THE CLOCK BOOK

First edition

TABLE CLOCK

MECHANICA M5

Instruction manual,
development
and technology

UHRENBAUSATZ

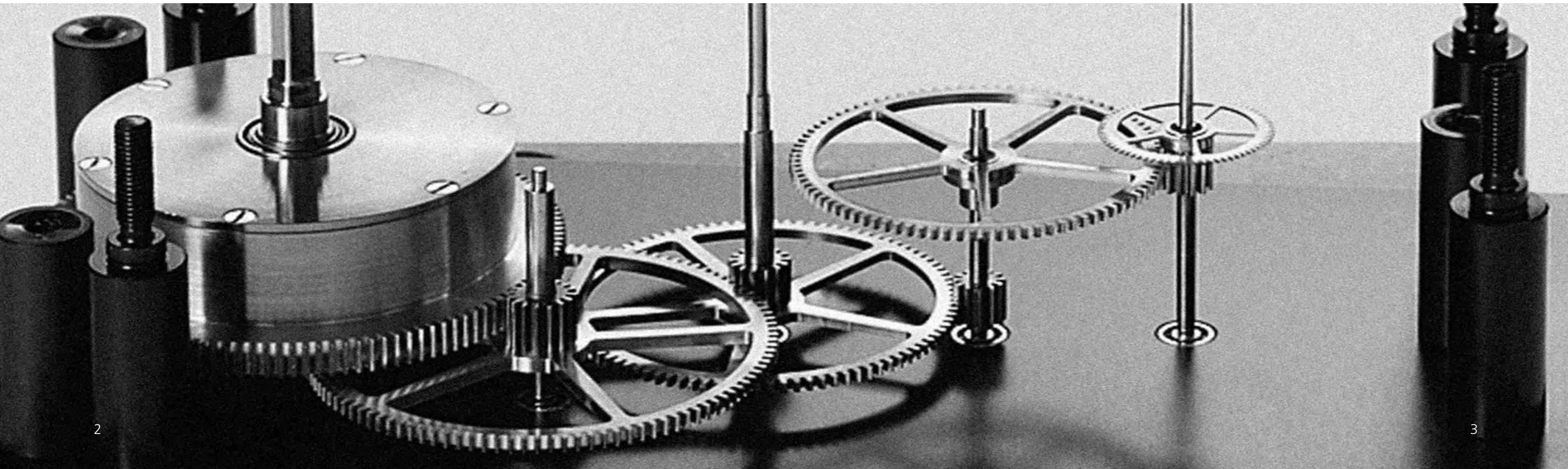
BUILD YOUR OWN PERSONAL PIECE OF HISTORY

Black varnish – Base clock kit

Black varnish – Upgraded with the date indication

Walnut – Base clock kit

Cherry – Upgraded with the moonphase indication



THE IDEA

Dear clock enthusiasts!

Thank you for your interest in our unique clock kits and for taking your time to collect information.

Especially in today's hectic times, which are characterized by mobile phones, computers and anonymity, more and more people are enjoying mechanical timekeepers again. These are, of course, mostly watches, but also increasingly clocks.

The steady ticking of a clock and the even swinging of the pendulum creates a soothing atmosphere in every room. A pendulum clock increases the coziness enormously. The fascination of the visible and discreetly audible mechanical processes inspired us to get the Latin name Mechanica.

Clock enthusiasts from all over the world often expressed their wish to purchase individual parts such as gears, pendulums or clock cases from the Erwin Sattler clock collection. We always had to reject such wishes, because parts from us are only to be found in clocks from the manufacture Erwin Sattler!

The wishes of our customers caused us to consider how all of this would be compatible and the idea of creating a clock kit came up. We considered how all of this would be compatible and came up with the idea of creating a clock kit. A clock to be assembled by the customer, even a precision pendulum clock! In the history of clock making there were historical models, such as the company Strasser & Rohde, which delivered individual components for precision clocks to watchmakers in the late 19th century.

With more than 30 years of experience in precision pendulum clock construction, in which we have manufactured more than 1000 precision pendulum clocks with a seconds pendulum (such as the Classica Secunda 1995) and over 13000 regulator pulley clocks, we started the adventure of a first clock kit model, the 5/6 second precision pendulum clock Mechanica M1.

It was and is important for us to continue the tradition of classic clock making that has been developed over the past centuries and further develop it with the available means of today. The know-how, our modern CNC-controlled machines, an independent construction and the use of contemporary material made this project possible.

In the meantime, more than 1000 satisfied Mechanica customers have made an enormous contribution to the existence and constant improvement of this unique clock kit idea.

All movements of the Mechanica series, from the first M1 to the latest M5, consist of approx. 100 clockwork parts. They are designed in such a way that they can be easily assembled even by less experienced friends of fine timepieces. Nevertheless, they are characterized by the same high technical quality features that an Erwin Sattler precision clockwork also has.

Valuable clocks are the highlight in every room and delight every day. They are the pride of every owner, especially when, as in this case, he also assembled the clock himself. A clock of this quality, if given the right care, will all outlast us and can be passed on from generation to generation with great pride.

Your clock kit team!

UHRENBAUSATZ

MECHANICA
M5

Many thanks to all who made
this project possible:

Production of the entire movement:
Clockmakers, Master Clockmakers,
Engineers and Mechanics of Erwin Sattler GmbH & Co.KG

Production of the case:
Fa. Josef Wochner, Heiligenzimmern

Construction, texts:
Jürgen Kohler, Erwin Sattler GmbH & Co. KG
Sabine Müller, Erwin Sattler GmbH & Co. KG

Graphics:
Atelier Schrader, Gräfelfing

Responsible for the concept and achievement of the project:
Stephanie Sattler-Rick, Markus Glöggler,
Jürgen Kohler Erwin Sattler GmbH & Co. KG

Protection fee: EUR 25,–

INSTRUCTION MANUAL
MECHANICA M5

Before the thrill of anticipation overtakes you and you begin assembling your Mechanica M5, we ask you to you carefully read the following information.

Your Mechanica M5 is a precise table clock*, which means the individual components have been manufactured with the utmost precision at very low production tolerances.

In order to avoid damaging the somewhat sensitive components, we recommend you use great care in unpacking and assembling the parts.

The sequence of steps explained in the instruction manual was designed to save you unnecessary difficulty and ensure that all goes smoothly.

Assembly instructions for numerous other possible options are listed as »Accessories« near each of the steps and clearly marked as such so you can differentiate them.

Accessories A clear listing of the accessory equipment with short descriptions currently available to technically and visually upgrade your Mechanica M5 can be found at the end of this book on pages 94 - 95.

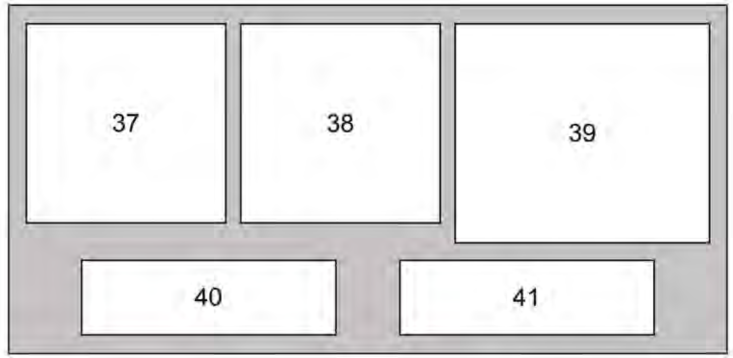
In the assembly instructions and explanatory remarks, we have decided to refrain from using technical jargon as far as possible.
Technical words that could not be avoided are explained in the glossary at the end of this book. These are marked with an asterisk * in the text.

Safety notice

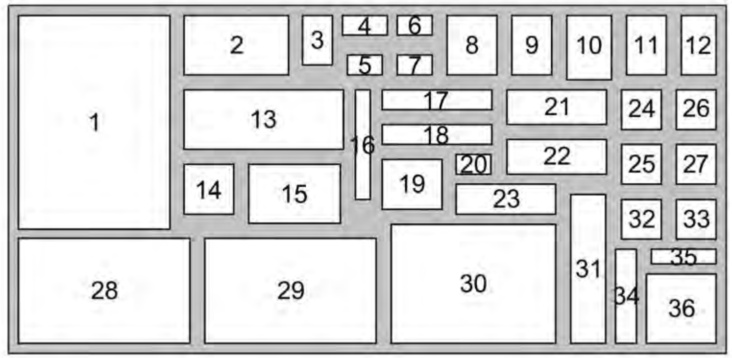
Your table clock kit contains quickly moving parts. In order to avoid danger of injury, please take note of all safety precautions and advice!

The assembly of your Mechanica M5 is clearly divided into three levels and organized into numbered compartments.
The corresponding numbers are also specified on each of the components, tools, and auxiliary accessories so they can be easily located. An overview of the levels' numbers can be found on the packing list and the illustration at right.

Upper level



Centre level



Lower level

- ☐ Base plate with movement base
- ☐ Cornice plate
- ☐ Lid of secret compartment
- ☐ Inlay fleece for the secret compartment
- ☐ Back side bars
- ☐ Case brace (stainless steel)
- ☐ Assembled door
- ☐ Door seal

We begin with the case,

which, if it is the natural wood version, must first be varnished with the care product that came in the kit. It is important to make sure that the room you are working in is well ventilated. In order to avoid the possible danger of fire, store the oil soaked cloth only in the jar delivered with your kit. During the time the case needs to dry out, you can carefully and tranquilly read through the rest of the process here. Please be very careful when you assemble the case as it is entirely possible to injure yourself with the glass panes. Carefully prepare your workspace before continuing with the assembly of the movement. It needs to be kept clean and should be outfitted with a good light. The components have been cleaned by us and packed up cleanly and carefully. In order to avoid unnecessary soiling, please only take the parts out of the packaging right before you need to use them. Check the parts and and make sure they are not damaged in any way.

The ball bearings* intended to bear the gear train* are crafted in stainless steel*, so that they attain the least possible amount of friction*, they are not sealed. Thus, these parts should be protected from dust and small dirt particles during assembly. The steel arbors* of the gear wheels are not coated with anything and can rust. The material they are crafted from was chosen with regard to hardness and longevity. These wheels should therefore only be handled for assembly when wearing the gloves found in this kit and should be picked up only by the teeth of the gold-plated wheel* or by grasping the arbor* of it with tweezers. Should one of the gear wheels fall, please take a close look at the teeth using the included loupe. A slight imperfection or crooked tooth can impede the easy turning of the gear train*. A component that has been damaged in this way must be replaced. Please take care not to injure yourself with the needle of the oil syringe found in the kit. For this reason, please make sure that it remains out of reach of children. When unscrewing the dial, you also run a certain risk of scratching its surface. Thus, we would like to remind you here again to proceed with great care. The dial is indeed the face of your Mechanica M5.

Should you have any problems assembling your clock or getting it to run, please give us a call.

You can reach us during weekdays from 9:00 am to 4:00 pm CET at the following number:
+49 (0)89 / 8955 806-20

If you have decided to purchase the black case variation you can begin directly with the version of the case.

The following instruments are included to treat the surface of the natural wood case in a competent manner:

Tools

- ✔ Auro natural oil — *Compartment (31)*
- ✔ Polishing cloth — *Compartment (1)*
- ✔ Steel wool — *Compartment (36)*
- ✔ 1 Roll of tape — *Compartment (1)*

You will find the case components in the packaging's lower level.

Get the following components ready for surface treatment:

Components

- ✔ Base plate — *Lower level*
- ✔ Cornice plate — *Lower level*
- ✔ Lid of secret compartment — *Lower level*
- ✔ Back side bars — *Lower level*
- ✔ Assembeled door — *Lower level*

Before you begin with the oiling, the glass of the case door must be masked off.

The door glass is firmly connected to the two door strips and cannot be removed. To prevent unnecessary damage and contamination of the glass, you should mask the glass on both sides up to the edge where it is fixed in the strips. A roll of tape is included with your clock kit.

Safety notice

Oil your case only in well ventilated rooms. In order to avoid ignition, store the oil-soaked wool cloth only in the jar included in your kit and keep it closed.

The oil that came in your clock kit is a product created on a natural basis. Despite this, proceed working on the following steps in a room that is well ventilated.

Surface treatment of the natural wood case

The case of your Mechanica M5 is crafted in solid wood.

With the exception of the black painted version, these cases are all untreated and must be varnished with the oil that came in your kit.

