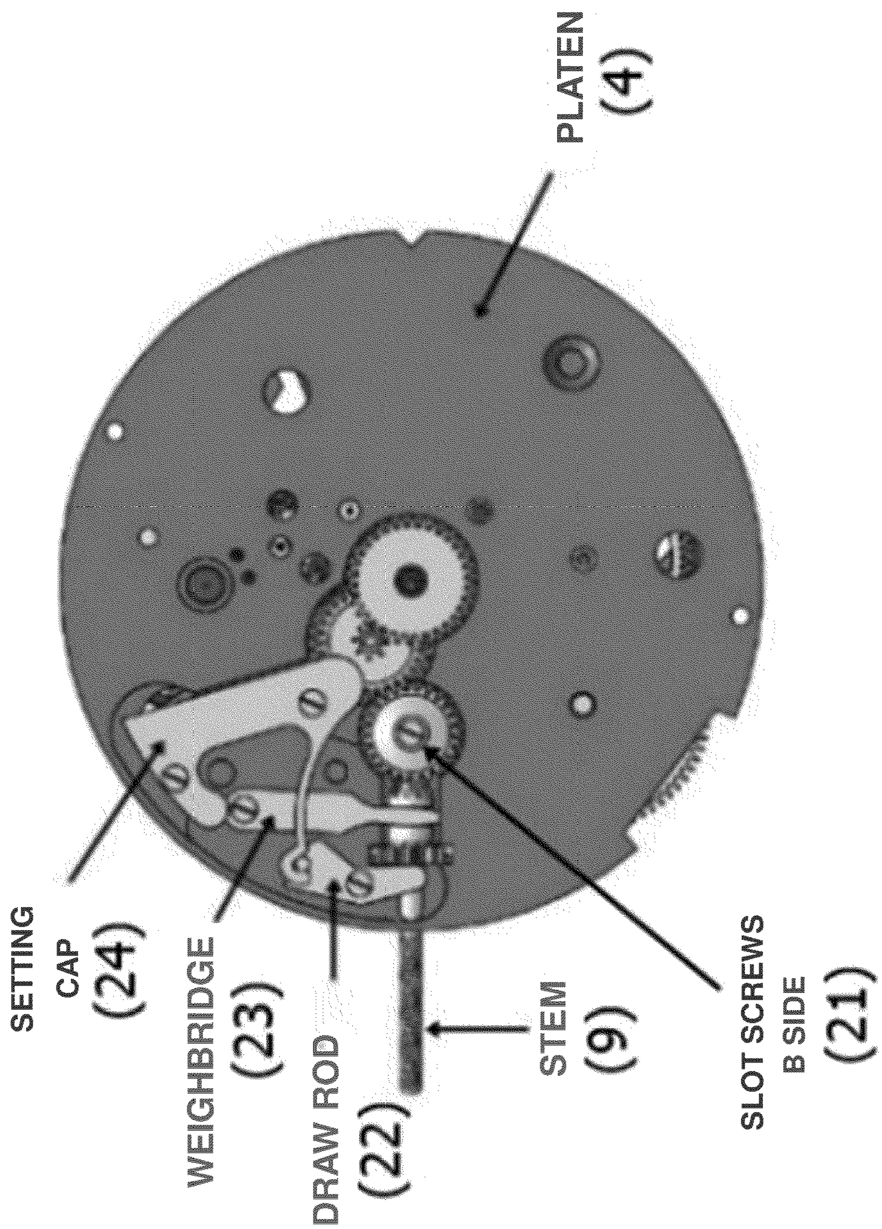
PLATEN
(4)
SETTING
CAP
(24)
WEIGHBRIDGE
(23)
DRAW ROD
(22)
STEM
(9)
SLOT SCREWS
B SIDE
(21)