This surface treatment protects the wood from moisture, beautifully brings out the natural texture of the woods and has the advantage of allowing damage to the surface to be reworked and rectified at any time without problem.

The care oil from Auro is based on linseed oil with the addition of tree resins and natural waxes and is therefore ecologically safe. Nevertheless, please note the accompanying safety warnings!

Let´s go

The best way to proceed with oiling the case is as follows:

To prevent your workplace from getting dirty, cover it with cardboard or blank paper, as the oil is difficult to remove once it has dried out.

The case parts are already pre-ground and ready to be oiled. Use the supplied polishing cloth to apply the care oil.

Rub all case parts with the oil. After about 20 minutes the wood should have absorbed the applied oil. In places where the oil is still clearly on the surface, you must remove it with the cloth.

Now the treated wooden parts should dry for 12-24 hours and the oil should harden.

When the surfaces feel dry to the touch, you can use the steel wool to smooth them one more time before applying the oil a second time since the oil stimulates the wood fibers and they stand out slightly.

The smoother the surfaces are before oiling, the more beautiful the case will look later.

To remove the raised wood fibers, it is sufficient to slide the steel wool lightly over the surface during the intermediate sanding.

The second oiling process is exactly the same as the first time.

Since the wood is no longer as absorbent, take special note of the spots where the oil did not fully settle in to the wood. Oil your case only in well ventilated rooms.

If your lighting is good, you will be able to easily recognize these spots. Now allow the case parts to dry for at least 24 hours before assembling them.
The surfaces should feel dry and no longer sticky. If you have the feeling that the surfaces are still absorbing the oil well, you can treat the housing parts a third time after another intermediate sanding.

Now you can start assembling the movement.

Tip

Leave the case enough time to dry thoroughly. To do this, place it in a warm, dry and well ventilated location.

Please use the special tools supplied and handle them properly!

The syringe is used for dosed oiling of the ratchet wheel*.
Avoid »bathing« the components in oil. The Gear train* runs completely on ball bearings and needs no oil.

This is how you lubricate properly:
Carefully push on the plunger of the syringe until a small drop of oil apperas on the needle. Only then do you move the needle to the place to be oiled and brush the drop off.

We wish you much fun and success!

Take your time. Concentrate and be careful when assembling the movement. Your workspace or bench should be particularly clean and well lit.
First, get all the tools ready you will need for assembling.

Tools

- ✔ Allen key, 0,9 mm — *Compartment (13)*
- ✔ Allen key, 2,5 mm — *Compartment (13)*
- ✔ Tweezers (dressing forceps) — *Compartment (13)*
- ✔ Watchmaker's screwdriver — *Compartment (13)*
- ✔ Standard screwdriver — *Compartment (13)*
- ✔ Watchmaker's loupe — *Compartment (14)*
- ✔ Assembly base — *Compartment (30)*

An assembly base is included for the assembly work. Its application can be seen in the respective illustrations.

The high-quality components are best kept at hand, but in their dustfree packaging and in the compartments of the foam packaging so they are shock-protected.

Note

Please always follow the recommended sequence in the assembly instructions.

In the instruction manual that follows, we have consciously decided not to go into a functional description of each of the individual parts so that the assembly can be accomplished more quickly.
The functional aspects of your Mechanica M5 are extensively discussed in Chapter II – »Technology and functions of the Mechanica M5« starting on page 65.

Assembly of the back plate for the standard version

You need the following components:

Components

✔ Back plate	*Compartment (28)*
✔ 4 x pillars*	*Compartment (4)*
✔ 4 x Allen countersunk-head screws M4 x 10	*Compartment 26)*
✔ 4 x washers	*Compartment (26)*
✔ 3 x protective pillars*	*Compartment (5)*
✔ 5 x ball bearings* for the back plate	*Compartment (6)*

Accessories

Set of fine-polished screws

A finely polished screw set is available as an accessory for your Mechanica M5. A total of 20 fine-polished and fine turned stainless steel screws* and 4 gold-plated washers significantly enhance the appearance of the movement and replace the corresponding standard parts when assembling the movement.

Components

✔ 4 x cylinder-head screws M4 x 6 replace the standard four Allen countersunk-head screws M4 x 10 and 4 gold-plated washers to screw the back plate to the pillars*	*Compartment 28)*
✔ 7 x cylinder-head screws M2 x 4 to screw the minute wheel* pillar* , the escapement* and the dial	*Compartment (28)*
✔ 4 x knurled nuts M4 to screw the front plate	*Compartment (28)*
✔ 3 x cylinder-head screws M1,4 x 4 to screw the intermediate wheel* and the seconds scale	*Compartment (28)*
✔ 2 x cylinder-head screws M4 x 6 to screw the ratchet wheel cock* to the front plate	*Compartment (28)*

Note

Use the standard screwdriver to screw the polished M4 cylinder-head screws.

All of the movement components have been manufactured and inspected using the greatest care. In order to avoid dirtying the components, you should only open the little bag containing the clean components right before you need to assemble them.

Note

Use the assembly base as your underlay for the following assembly steps to avoid scratching up your workspace or the movement's plates.

Put the movement pillars into the drilled holes of the assembly base. Then put the plate* onto the top of the pillars. The engraving »Mechanica W5« on the back of the back plate should be showing upward. The varying shapes of the pillar tops will help you avoid erroneous positioning. Lay the four washers on top and screw them to the pillars* using the four Allen countersunk-head screws M4 x 10. Turn the plate around and now screw the three protective pillars in using your hand.

Then put the five stainless steel ball bearings into the movement side pocket holes of the back plate. Because of their varying diameters, the bearings only fit into the correct places. The side that the ball bearings' roll cages end up on is not important.

Assembly of the back plate for the moon phase or date indication

If your Mechanica M5 has a moon phase or date indication, two of the three protective pillars must be screwed into the thread on the right-hand side of the back plate (the two threads on the lower side of the back plate thus remain empty).

Another change to the standard movement is the positioning of the large spring barrel ball bearing. Like the protective pillars, this is inserted into the ball bearing pocket on the right-hand side of the back plate. As a result, the lowest ball bearing pocket of the back plate remains empty here as well.

The assembly of the moon phase and date indication continues on page 30.

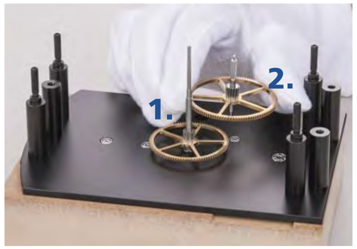
Assembling the gear train

Since the surfaces of hardened steel arbors* are not treated, please use the gloves included in the set. The gold-plated wheels can get scratched if they come into contact with the harder material of the steel tweezers.

The pre-assembled gear train components and their arbor pivots should be added to the ball bearings in the following order and observing the installation position:

Components

1. Minute wheel*	*Compartment (10)*
2. Center wheel*	*Compartment (9)*
3. Spring barrel*	*Compartment (8)*
4. Fourth wheel*	*Compartment (11)*
5. Seconds wheel*	*Compartment (12)*



Safety notice

The Spring barrel may not be opened due to danger of injury, because of the sharp-edged spring jumping out.

Preparation and assembly of the front plate for the standard version

The following components are needed:

Components

✔ Front plate	*Compartment (29)*
✔ Intermediate wheel pillar	*Compartment (27)*
✔ Cylinder-head screw M2 x 4	*Compartment (27)*
✔ 5 x Ball bearings* for the front plate	*Compartment (7)*
✔ 3 x Allen countersunk-head screws M4 x 10	*Compartment (27)*
✔ 4 x Washers	*Compartment (27)*
✔ 4 x Knurled nuts	*Compartment (27)*

Lay the assembly base with the partially assembled movement aside in order to prepare the second plate, known as the front plate, for assembly.

Note

Use, for example, the cardboard box from the packaging of your M5 or a sheet of paper as a base for the following assembly steps, in order to avoid scratching the workstation or the movement plate.

Assembling the intermediate wheel pillar

On the outside (dial side) of the front plate the click spring* is already pre-assembled.

The intermediate wheel pillar* is now also inserted into the upper hole on the outside and screwed on from the inside with a cylinder head screw M2 x 4.

Adding the ball bearings to the front plate

Now the ball bearings are inserted into the pocket millings of the front plate, for this you have to turn the front plate over.

In case the ball bearings don't seem to be stabilized enough in the pocket holes, they can alternatively be added to the corresponding arbor pivots. This prevents them from falling out when the front plate is turned over.

Suggestion

The ball bearings do not get oiled!

Adding the front plate to the movement frame for the standard version

Now combine the front plate with the partially assembled movement at the back plate. To do this, turn the front plate over and lower it. Carefully guide the pivots* and tops of the pillars* into the ball bearings and holes.

The three protective pillars are screwed in using M4 x 10 countersunk-head screws. Screwing this is very important to avoid accidental opening of the movement!

Now secure the front plate to the pillars using the four washers and four knurled nuts.

After screwing the plates* examine the endshake of the arbors* in order to avoid the bearings sticking. To do this, carefully grasp the arbors with the tweezers and move them toward the pivots. If you turn the movement over, you should be able to acoustically hear the arbors fall onto the bearings.

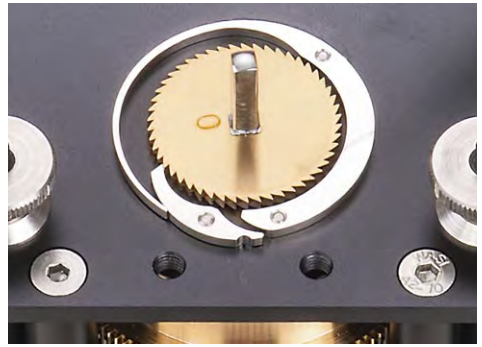
Adding the click for the standard version

The click spring* is already pre-assembled on the front plate. Now complete the click* by adding at the components in this order:

Components

- ✔ Ratchet wheel* *Compartment (19)*
- ✔ Ratchet* *Compartment (19)*

When adding the ratchet wheel*, please make sure that the side marked with an O (for the German word »oben,« up) is visible. When the ratchet* is correctly positioned, like in the illustration below, teeth will mesh and fit tightly with the teeth of the ratchet wheel. The click spring should securely push the teeth; if necessary the click spring might have to be correspondingly bent. Please make sure that the click spring is in the correct position; it should be rigidly supported and flat on the front plate.



Caution

Check the assembly of the click very carefully. Incorrectly installed click components can damage the movement and there is a considerable risk of injury!

Oiling the click

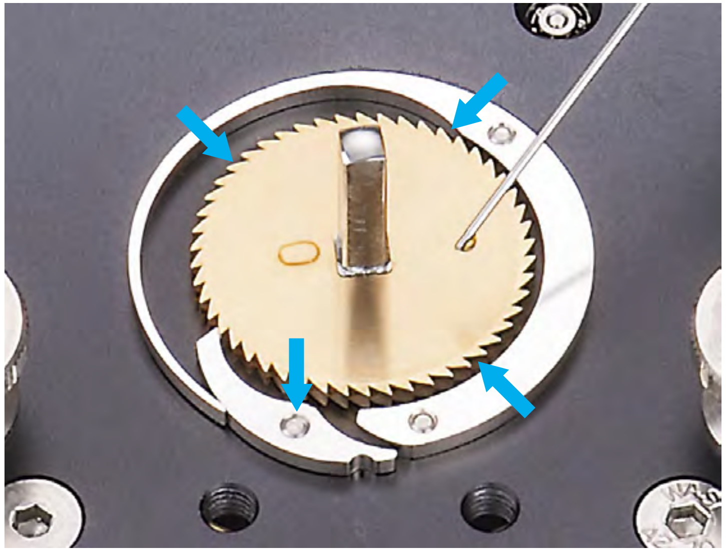
The gear train of your Mechanica M5 runs on ball bearings, which should not be lubricated.

✔ Clock oil   *Compartment (13)*

The click, however, should be lubricated with a small drop of oil in three spots around the circumference of the ratchet wheel* and the set pin of the ratchet. Be careful, though: too much oil is just as bad as no oil at all.

Safety notice

Be aware of possible injury by the oil syringe. For this reason, please make sure it is out of reach of children at all times.



Only use the oil made especially for clocks delivered with this clock kit in the syringe - Möbius Microgliss D5 - and follow directions on how to properly lubricate in the section »Using the Tools« on page 19 of this booklet.

Securing the click for the standard version

The click can now be secured by adding the ratchet wheel cock:

Components

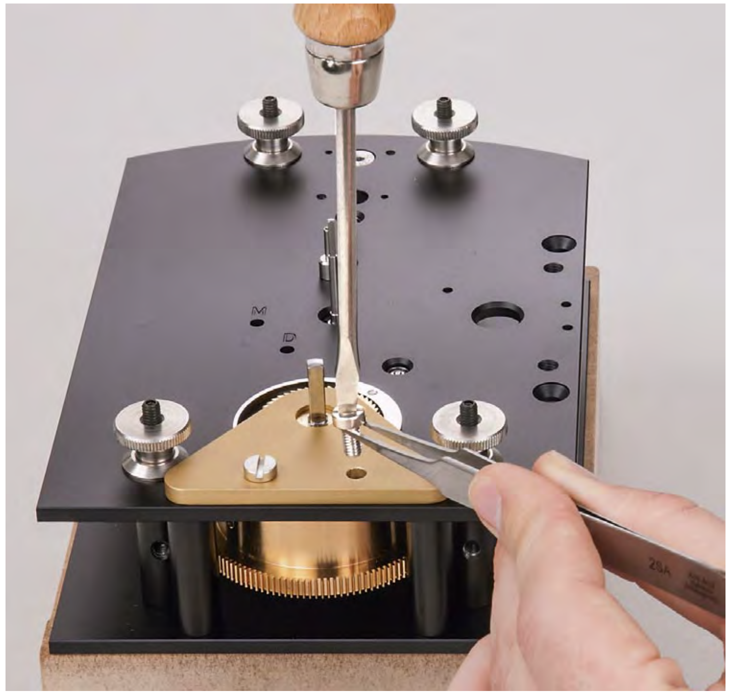
✔ Ratchet wheel*cock   *Compartment (19)*
✔ 2 x Cylinder-head screws M4 x 8   *Compartment (19)*

In order to ensure the ratchet wheel cock is secured, make sure that the two cylinder-head screws M4 x 8 are securely tightened.

To avoid damage to the Gear train* when the spring barrel* is tensioned, the front and back plates must be screwed together with three protective pillars* in addition to the four movement pillars. Thus it is guaranteed that the ratchet wheel cock and click are removed before the front and back plates* are separated. The click may only be taken apart and removed if the spring barrel is not tensioned.

Safety notice

The Spring barrel may only be tensioned after the assembly of the ratchet wheel cock and escapement to avoid danger of injury.



Caution

Before taking the movement apart, you must make sure that the spring barrel is not tensioned. Follow the tips in the chapter »Disassembling the Movement« on page 63 - 64.

The assembly of the standard version continues on page 36!

Accessories

Moon phase- and date indication

Assembling the gear train for the moon phase and date indication

Since the surfaces of hardened steel arbors* are not treated, please use the gloves included in the set. The gold-plated wheels can get scratched if they come into contact with the harder material of the steel tweezers.

The pre-assembled gear train components and their arbor pivots should be added to the ball bearings in the following order and observing the installation position:

Components

1. Minute wheel* — *Compartment (10)*
2. Center wheel* — *Compartment (9)*
3. Spring barrel* — *Compartment (8)*
4. Fourth wheel* — *Compartment (11)*
5. Seconds wheel* — *Compartment (12)*

Preparation and assembly of the front plate for the moon phase and date indication

Components

- ✔ Front plate — *Compartment (29)*
- ✔ Intermediate wheel pillar — *Compartment (27)*
- ✔ Cylinder-head screw M2 x 4 — *Compartment (27)*
- ✔ 5 x Ball bearings* for the front plate — *Compartment (7)*
- ✔ 3 x Allen countersunk-head screws M4 x 10 — *Compartment (27)*
- ✔ 4 x Washers — *Compartment (27)*
- ✔ 4 x Knurled nuts — *Compartment (27)*
- ✔ Cylinder-head screw M2 x 4 — *Compartment (15)*
- ✔ Driving wheel pillar — *Compartment (15)*

Lay the assembly base with the partially assembled movement aside in order to prepare the second plate, known as the front plate, for assembly.

Note

Use, for example, the cardboard box from the packaging of your M5 or a sheet of paper as a base for the following assembly steps, in order to avoid scratching the workstation or the movement plate.

Adding the intermediate wheel pillar

On the outside (dial side) of the front plate the click spring* is already pre-assembled.
The intermediate wheel pillar* is now also inserted into the upper hole on the outside and screwed on from the inside with a cylinder head screw M2 x 4.

Adding the driving wheel pillar

Insert the driving wheel pillar into the appropriately marked hole and screw it with the enclosed cylinder head screw M2x4.

Moon phase indication = M

Date indication = D

Adding the ball bearings to the front plate

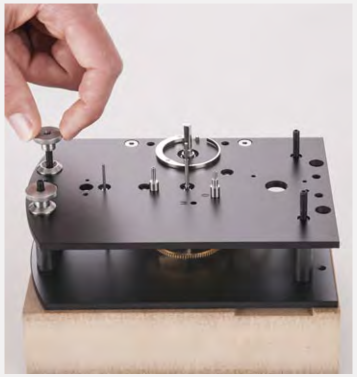
Now the ball bearings should be put into the pocket holes of the front plate. It is not possible to put them in the wrong place due to the varying sizes of the bearings.
The ball bearings are not oiled!
The lowest, central ball bearing pocket remains empty!
In case the ball bearings don’t seem to be stabilized enough in the pocket holes, they can alternatively be added to the corresponding arbor pivots. This prevents them from falling out when the front plate is turned over.

Adding the front plate to the movement frame

Now combine the front plate with the partially assembled movement at the back plate. To do this, turn the front plate over and lower it. Carefully guide the pivots* and tops of the pillars* into the ball bearings and holes.

The three protective pillars are screwed in using M4 x 10 countersunk-head screws. Screwing this is very important to avoid accidental opening of the movement!

The front plate is now initially fixed with two washers and two knurled nuts on the two upper pillars.



After screwing the plates* examine the endshake of the arbors* in order to avoid the bearings sticking. To do this, carefully grasp the arbors with the tweezers and move them toward the pivots. If you turn the movement over, you should be able to acoustically hear the arbors fall onto the bearings.

Adding the click

The click spring* is already pre-assembled on the front plate. Now complete the click* by adding at the components in this order:

Components

- ✔ Ratchet wheel* *Compartment (19)*
- ✔ Ratchet* *Compartment (19)*

When adding the ratchet wheel*, please make sure that the side marked with an O (for the German word »oben,« up) is visible. When the ratchet* is correctly positioned, like in the illustration below, teeth will mesh and fit tightly with the teeth of the ratchet wheel.
The click spring should securely push the teeth; if necessary the click spring might have to be correspondingly bent. Please make sure that the click spring is in the correct position; it should be rigidly supported and flat on the front plate.

Safety notice

The Spring barrel may only be tensioned after the assembly of the ratchet wheel cock and escapement to avoid danger of injury.

Oiling the click see page 28

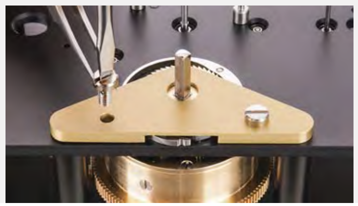
Securing the click

The click can now be secured by adding the ratchet wheel cock:

Components

- ✔ Ratchet wheel cock * *Compartment (19)*
- ✔ 2 x Cylinder-head screws M4 x 8 *Compartment (19)*

In order to ensure the ratchet wheel cock is secured, make sure that the two cylinder-head screws M4 x 8 are securely tightened. To avoid damage to the Gear train* when the spring barrel* is tensioned, the front and back plates must be screwed together with three protective pillars* in addition to the four movement pillars.



Thus it is guaranteed that the ratchet wheel cock and click are removed before the front and back plates* are separated. The click may only be taken apart and removed if the spring barrel is not tensioned.

Caution

Check the assembly of the click very carefully. Incorrectly installed click components can damage the movement and there is a considerable risk of injury!

Accessories

Components

Assembly and mounting of the moon phase plate

1.	**Zip bag: »Moon phase module«**	*Compartment (15)*
✔	Moon phase plate	*Compartment (15)*
✔	Jumper spring	*Compartment (15)*
✔	Spring stud	*Compartment (15)*
✔	Cylinder-head screw M 2,5 x 10 mm	*Compartment (15)*
✔	Moon wheel pillar	*Compartment (15)*
✔	Cylinder-head screw M 2 x 3 mm	*Compartment (15)*
✔	2 x Knurled nuts	*Compartment (27)*

Assembly of the moon phase plate

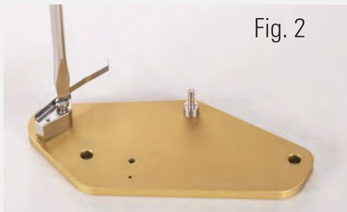
First screw the pillar for the moon wheel with the enclosed cylinder head screw M2 x 3 on the plate, analogous to Fig. 1. Now the pre-bent jumping spring (caution: the spring is already bent in such a way that a reliable function of the moon phase display is guaranteed, so please do not bend the spring!) is placed on the spring stud. A double-sided alignment pin in the spring stud helps to precisely position all parts. Both parts are screwed through the jumper spring and the spring stud with an M2.5 x 10 mm cylinder head screw to the moon phase plate. To check, please compare the position of the parts in Fig. 2 again.

Notice

The shape of the spring stud and the jumper spring are congruent when positioned correctly or flush.

Fig. 1

Fig. 2



Please now place the moon phase plate on the two lower pillars as shown in Fig. 3 and screw them together with the two knurled nuts.
Caution: The two knurled nuts must be installed here with the knurl down! (without washers!)

Fig. 3

Assembly and mounting of the date plate

Accessories

Components

1.	**Zip bag: »Date module«**	*Compartment (15)*
✔	Date plate	*Compartment (15)*
✔	Jumper spring	*Compartment (15)*
✔	Spring stud	*Compartment (15)*
✔	Cylinder-head screw M 2,5 x 10 mm	*Compartment (15)*
✔	Date wheel pillar	*Compartment (15)*
✔	Cylinder-head screw M 2 x 3 mm	*Compartment (15)*
✔	2 x Knurled nuts	*Compartment (27)*

Assembly of the date plate

First screw the pillar for the date wheel with the enclosed cylinder head screw M2 x 3 on the plate, analogous to Fig. 1. Now the pre-bent jumping spring (caution: the spring is already bent in such a way that a reliable function of the date display is guaranteed, so please do not bend the spring!) is placed on the spring stud. A double-sided alignment pin in the spring stud helps to precisely position all parts. Both parts are screwed through the jumper spring and the spring stud with an M2.5 x 10 mm cylinder head screw to the date plate. To check, please compare the position of the parts in Fig. 2 again.

Flg. 1

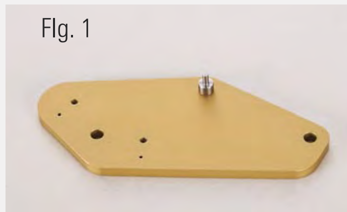


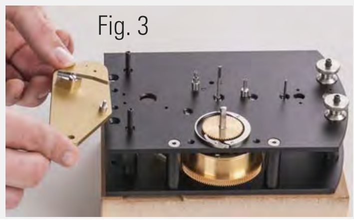
Fig. 2

Notice

The shape of the spring stud and the jumper spring are congruent when positioned correctly or flush.

Please now place the date plate on the two lower pillars as shown in Fig. 3 and screw them together with the two knurled nuts. (without washers!)