Fig. 3

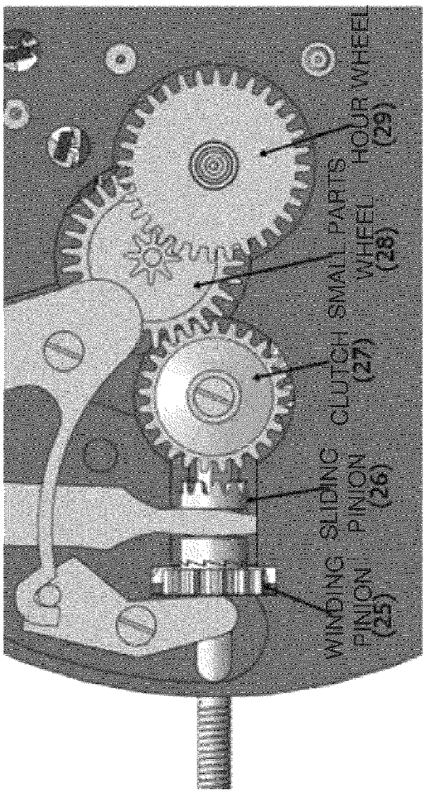

Fig. 4

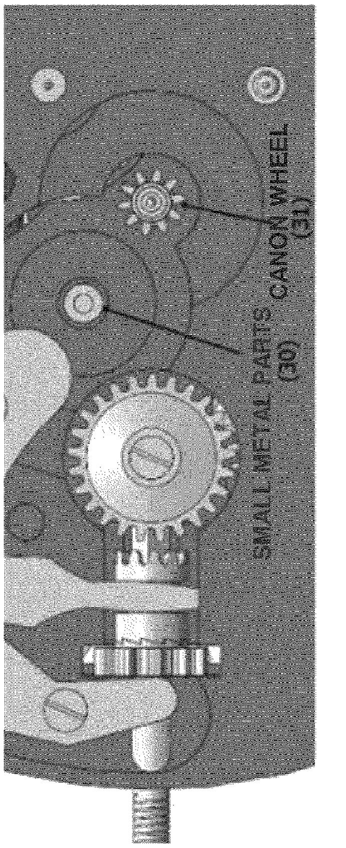

Fig. 5

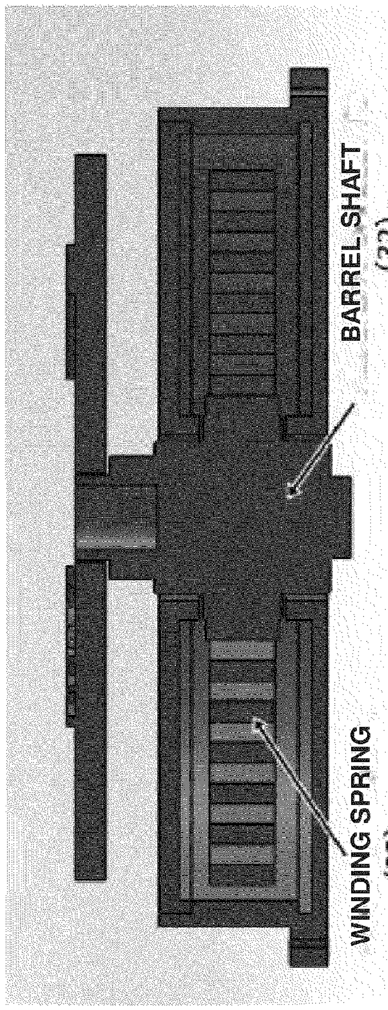

Fig. 6

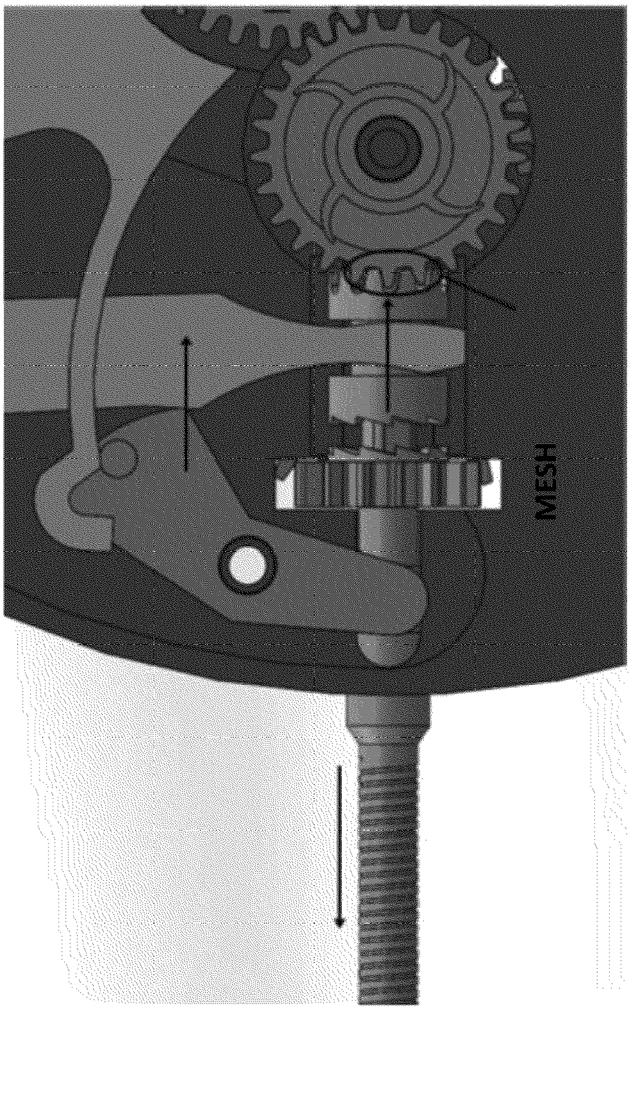

Fig. 7

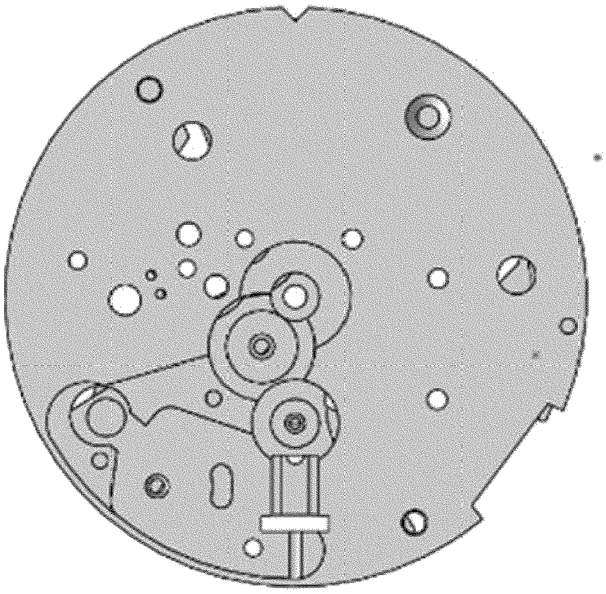

Fig. 9

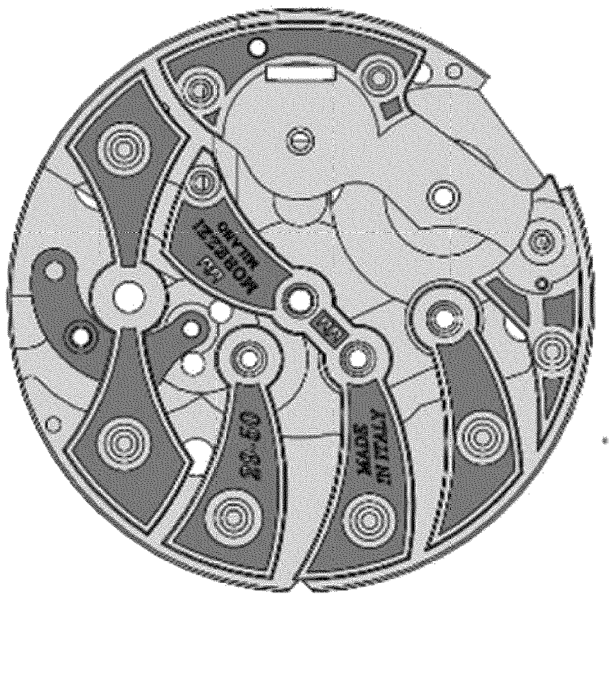

Fig. 8

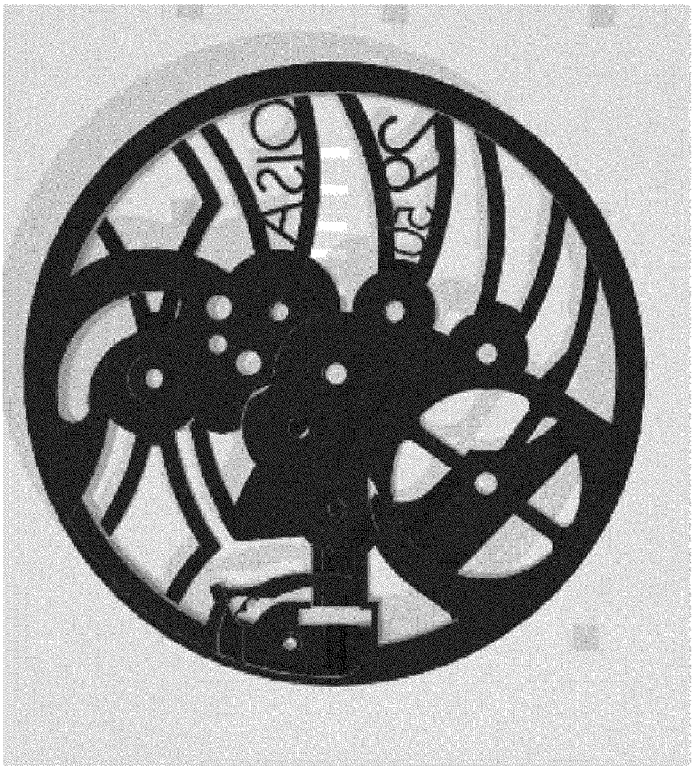