Fig. 3

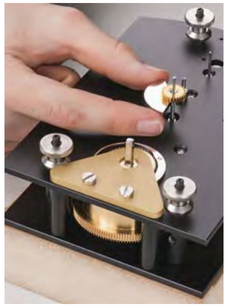


Assembling the motion work for all versions

Components

In order to add the motion train*, you will need:

✔ Canon pinion* with counterweight*	*Compartment (22)*
✔ Allen screw M2 x 2	*Compartment (22)*
✔ Intermediate wheel*	*Compartment (22)*
✔ Cylinder-head screw M1,4 x 3	*Compartment (22)*
✔ Hour wheel* with hour wheel pipe	*Compartment (22)*
✔ Minute hand	*Compartment (17)*

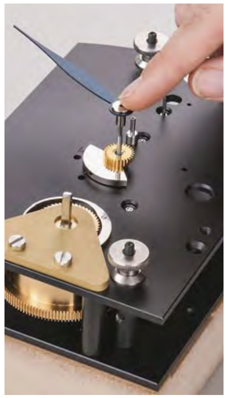


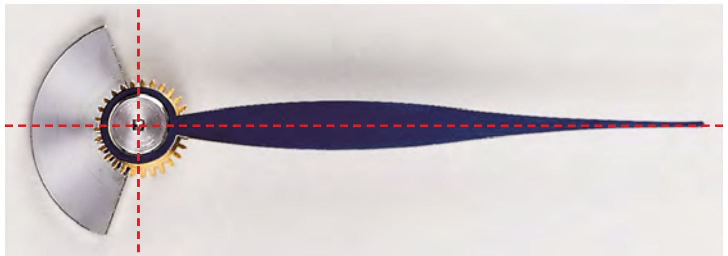
Adding the canon pinion with counterweight

To avoid dynamic imbalance of the center wheel arbor, the canon pinion* already comes with the counterbalance matching the minute hand pressed in. Put the canon pinion* with counterbalance on the center wheel arbor.

Aligning the minute hand in relation to the counterbalance

Before you fixate the canon pinion* with the already screwed-in Allen screw M2 x 2, put the minute hand on the square of the minute wheel arbor and align the counterbalance in relation to the hand (see illustration).

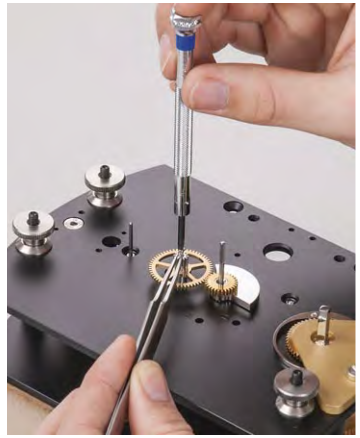




The Allen key with the width of 0.9 mm can be a help to you in doing this if you put it into the loosely screwed Allen screw M2 x 2 - which is directly underneath the hand.

Put the intermediate wheel on the intermediate wheel pillar

Make sure that the installation position is correct. By screwing the cylinderhead screws M1.4 x 3 into the intermediate wheel pillar, you will ensure that the intermediate wheel is in the correct position.



Note

Make sure to check for ease of movement and endshake of the Intermediate wheel.

Add the hour wheel

Then slide the hour wheel pipe with the pressed-on hour wheel onto the minute wheel arbor.

Safety notice

Only test the gear train if the plates and ratchet wheel cock are secured! Don´t put your fingers between the plates to grab the wheels. The quickly moving wheels can injure you!

Check the gear train for ease of movement

✔ Winding key *Compartment (23)*

After you have firmly connected the motion work* to the movement by tightening the M2 x 2 Allen screw in the canion pinion, insert the winding key onto the square of the barrel arbor. Test the entire gear train for ease of movement by carefully tensioning the mainspring* by just one ratchet wheel* tooth in a clockwise direction. This is okay if it continues to turn quietly and evenly for some time due to the inertia.

In the picture you can see the winding of the standard version, in the versions with moon phase display and date display the winding square is on the right side of the movement.

Check list: gear train

Axial clearance of arbors*
All arbors need to be able to move back and forth a little between the plates. along their axes. The clearance should be visible and clearly tangible.

☐ OK

Motion work
The intermediate and hour wheels should easily sit on their arbors or pillars and must have axial clearance.

☐ OK

Spring barrel
When winding, the ratchet should be audible as it locks into the ratchet wheel*. While the mainspring unwinds, the gear train should rotate evenly and become continuously slower.

☐ OK

Accessories

Components

Adding the moon disc wheel

2. Zip bag: Moon phase-module *Compartment (15)*

- ✔ Moon / date driving wheel *Compartment (15)*
- ✔ Cylinder-head screw M 1,4 x 3 mm *Compartment (15)*
- ✔ Moon disc wheel *Compartment (15)*

In the next step the moon driving wheel (with the driving pin facing upwards) is placed on the free intermediate wheel pillar on the front plate. It is secured on this with the cylinder head screw M1.4x3.

Finally, the moon disc wheel is placed on the free pillar at the bottom of the moon phase plate.

When putting on the moon disc wheel, please ensure that the driving pin of the moon driving wheel is exposed and is not jammed by the moon disc wheel.

Also make sure that the jumper spring rests against the circumference of the moon disc wheel. It must not be under or over the wheel. Please also check here that the jumper spring positions the moon disc wheel exactly, i.e. that the nose of the spring always touches two teeth of the moon disk wheel at the same time.

Function check

Before you continue with the assembly of the dial, you should check the correct function of the moon phase. Please place the minute hand on the center wheel arbor. Now carefully turn the hand clockwise. The driving pin of the driving wheel should now engage in exactly one tooth of the moon disc wheel and advance it by exactly one graduation, (if you turn the hand further, the driving pin will touch the next tooth - this is necessary due to the design). The jumper spring must precisely allow this driving process through its geometry.

Accessories

Components

Adding the date wheel

2. Zip bag: Date-module *Compartment (15)*

- ✔ Moon / date driving wheel *Compartment (15)*
- ✔ Cylinder-head screw M 1,4 x 3 mm *Compartment (15)*
- ✔ Date wheel *Compartment (15)*

In the next step the date driving wheel (with the driving pin facing upwards) is placed on the free intermediate wheel pillar on the front plate. It is secured on this with the cylinder head screw M1.4x3.

Finally, the date wheel is placed on the free pillar at the bottom of the date plate.

When putting on the date wheel, please ensure that the driving pin of the date driving wheel is exposed and is not jammed by the date wheel.

Also make sure that the jumper spring rests against the circumference of the date wheel. It must not be under or over the wheel. Please also check here that the jumper spring positions the date wheel exactly, i.e. that the nose of the spring always touches two teeth of the date wheel at the same time.

Function check

Before you continue with the assembly of the dial, you should check the correct function of the date. Please place the minute hand on the center wheel arbor. Now carefully turn the hand clockwise. The driving pin of the driving wheel should now engage in exactly one tooth of the date wheel and advance it by exactly one graduation, (if you turn the hand further, the driving pin will touch the next tooth - this is necessary due to the design). The jumper spring must precisely allow this driving process through its geometry.

All components of your Mechanica M5 have been carefully checked in our factory.

If, however, a component does not function properly and one of the test criteria listed above cannot be guaranteed, please contact us by phone. This enables us to help you quickly and easily.

Call us any weekday from 9am to 4pm.
+49 (0)89 / 8955 806-20

Installing the Escapement

As soon as you have assembled and tested the gear train, you can add the watch's regulating organ: the pre-assembled escapement* with its 11 rubis and Swiss lever escapement*.

Every escapement for the Mechanica M5 has been carefully examined and adjusted in our factory before delivery. In order to reach satisfying rate results right from the start, please ensure that the balance spring stud carriers*, buckle and index* are not accidentally moved before being put into operation.

Note

In addition to the screw balance, the escapement has a blued balance spring, blued screws and 11 ruby jewels. The escapement bearings are pre-oiled.

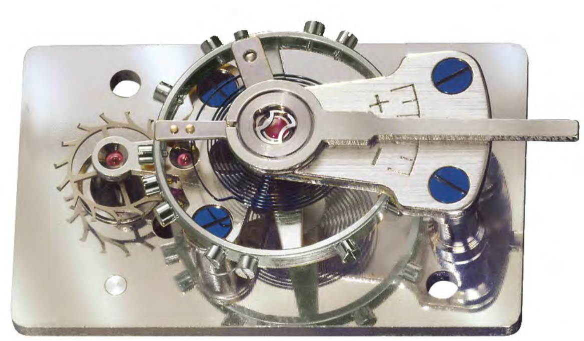
To fit the escapement you will need:

Components

- ✔ Escapement with Swiss lever escapement — *Compartment (21)*
- ✔ 2 x Cylinder-head screw M2 x 4 — *Compartment (21)*

Tools

- ✔ Screw driver — *Compartment (13)*
- ✔ Tweezers (dressing forceps) — *Compartment (13)*



To install the escapement, it is best to only grasp it by the base plate or on the balance cock.

Before installing it to the movement, remove the folded strip of paper for transport security of the balance using the tweezers.

Carefully insert the escapement into the hole in the direction of the seconds wheel* inclined from the upper end of the front plate as shown in the illustration. Both fitting pins must find into the corresponding holes on the front plate.

Please be especially careful when screwing down the escapement. The screwdriver should not slide and inadvertently damage the sensitive components of the escapement.

Take care that the escape wheel pinion engages the seconds wheel and the escapement lays flat on the front plate.

Caution

Please be careful when handling the escapement, making sure that the sensitive balance, balance spring, and the filigreed escape wheel are not touched or damaged!

Caution

Only apply a slight amount of strength when adding the escapement. The filigreed components of the escapement can easily be damaged!

The escapement can now be carefully screwed to the front plate using two cylinder-head screws M2 x 4.

So that the escapement can perfectly fulfill its function, it is imperative that it lay flat on the front plate and be tightly secured.

Testing the escapement

Put the movement upright in front of you on the level workspace in an upright position. Now carefully tension the mainspring* by 2-3 teeth of the ratchet wheel* so that the balance begins to move using the winding key in the clockwise direction.

☐ OK

If the escapement does not begin to move, please do not continue tensioning the mainspring, but rather once again examine whether the escape wheel pinion is engaging the seconds wheel*. If you are unsure, remove the escapement and add it again to be sure. Ensure that the mainspring is not tensioned after removing the escapement. To avoid unnecessarily straining the gear train*, you can simply stop it by using your fingers on the pivot of the second hand extending out from under the movement.

Caution

Only test the escapement if the plates and ratchet wheel cock are tightly secured!

The balance's amplitude

Now tension the mainspring somewhat further and test the amplitude* of the balance*.This should move evenly and the balance spring* should also "breathe" more evenly. The balance will move from its center to its inversion point about 220 degrees.

The escapement of your Mechanica M5 was carefully examined in our manufactory.

Despite this, if a component should not work properly and one or more of the testing criteria listed above cannot be guaranteed, please give us a call. This makes it possible for us to help you in a quick and uncomplicated way.

Caution

Don't put your fingers between the plates and wheels. You could be injured by the quickly rotating wheels!

Call us any weekday from 9am to 4pm.
+49 (0)89 / 8955 806-20

Adding the dial for the standard version

Having concluded the assembly of the movement, you must now add the dial and hands to your Mechanica M5 precision movement in order to form a complete timekeeper.

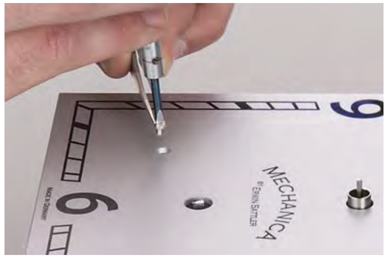
You will need:

Components

- ✔ Dial — *Compartment (37)*
- ✔ Seconds scale — *Compartment (38)*
- ✔ 2 x Cylinder-head screws M1,4 x 3 — *Compartment (20)*
- ✔ 4 x Cylinder-head screws M2 x 4 — *Compartment (20)*
- ✔ Set of standard hands — *Compartment (17+18)*
- ✔ Date hand — *Compartment (17+18)*

First get the dial ready for assembly by putting the seconds scale on the dial and installing them together from the front using the two cylinder-head screw M1.6 x 6.

Standard dial



Carefully place the pre-assembled dial on the four knurled nuts of the pillars* and secure them using four cylinder-head screws M2 x 4.

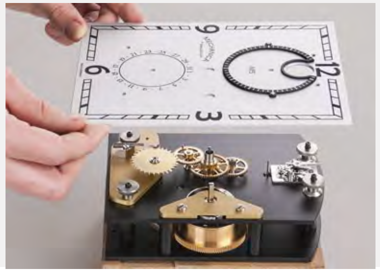
Accessories

Adding the dial with the moon phase indication

Carefully place the pre-assembled dial on the four knurled nuts of the pillars* and secure them using four cylinder-head screws M2 x 4.

Adding the dial with the date indication

Accessories

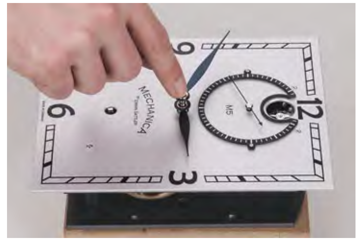


Carefully place the pre-assembled dial on the four knurled nuts of the pillars* and secure them using four cylinder-head screws M2 x 4.

Adding the hands

Then place the hands on each of their arbors* in the order listed below:

1. Second hand
2. Hour hand
3. Minute hand



Caution

When adding the minute hand, please ensure its proper position in relation to the counterweight (see illustration on page 36).

Aligning the hands

The minute and hour hands must now be aligned. Position the minute hand at the full hour. Hold onto the minute hand and carefully move the hour hand toward an hour marker. Test them by carefully moving the minute hand so that the hands don't touch each other or the dial.

Aligning the hands with the moon phase indication

Accessories

If you have now set all hands as described, the moon phase operation must be checked. Now turn the minute hand clockwise until the moon phase disc begins to turn. Now set the minute hand to the full hour. Hold the minute hand and turn the hour hand to the "1 o'clock" position. It is now guaranteed that the operation of the moon (duration approx. 2 hours) can take place at night and that you always have the correct moon phase in view during the day.

Accessories

Adding the date hand and aligning the hands

The date hand is pushed into the tube of the date wheel. Make sure that the hand is already pointing as precisely as possible to a digit of the date. This saves you the laborious task of aligning the hand later.

If you have now set all hands as described, they should be compared with the date operation. Now turn the minute hand clockwise until the date hand begins to turn. Now set the minute hand to the full hour. Hold the minute hand and turn the hour hand to the “1 o'clock” position. It is now guaranteed that the operation of the date (duration approx. 2 hours) can take place at night and that you always have the correct date in view during the day.

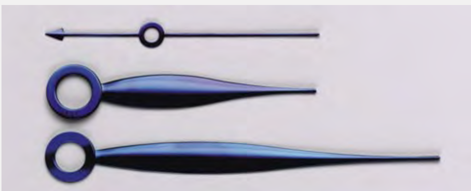
Accessories

Hand-domed and polished set of hands

The elaborately handcrafted domed*, polished and blued* hands, available as accessories, are small masterpieces that enhance the dial of your Mechanica M5.

Please note that the handcrafted hands are treated with a special spray of wax to protect them from corrosion.

To make the full shine of the polish and the dome visible, carefully rub the wax layer with a soft cotton cloth or leather rag.



Accessories

Hand-domed and polished date hand

The movement is now fully assembled. It continues with the case. Put the movement in a safe place protected from dust!

Get the following tools ready for assembling the case:

Tools

✔ Watchmaker's screwdriver	*Compartment (13)*
✔ Standard screwdriver	*Compartment (13)*
✔ Allen key 3 mm	*Compartment (13)*
✔ Oil syringe	*Compartment (13)*

In addition to the already oiled wooden parts, the complete case also consists of the following components:

Components

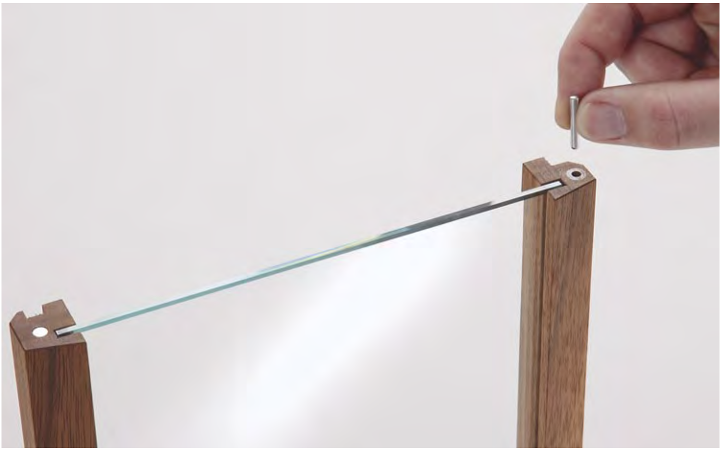
✔ Inlaid fleece	*Lower level*
✔ 2 x Side glass panes	*Compartment (40 + 41)*
✔ Glass pane for the back	*Compartment (39)*
✔ 2 x Door seal	*Lower level*
✔ Foam rubber cords	*Lower level*
✔ 2 x Hinge pins	*Compartment (24)*
✔ 2 Case rods (stainless steel)	*Lower level*
✔ 8 x Case screws, cylinder head allen screws M4 x 18	*Compartment (25)*
✔ 8 x Washers	*Compartment (25)*
✔ 4 x Case feet in 2 different variants	*Compartment (3)*
✔ 8 x Countersunk-head screws 2 x 8	*Compartment (3)*
✔ 4 x Felt inserts	*Compartment (16)*
✔ All case parts	*Lower level*

Optionally, if already supplied with the order, an engraved plate with two countersunk slotted screws *Compartment (30)*

The case door is assembled first.

Push the two hinge pins into the holes on the front sides of the left door strip.

So that the door stays closed later, there are already built-in magnets in the front sides of the right door strip.



Anti-reflective mineral glasses

Accessories

To individually optimize the look of the case, we offer an alternative to the standard glass panes a set of anti-reflective mineral glasses. These are supplied already inserted in the corresponding case parts instead of the standard glass panes.

The anti-reflective mineral glasses cannot be retrofitted!

When cleaning the anti-reflective glasses, please use a clean, dust-free cloth. The glasses are very sensitive, so the anti-reflective layer could be damaged.

If you use a glass cleaner, please never apply it directly to the glass, but rather to the appropriate cleaning cloth.

Now pre-assemble the base and the cornice plate.

The hinge bushings are already inserted in the bottom and cornice plate. Using the oil syringe included, put a drop of watch oil in each bushing.

Please note the instructions for using the tools on page 19 of this book.

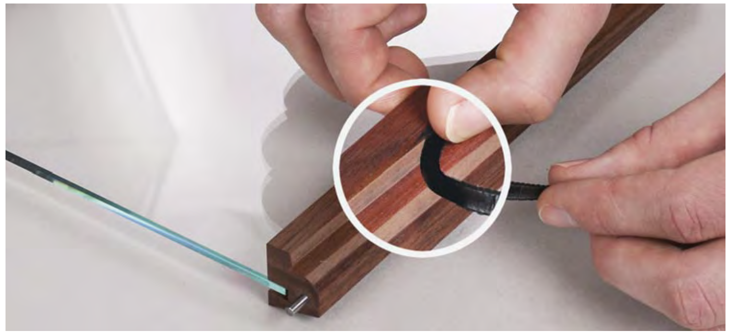
The secret compartment milled out in the cornice for the winding key is covered with a self-adhesive inlay. Peel off the protective film on the back of the fleece and position it in the cutout. Press the fleece firmly in place.

Gluing the door seals to the front side bars.

In order to protect the movement from entering dust later on, the case is outfitted with door seals. Cut the enclosed self-adhesive door seal to the appropriate length and peel off the protective film from the adhesive back.

Glue one sealing strip, without stretching or twisting it, into the longitudinal milling of the right sidebar.

Please stick the second sealing strip in the outer fold of the left door strip. This sealing strip is later pressed against the inside of the left side glass.



Mount the engraving plate

If you have already received your personal engraving plate with your M5, we would recommend that you attach it to one of the following two locations:

On the base plate in front of the movement base.

On the rear face of the movement base.

Of course, you can also choose any other position that suits you.

Installation of the back side bars and the stainless steel case rods on the base plate.

Each of the back side bars have a dowel pin inserted on both end faces. Place the bars so that the dowel pin is in the corresponding hole in the base plate.

For easier orientation: The sloping side of the sidebar must be parallel to the rear radius of the base plate. Now you can fasten the bars to the base plate with the cylinder head Allen screws M4 x 18 and the corresponding washers. The situation is similar with the two stainless steel case rods. These are screwed together through the two holes in the base plate with two additional cylinder head Allen screws M4 x 18 and the corresponding washers. Both stainless steel rods are absolutely identical, therefore confusion is impossible.

Installation of the movement in the case

To install the movement you need:

- ✔ 2 x movement fitting Allen screws M4 x 60 — *Compartment (25)*
- ✔ 2 x Washers — *Compartment (25)*
- ✔ Allen key 3 mm — *Compartment (13)*

Components

Tool

In preparation for installing the movement, place the fully assembled movement with the dial facing up on two foam strips enclosed in the case packaging.

Caution

Use, for example, the cardboard box from the packaging of your M5 or a sheet of paper as a base for the following assembly steps to avoid scratching the dial or the sensitive parts.

Insert the two movement fitting Allen screws M4 x 60 with the corresponding washers through the bottom of the case from below. Now slide the partially assembled case with the movement fitting Allen screws under the movement or the dial. The height of both parts should match each other exactly, so that you can now easily turn the movement fitting Allen screws from below into the transverse hole in the lower movement pillar.

Insertion of the foam rubber cords
Three correspondingly long foam rubber cords are now placed in the three glass grooves in the base plate. They ensure a secure fit of the glasses on the finished case and prevent them from "rattling".

Inserting the glasses

Now slide the side glasses and the glass for the back side into the grooves of the side bars and base plate. Make sure that the glasses sit securely in the grooves in the bottom of the case.

Caution

Install the glasses very carefully, damaged glasses can lead to serious injuries!

Inserting of the case door
Now place the case door with the already inserted hinge pin into the brass bushing of the base plate and close it. Caution, the door has the hinge on the left, so it can be opened from the right.

In the next step you put on the cornice, making sure that two pins of the rear side bars are inserted into the corresponding holes in the cornice plate and the upper hinge pin is inserted into the corresponding bushing.

Adding the cornice.
The cornice is screwed on using four Allen cylinder head screws M4 x 18 and the corresponding washers, with the rear case bars as well as to the stainless steel case braces.

Adding the case's feet

To screw on the case feet, turn the case upside down without the secret compartment cover - with the cornice on the work surface (cardboard from the packaging or a sheet of paper to avoid scratching the high-quality case.

Place the four case feet with the through-holes on the corresponding holes in the bottom plate. The position of the different case feet is determined by their shape, analogue to the rear case bars The case feet are fastened from the milled side with 2 countersunk screws 2 x 8 each and then provided with a felt insert.

Caution

The movement must be firmly screwed to the case, only then can the case be turned "upside down" without hesitation.

Putting the casing cover on the secret compartment

Finally, turn the finished case back around so that it's on its feet and put the casing cover on the secret compartment. To secure its position, the casing cover is outfitted with two magnetized fasteners on the left and right sides. The little groove on the long end of the cover is there to make taking the cover off easier and should be positioned toward the back.

Putting your Mechanica M5 into motion

Winding the clock

Tool

✔ Winding key *Compartment (23)*

If the escapement* already moved flawlessly when tested, you can now completely wind your clock for the first time. End the winding process immediately, if you notice resistance of the stopworks* banking at the spring barrel*.

If the movement was completely run down, it only takes 3.5 winding revolutions until the spring barrel* is completely tensioned again. This is enough power for your Mechanica M5 to continue ticking for seven days.

Setting the time

Set the clock to the correct time. When doing this, the minute hand can be moved backward or forward; you may not turn the second hand.

Now enjoy the ticking of your Mechanica M5!

Accessories

Setting the moon phase

With the help of the adjustment tool (compartment 13) you can carefully press the rubberized side on the moon phase disc and adjust it. Please consider, one tooth means one day.

Important: The moon phase must not be adjusted during the switching process, please note this, otherwise various parts of the movement could be damaged.

Caution

The switching process for moon and date should be as described above (Page 47/48) have been set to the time at midnight!

Setting the date

The correct date is set by turning the date hand. Please note, however, that the date must not be changed during the switching process. If you feel resistance, do not continue to turn with increased force, otherwise various parts of the movement could be damaged!

Regulating your Mechanical M5

As soon as you have put your Mechanica M5 in motion and set the exact time, you can begin regulating* the clock so that it keeps the most accurate time possible.

✔ Regulation pin *Compartment (13)*

Please regulate the escapement only by using the index.

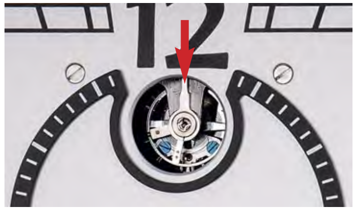
The other regulating organs explained in Chapter II »Technology and function of the Mechanica M5« have been pre-regulated in our factory and should not be altered.

After an observation time of seven days, compare the time display of your Mechanica M5 - the watchmaker calls this the »state*« - with a comparative clock like a radio-controlled timekeeper. With this deviation you calculate the daily rate of* of the clock, which tells you if it is fast or slow in comparison to a reference time. At the beginning of the regulation*, your Mechanica M5 will probably show a slight deviation. Don't be troubled by this; using the index* on the escapement* you can effortlessly adjust your clock.