Fig. 11

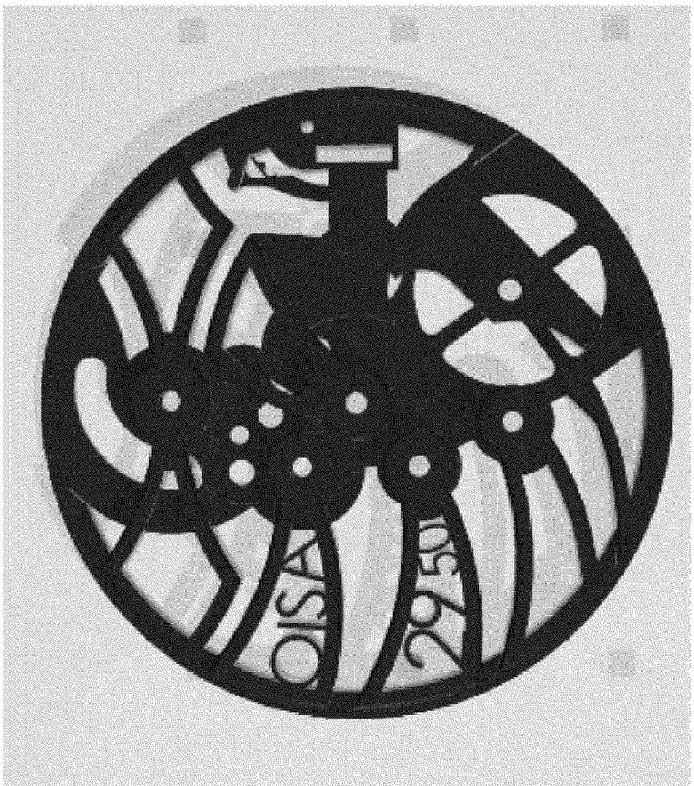

Fig. 10

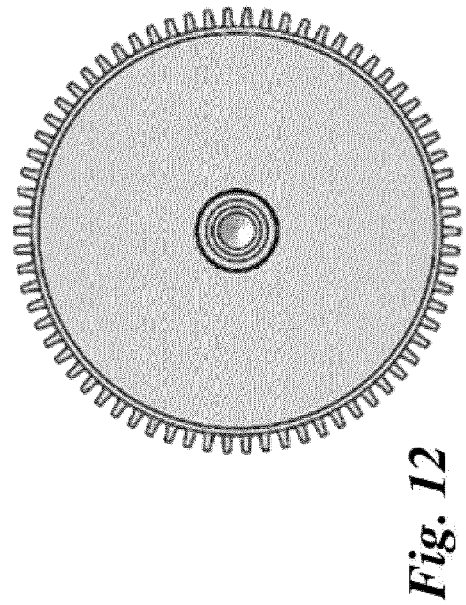

Fig. 12

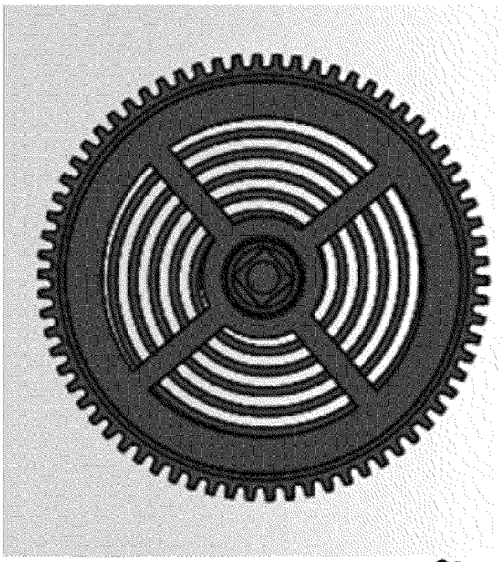

Fig. 13

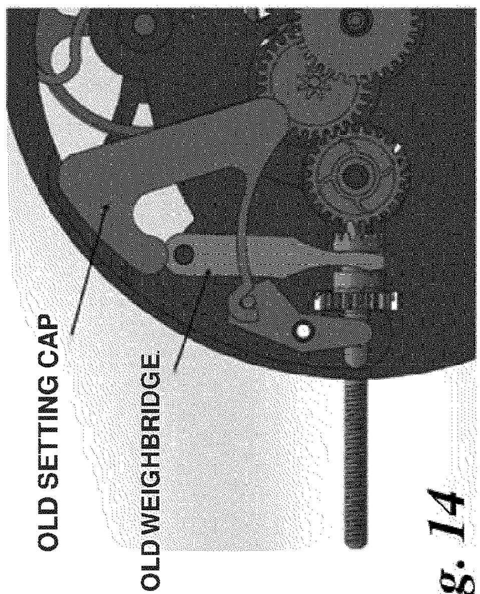

Fig. 14

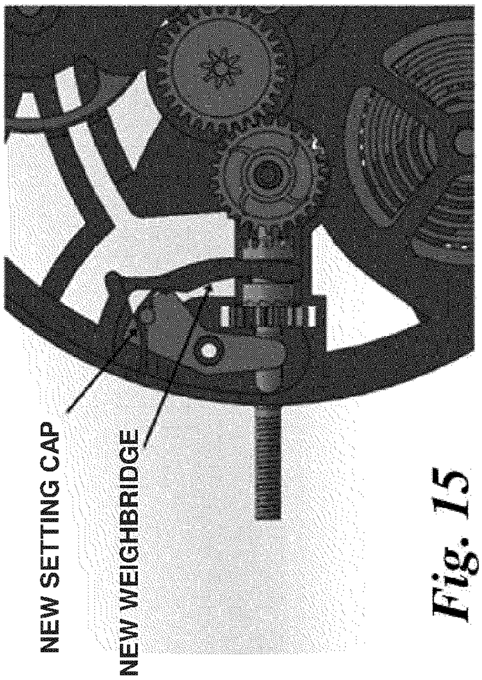

Fig. 15

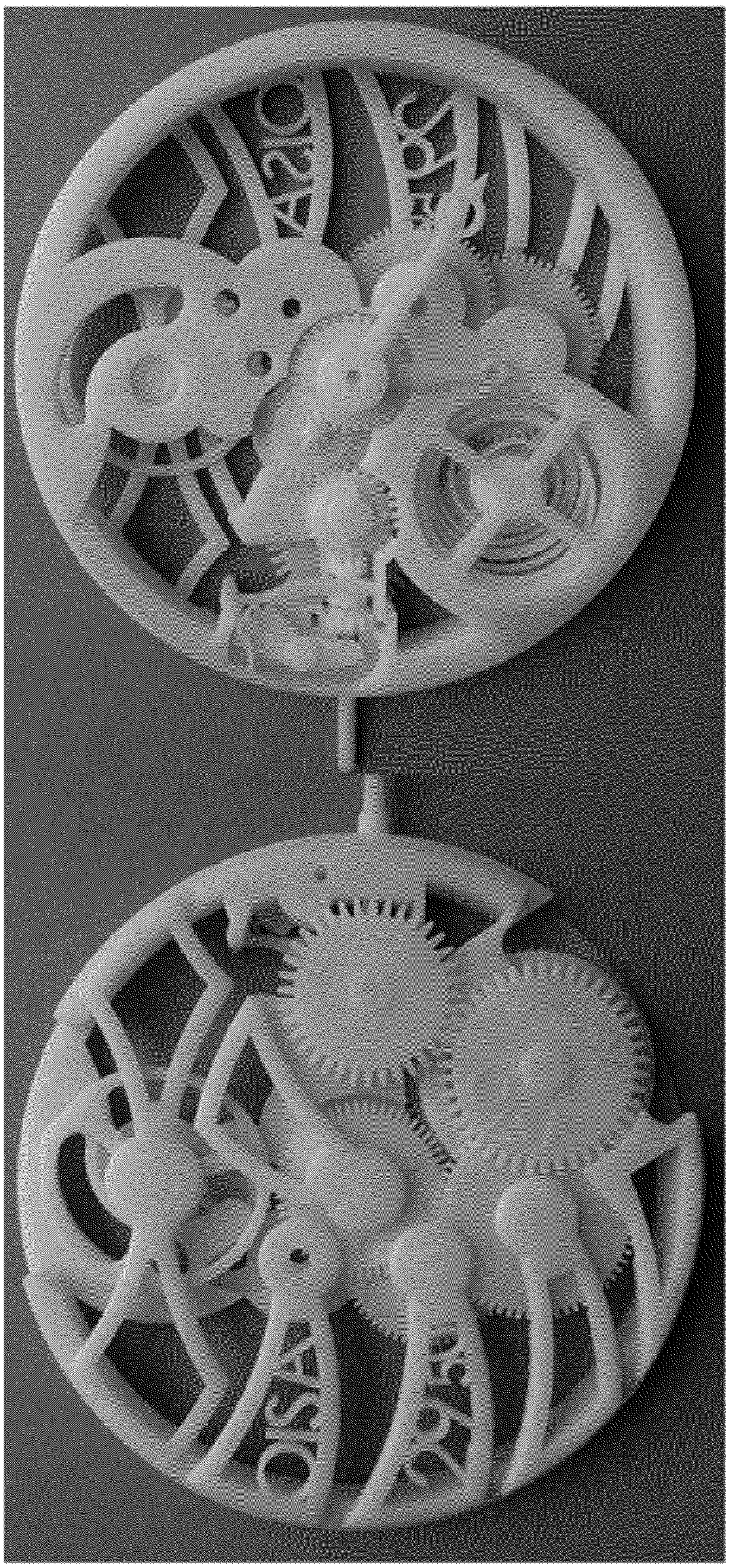

Fig. 17

Fig. 16

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 20 18 7622

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2010/290319 A1 (SWARTZ ROBERT [US] ET AL) 18 November 2010 (2010-11-18) * paragraphs [0005], [0006], [0012], [0014], [0020] - [0028]; claims 1-20; figures 1-2 *	1-10	INV. G04D3/00 G04B1/14 G04B3/04 G04B13/02 G04B29/02
A	EP 2 485 099 A2 (RICHEMONT INT SA [CH]) 8 August 2012 (2012-08-08) * paragraphs [0007] - [0011], [0018], [0021], [0025], [0026], [0028], [0031], [0033], [0034]; claims 1-15; figures 1-10 *	1-10	
A	WO 2019/120933 A1 (ETA SA MFT HORLOGERE SUISSE [CH]) 27 June 2019 (2019-06-27) * abstract; claims 1,9,11; figures 1-9 *	1-10	
			TECHNICAL FIELDS SEARCHED (IPC)
			G04D B33Y G04B

The present search report has been drawn up for all claims

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Place of search	Date of completion of the search	Examiner
The Hague	26 November 2020	Laeremans, Bart

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