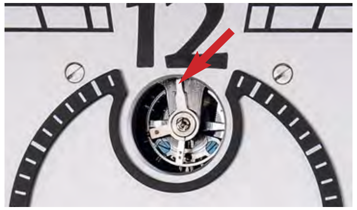
Caution

At the end of this book you will find a rate table. You can fill in the changes in regulation and thus more systematically regulate your Mechanica M5.*

Additionally, the rate table can be used to keep track of the rate precision of your clock.*



The index* is located behind the dial at 12 o'clock.



The changes can be seen using the scale engraved on the balance* cock through a cutaway in the dial.

Proceed with the regulation carefully. To do this, insert the regulating pin from above through the elongated hole in the cornice onto the index of the escapement. Move the index only in very small steps, otherwise the changes can become too great.

After making the first corrections, please observe the rate of your clock for a whole week since the rate of a clock driven by mainspring can balance itself out over the course of a full power reserve. You may need to fine regulate as described above.

Care and maintenance

After successfully assembling and fine adjusting your Mechanica M5, you can be proud to have completed and regulated your own precision timepiece.

Like every other instrument expected to have high accuracy, your Mechanica M5 demands careful treatment and a certain amount of maintenance.

Caution

Never leave the case open!

We thus recommend that you never leave your case open for longer periods of time so that no dust can settle on the movement.

Because of its design and the use of numerous ball bearings*, your Mechanica M5 has an exceptionally low-maintenance movement. Oil however has a certain aging process and will loose it`s lubrication ability over the years.

For this reason, cleaning the individual components using a special cleansing process is necessary after the clock has been running for five to seven years.

Caution

Maintenance can be performed in our manufactory anytime.

We can offer you the service of maintenance in our manufactory. The components that may have experienced wear can either be reworked or replaced with originals.

If cared for, the Mechanica M5 can tirelessly perform its function as a valuable timekeeper and proudly be passed along from generation to generation.

Removing the movement

For subsequent installation of additional equipment you will need to remove the movement. Please reserve sufficient time to modify your Mechanica M5 in order to complete the steps described.

Caution

For the following steps of the procedure, use something like the lid of the packaging your M2 came in or a piece of paper as your underlay in order to avoid scratching the case and high-quality components.

For any modification to the movement, please consult the tips found in the section »Important Information before Beginning« at the beginning of this book. The sequence of steps helps you tosave needless effort and make success certain.

Please carefully prepare your workspace before beginning to remove the movement. Your workspace must be kept clean and should be well lit.

You will need

Tools

- ✔ Allen key 3 mm — *Compartment (13)*
- ✔ Tweezers (dressing forceps) — *Compartment (13)*
- ✔ Assembly base — *Compartment (30)*

Only remove the movement if it has no power reserve, meaning the mainspring* is completely slack after about seven days and the escapement* comes to a stop without tension after by itself. Should the mainspring not yet be fully unwound, components of your M5 could be damaged and there is danger of injury.

Caution

Please use the gloves included in the kit to remove the movement and possibly disassemble it. Contact with sweat could otherwise leave marks that may be very difficult to remove.

Lay the case down carefully with the back on the surface and loosen the seat-board with the two cylinder-head Allen screws M4 x 60 and their corresponding washers on the bottom of the case.

Caution, the movement is now loose in the case! To avoid damage, set up the case very slowly and carefully, open the door and slowly pull the movement from the base of the base plate, while holding the movement with both hands so that it cannot damage the case. Then place the movement on the assembly base.

Caution

Make sure that the movement is only disassembled if the mainspring has absolutely no tension.

Disassembling the movement

To check the movement or to later add additional components, it may be necessary to disassemble the movement. Please take note that the disassembly must take place in the opposite order as the assembly:

1. Take off the hands
2. Remove the dial
3. Take out the escapement*
4. Test the gear train*

Test the clearance of all wheels. If they can be very slightly axially moved, the mainspring is not tensioned. If the gear train is stuck and only now releases its tension, brake it using your fingers on the seconds wheel arbor until it stops.

Safety notice

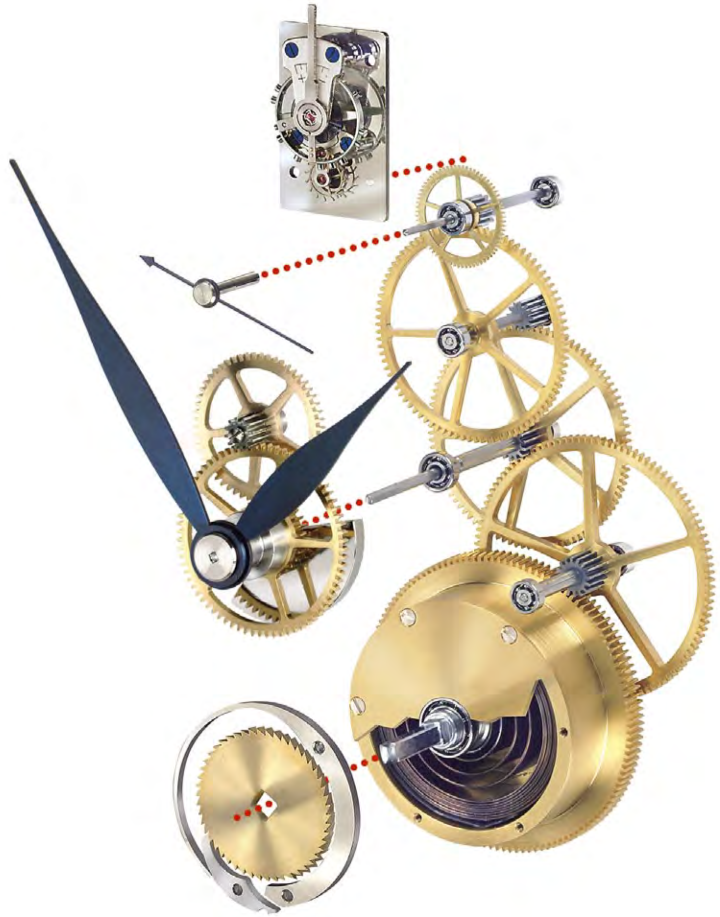
Due to possible injury, make sure that the ratchet wheel* cock is only removed if the mainspring has absolutely no tension.*

5. Removing the ratchet wheel cock

Make sure that the ratchet wheel cock is only removed if the mainspring has absolutely no tension and that the Gear train has no more energy stored.

To disassemble the rest of the movement, please follow the instructions outlined in this book in the opposite order.

TECHNOLOGY AND FUNCTION OF THE MECHANICA M5



The following descriptions are meant to give you a little overview of how your mechanical table clock functions and the special elements of its design.

It is indeed a demanding task to explain to the interested connoisseurs the complex ways how the escapement*, gear train* and and driving mechnism work together in a relatively short, yet comprehensible text. We watchmakers learned this during a three years apprenticeship.

However, it is important to us to give you not only the possibility of assembling your own table clock with this kit, but to also share our enthusiasm for this type of timepiece with you.

It is the fascinating interplay of nature's laws and what at first glance seems to be simple mechanics that allows us to measure the passing of time with enormous precision. Over the course of the last centuries, watchmakers have put great effort into increasing the accuracy of mechanical watch movements using the means at their disposal.

Today, we feel obliged to carry on this tradition and are thus consistently trying to improve our exclusively mechanical timepieces using the aid of new materials, modern manufacturing processes, and new design solutions.

Today, the fascination of a precision table clock is not only tied to its precision, but closer observation will allow you to see its simple, clear design. In it, we can observe and understand the effects of nature's laws. A mechanical clock is a lively and - some say - living thing, and your Mechanica M5 is even something tangible in the full meaning of the word.

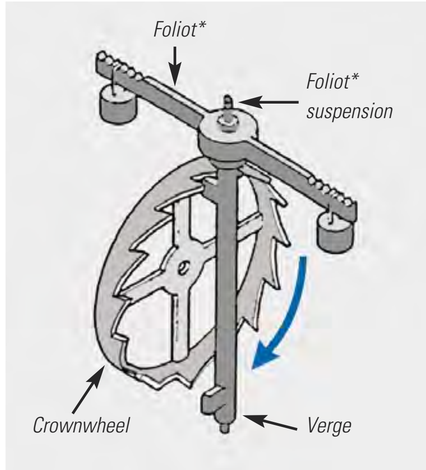
Over the course of the last 400 years, watchmakers have tried to compensate the influences of gravity that prevent a timepiece from working with complete accuracy with innovative designs. Before we take a closer look at the structure of the escapement*, let us take a short journey through history so that we can understand the invention, development, and perfection of the escapement*.

The following list of escapements claims not to be complete. Here we are solely visiting some of the important stations along the way toward the development of today's Swiss lever escapement*.

Verge escapement (from approx. 1300)

The development of modern timekeeping began in the high Middle Ages. Probably as early as the thirteenth century mechanical clock movements were being made using toothed wheels - an element that has remained the technical basis for the history of the art of watchmaking all the way to the modern day.

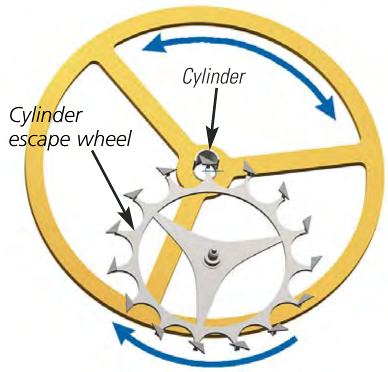
The first mechanical clocks used the foliot* as their escapements, a component with adjustable weights named for its visual similariy to a scale. The oldest form of escapement - the verge* - used in conjunction with the foliot could only guarantee an uneven rate for the movement. The Verge escapement had other decisive disadvantages, but remained in use in simple movements until the mid-1800s. Because of the recoil of the Crown wheel*, this escapement showed very high loss due to friction* and thus did not freely oscillate. The recoil is defined as the direction of motion of the Crown wheel (and later the escape wheel), in which it is pushed opposite its normal direction



of rotation until the escapement reached its inversion point* after dropping the Verge escapement pallet (later the escape wheel tooth). The escapement was thus attached to the gear train* during the entire duration of its oscillation.

Cylinder escapement (from 1695; improvement from 1720)

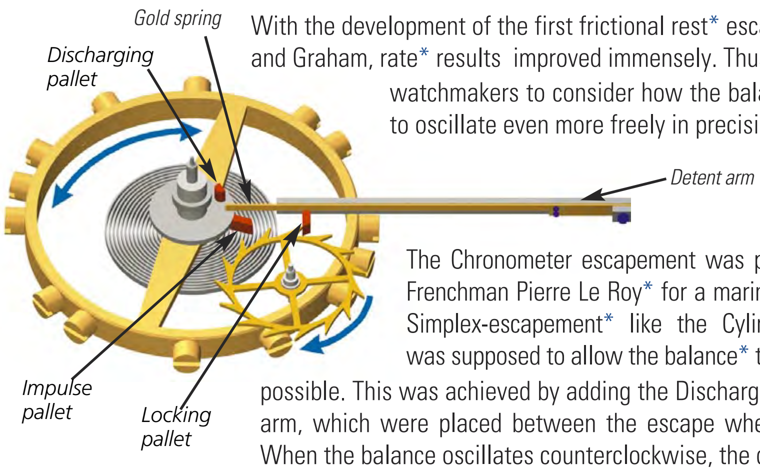
The Cylinder escapement represented a small revolution in the history of portable timekeeping since this escapement functioned with far more precision than the verge escapement* that had been in use until then.



The balance* in a cylinder escapement can oscillate much further(amplitude*) and bothersome losses due to friction* are much smaller than those of the recoiling* Verge escapement. The Cylinder escapement is a so called Frictional rest escapement* since the escape wheel stands still resting during the supplementary arc of the balance.The base idea goes back to 1695 to famed English watchmaker Thomas Tompion*. Around 1750, Tompion's pupil, friend, and later partner George Graham* achieved urther improvement on this escapement for pendulum clocks using enhanced manufacturing techniques, giving direction to the whole of watchmaking at the time. Graham is one of watchmaking's most famous watchmakers thanks to the Graham escapement named for him, an ingeniously simple Frictional rest escapement for pendulum clocks.

Chronometer escapement (1766 with spring, 1772 with pivoted detent

With the development of the first frictional rest* escapements by Tompion and Graham, rate* results improved immensely. Thus, it was logical for watchmakers to consider how the balance* can be allowed to oscillate even more freely in precision timepieces.



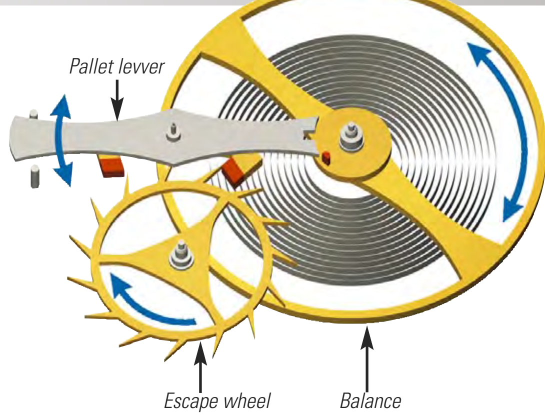
The Chronometer escapement was probably developed by Frenchman Pierre Le Roy* for a marine chronometer*. As a Simplex-escapement* like the Cylinder escapement*, it was supposed to allow the balance* to oscillate as freely as possible. This was achieved by adding the Discharging pallet* and detent arm, which were placed between the escape wheel and the balance*. When the balance oscillates counterclockwise, the detent arm is pushed to the side for a moment by the balance's Discharging pallet* and the escape wheel can pass its impulse to the locking pallet. After that, the escape wheel is stopped precisely at the next tooth by the locking pallet* via the recoiling detent arm. When the balance oscillates back, the crooked, fine gold spring of the detent arm allows the impulse pallet to pass. There are numerous variations of the Chronometer escapement from England, for example with detent bar and lever arm.

The Chronometer escapement was an important step toward the precision timepiece. However, this type of escapement is not the only decisive element for the rate precision of a watch or clock. This is also dependent upon the temperature compensation of the balance and the quality of the balance spring*.

The fact that the Chronometer escapement could not assert itself is chiefly due to two things: for one, it was much more elaborate than the Club-tooth Lever escapement developed a little later and for another it was much more receptive to shocks. Also, the balance did not restart by itself if it was stopped by a blow. And if the balance was made to go faster by an outside blow, it very easily began »galloping«, which means that too large oscillations of the balance saw it passing several teeth (rather than just the one it should). In summary, it must be underscored that to this day the Chronometer escapement remains the most precise, if the most complicated escapement for portable timekeepers.

English Lever escapement (from 1792)

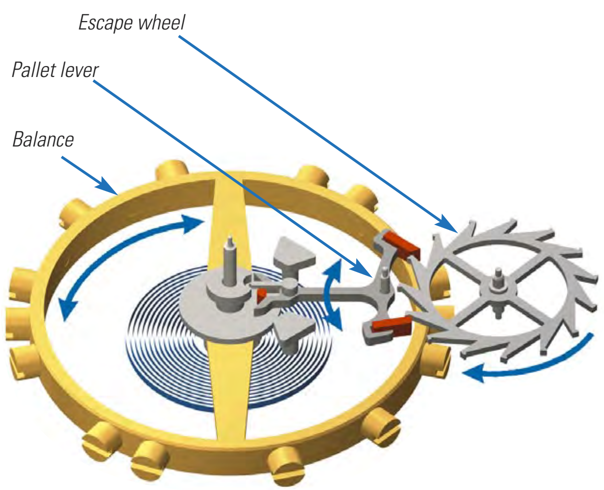
The English Lever escapement is an early form of the jeweled Lever escapement*. It follows the design elements of the Graham escapement* and was the basis for the Club tooth Lever escapement. The pointed, thin, oothed wheels were however very sensitive, which made keeping oil on the pallets* hard, and did not encourage an optimal transmission* of energy.



Swiss lever escapement (from 1855)

Thomas Mudge* entered his apprenticeship with famed watchmaker George Graham* at the tender age of 14 and took over his business in London after Graham's death. Mudge was an ingenious watchmaker and probably already invented the free-sprung lever escapement* in 1759 as he worked on a chronometer. Its characteristic element is the lever whose shape is reminiscent of a ship's anchor, and it is the connecting part between the escape wheel* and the balance*. Mudge and his contemporaries did not recognize the importance of this escapement, and Mudge didn't live to experience the triumph of his invention. Only later did numerous improvements made by capable watchmakers contribute to the fact that 99 percent of all portable mechanical watches are today outfitted with this escapement.

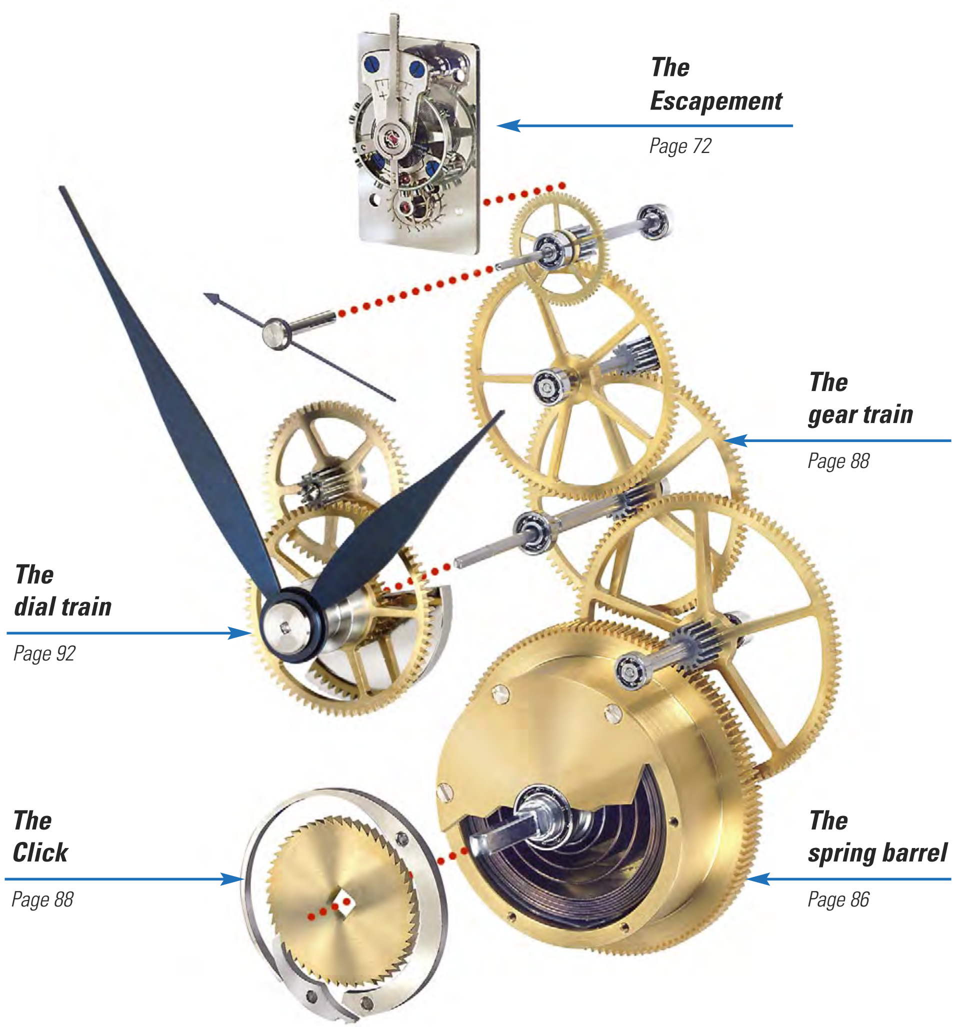
The Swiss lever escapement* and the Glashütte Lever escapement belong to the grouping of club-tooth lever escapements*, which evolved from English lever escapements*. The Swiss lever escapement also falls into the category of free-sprung Lever escapement because the balance* freely oscillates up to the inversion point after being moved by the pallet* lever.



The impulse pin*, also called the release* pallet, is located on the balance staff and takes over the motive impulse from the pallet lever.Generally, the impulse pin like the two pallets on the pallet lever is made of synthetic ruby* because of its low friction* coefficient and low abrasion. The Swiss lever escapement has become the most utilized escapement in portable timekeepers mainly because it has a relatively simple design with robust characteristics that protect it from shock, making good rate results possible.

Set-Up of the Mechanica M5

If you now take the time to try to understand the processes taking place in your Mechanica M5, you will be able to share our enthusiasm for watchmaking and look at your clock through different eyes in the future.



The Escapement*

In classic watchmaking two basic styles of regulating* organs are used:

- ✔ The pendulum* in grandfather clocks, wall or tower clocks, and pendulum clocks and
- ✔ the balance spring* for pocket and wristwatches and table clocks

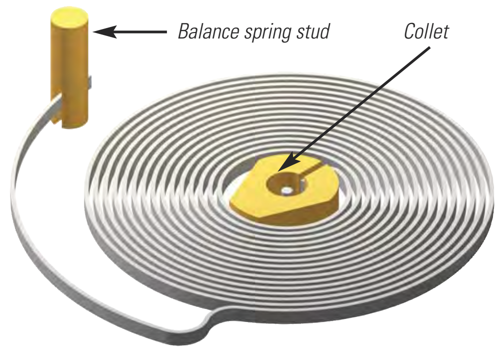
Caution

Please be careful when handling the escapement, making sure that the sensitive balance, and the filigreed escape wheel are not touched or damaged!

The first classic mechanical escapement for timepieces was the pendulum* discovered by Galileo Galilei* in 1585. With its regular oscillations, it was a major breakthrough in timekeeping. According to Galileo's observations, a pendulum`s* frequency remains constant regardless of its amplitude. The frequency is determined alone by the length of the pendulum under ideal conditions. While in a pendulum clock the returning force comes from gravity, in a balance system it is caused by the elastic deformation energy of a spring. The amplitude* of the pendulum amounts to just a few minutes of arc, while the balance generally has an amplitude between 200 and 300 degrees depending on the design and use (pocket watch, wristwatch, or table clock).
The escapement* comprising balance*, pallet* lever, and escape wheel* builds the heart of every timekeeper and is responsible for the typical ticking sound a mechanical timepiece makes. It is based on a mechanical oscillating system to portion the time, which divides it into precisely defined sections. The length of an oscillation is determined by the reciprocal effect of the mass spring system in conjunction with the (mass) inertia of the balance* and the return energy of the balance spring*. The escapement alone does not a movement make, however. Additionally, the oscillation of the balance must be transmitted to the gear train* and, reciprocally, the motive energy from the gear train to the balance. These tasks are undertaken by the escapement*. In addition, the spring barrel* with its mainspring* and the gear train also play an important role so that the balance oscillates evenly, or isochronously as we say today. Finally, the time portions determined by the escapement have to be translated into minutes and hours via the dial train* and displayed on a dial.

Your Mechanica M5 is outfitted with a classic Swiss lever escapement* beating at a frequency of 18,000 semi-oscillations per hour (2.5 Hertz).

The Balance Spring



The invention of the balance spring for mechanical timepieces can be attributed to Christiaan Huygens*, who invented the Archimedian spring in 1675. Subsequently, generations of watchmakers have consistently attempted to have the balance* oscillate evenly or isochronously (isochron is Greek for »same in time«). Significant improvements were made again and again by making the spring more filigreed and lighter over the course of centuries.

The length of the balance spring* (number of turns or coils) was chosen in relation to the weight and moment of inertia of the balance, and the resulting elasticity is determined by the so-called pinning point* of the balance spring collet*. The diameter of the balance spring is normally between one-half and two-thirds of the diameter of the balance. The inside end of the balance spring is secured to a pressed collet* on the balance staff. The outer end of the balance spring is bent into a so-called Terminal curve* and secured to the pallet cock* via the balance spring stud* on the stud carrier*. If the balance wheel is moved from its position in either direction, the elastic balance spring deforms and stretches the more it does so, the bigger the rotational angle of the displacement. When the balance is then let go, it oscillates through the elastic force of the deformed balance spring back to dead center, where the balance's speed is the greatest. The oscillating energy allows the balance to rotate, but back across the other side of dead center* to a practically identical angle on the other side similar to the swing of a pendulum*. Without the braking effect of friction*, these oscillations would remain infinitely long. In order to compensate for the reality of friction, the balance as we explain later must be driven.

Abraham-Louis Breguet* empirically developed the balance spring* named for him in 1795. The Breguet balance spring has a bent up Terminal curve* that is also turned inward. It was later precisely calculated by Eduoard Phillips*. Through the asymmetrical deformation of the conventional flat hairspring, the contact points of the bearings with the pivots create additional friction* energy that disturbs the oscillating system - affecting it anisochronously. The Phillips Terminal curve, on the other hand, makes for symmetrical (concentric), and thus even, »breathing« of the balance spring, but does need more height than a simple flat hairspring.

Rate precision has always been strongly dependent upon temperature change. Metal alloys normally expand through heat, though the inner stability is reduced, and the material becomes softer and the spring loses elasticity. This phenomenon results in a change in frequency for the oscillating system since the balance* increases in inertia through the expansion and the balance spring becomes softer and less elastic. In a word, the isochronism* is lost. Thus, the balance spring is greatly dependent upon the temperature surrounding it.

In 1896, Swiss physicist and later Nobel Prize winner Charles-Edouard Guillaume* invented an iron-nickel alloy with an especially small thermal expansion coefficient and increasing elasticity with increasing temperature, which he called INVAR* (invariable). Invar, however, had a deceptive element: the high inner tensions of the metal structure. Only through elaborate tempering* (heat treatment) can the desired constant temperature behavior be achieved.

Invar alloys are used everywhere where the highest value is placed on stable material characteristics during temperature deviation. Invar is still today the base material for most balance springs and pendulum rods in precision timepieces.

In 1931, Swiss countryman Dr. Reinhard Straumann* further developed Invar, making it one of seven elements comprising an unbreakable, self-compensating, rust-free and antimagnetic alloy. This alloy, however, demands a special cold deformation before undergoing a lavish heat treatment.

It was given the (today) wellknown name NIVAROX* (nicht variable und oxydfest/ »not variable and oxide-proof«) and registered for a patent. This is the material that the balance spring of your Mechanica M5 is made of.

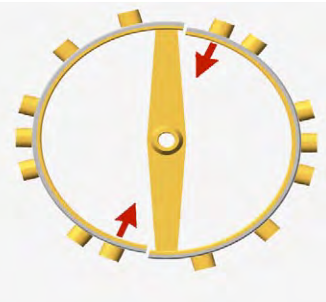
Beside Invar, another material for the manufacture of monometallic balance and escapement components as well as balance springs has become commonplace: GLUCYDUR*. The name is made up of the French words glucinium (meaning »beryllium«) and dur (»hard«). Glucydur is a very hard alloy comprising copper and 2-3 percent beryllium. It is non-magnetic, not oxidizing and has a very low thermal expansion. This alloy is also known as beryllium copper and is often used for highly stressed springs and relay contact material and for railroads (current collectors). A decisive disadvantage is that the alloy element beryllium is highly poisonous. When working beryllium copper, one therefore needs to be very careful.

The manufacture of high-quality balance springs begins with the precise combination of all pure materials for the melting mixture. In a vacuum space, these are poured into a raw cast block of about 20 cm diameter and 80 kg in weight from which is created a highly precise wire with a diameter of only 0.075 mm - thus thinner than a human hair - over the course of numerous individual operations like extrusion molding, warm and cold rolling, and forming by machines using diamond stretching stones. The precise, round wire is then rolled out to create the flat reel used for balance springs in an air-conditioned room at an incredible precision of 0.1 thousandths of a millimeter (1/10 micron).

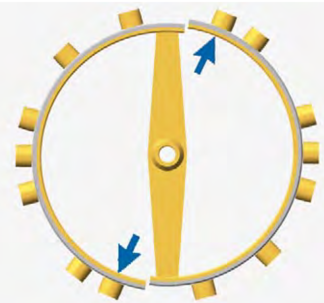
The rolled strip only a few tenths of a millimeter wide and a few hundredths of a millimeter thick are cut to the appropriate lengths and rolled out on an arbor before being subjected to warming treatment of about 700°C in a vacuum or a protective gas atmosphere. This allows the springs to take on the desired spiral shape and at the same time receive the necessary hardness and elasticity (thermoelastic coefficient) by creating an emulsive process in the alloy. The quality of balance springs are judged by their temperature coefficient, or the dependence of the elasticity on temperature.

The Balance

We have already described a large part of the problematic in manufacturing the oscillator* when we talked about the manufacture of balance springs. The biggest challenge here is to ensure the smallest possible influence of temperature change.
Without much ado, the balance wheel expands when heated - and the watch runs slow. If the balance wheel contracts as it cools, the watch will run fast. This was effectively combated in the past, reversing the behavior just described, by making bimetallic balance wheels: the first temperature compensation was born. The bimetallic balance wheel, as the name already suggests, is made using two layers of different metals, which expand in different strengths when heated and contract differently when cooled.



When heated, the outer layer expands more strongly, thus pushing the inner layer toward the center of the balance. This change in inertia accelerates the balance wheel and compensates for the softer balance spring when heated.



When cooled, the outer layer consolidates more strongly. The diameter of the balance wheel increases and the balance gets slower. The increased inertia of the balance wheel is thus the same as the cooling of the increasingly strong and hard balance spring.

Ideally, we are aiming at creating a self-compensating unit that includes the balance spring.

It is naturally better if the influence of temperature is kept as low as possible right from the beginning - or, ideally, even entirely avoided - by choosing suitable materials.

Because of today's extremely low manufacturing tolerances, contemporary mechanical watches and clocks now come almost exclusively outfitted with balances that have a smooth balance wheel. It was and is important to get the optimal interplay of balance spring and balance. If the components are suitably chosen during the pairing, the balance is able to compensate for the temperature behavior of the balance spring and vice versa. After manufacturing is completed, both the elasticity of the balance springs and the inertia of the balances are measured, correspondingly sorted, and optimally paired.

In classic high-quality timepieces and marine chronometers* of days gone by, elaborate screw balances were used. Even today these are still utilized in high-quality watch movements; they are absolutely ornamental in any timepiece.

The screws allow the following:

- ✔ the best possible compensation for potentially existent unbalance* and
- ✔ altering oscillation frequency.

Both of these measures allow improvement to the rate precision of a precision timepiece.

The influence of temperature is, however, not the only interfering factor. Change in position as well as shocks are important factors, particularly for pocket and wristwatches. Like any pendulum*, the balance* is exposed to the effects of gravity. Ideally, gravity should influence the even oscillation of the balance* as little as possible. To achieve this, the oscillating system - comprising balance and balance spring* - needs to be poised as precisely as possible.

While in previous times the unbalance* was compensated for by adjusting the numerous weighted screws and adapting the balance spring, today balance wheels are generally finely poised in fully automatic manner using computer-controlled laser trimming. This takes place with a fully assembled balance spring, since it heavily influences the balance of the oscillating system. Balance wheels are thus always considered a unit together with the balance spring*.

A non-powered balance would oscillate practically isochronously. This means that the length of the oscillations is independent of the amplitude* (or the angle of rotation). All efforts on the part of the watchmaker concentrate on retaining this isochronism*.

It is achieved by reducing the following causes of the changes:

- ✔ friction of the pivots
- ✔ insufficient balance (unbalance) of balance and balance spring
- ✔ influence of the escapement*
- ✔ temperature
- ✔ magnetism.

In watchmaking, oscillation frequency is defined by the number of semi-oscillations (either a »to« or a »fro«) the balance makes per hour. Every Semi-oscillation corresponds to the advancement of an escape wheel tooth (except for the Chronometer escapement).
The frequency of the balance of your Mechanica M5 is 18,000 vph (vibrations per hour), which corresponds to 2.5 Hertz.

The Escapement

The escapement is the passage between the oscillating organ* and the gear train*. The escapement not only has the task of blocking the gear train from running uncontrollably and only allowing it to move forward in steps, it is also responsible for driving the oscillating system. So that it can oscillate with as little disturbance as possible, it is necessary for the energy transmission* to take place as evenly as possible. To guarantee that the balance can move fully freely during the other oscillation, the impulse should take place through the smallest possible amplitude* of oscillation.

Assuming that forces of friction like

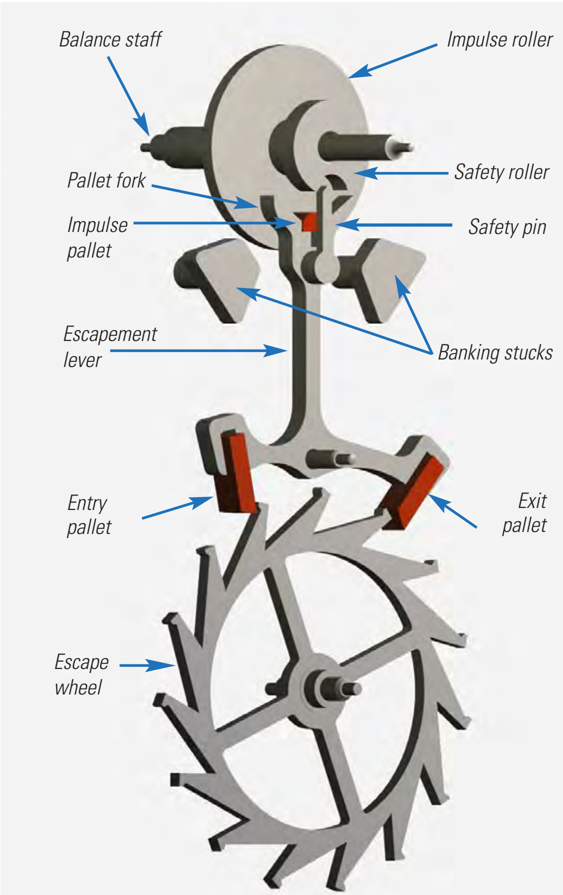
- ✔ bearing friction
- ✔ air friction
- ✔ inner friction of the balance spring*

don’t change, the result will be a constant amplitude of the oscillation system (rotational motion of the balance).

Theoretically, the oscillating system is not influenced if the impulse of the balance takes place exactly when it has reached its greatest rotational speed. In this state, the balance spring has fully released its tension. Since this corresponds to the balanced position when the balance is idle, this point is called dead center*. Ideally, the balance should oscillate evenly to both sides of dead center.

As previously described in the section on the development of escapements*, numerous escapements were invented to achieve the most even distribution of energy. Today, it is the Swiss lever escapement* that has asserted itself in portable mechanical timepieces.

Two pallets made of synthetic ruby are inserted into the arms of the pallet* lever and alternately engage a tooth of the escape wheel and hold it for a short time. Every time the balance passes Dead center* in either direction, the pallet stone takes the pallet fork with it. The pallet lever then releases a tooth of the escape wheel, which briefly moves forward. The energy created by the gliding of the escape wheel across the impulse plane of the pallet is transmitted to the balance's impulse pallet via the pallet fork.



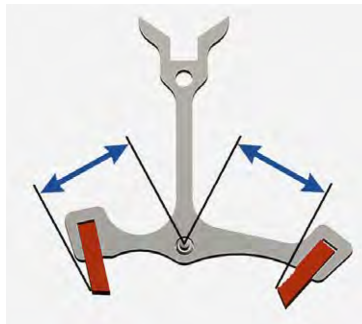
Except for the short moment in which the escapement is linked to the balance via the pallet fork and Impulse pallet, the oscillator* oscillates in a fully free manner independent of a drive mechanism. These are basic conditions for the even rate* of a timepiece. The few escapement types that possess this advantage are called free or detached escapements*. The Swiss lever escapement* is thus a free escapement*.
Only toward the end of the eighteenth century was it possible to manufacture such precise escapements.
Despite every effort to improve numerous details, mechanical table clocks and wristwatches cannot achieve the same precision that highquality precision pendulum clocks offer, such as those offered by clock manufacture Erwin Sattler. Precision pendulum clocks were used all the way to the middle of the last century as national time norms, reference clocks in observatories, and for other scientific purposes. Only later were they replaced little by little with quartz and atomic clocks.

Function of the escapement

The oscillations of the balance* are based on the alternate exchange of dynamic energy resulting from the motion of the balance and the energy saved in the balance spring as return energy (torque*).

Discharge* – Lift* – Drop*
This is the order in which the events of the Swiss lever escapement* occur during each Semi-oscillation*. Each ticking sound thus comprises these three single sounds and can be recorded by the watchmaker using a special machine (called a Timing machine*) and can be differentiated by their differing volumes (see the determination of rate precision). By analyzing the sounds, the expert can make detailed conclusions about the sequence of the escapement's movements and use it as a basis for optimization. The slightly differentiated sound made by the entry and exit pallets hitting teeth is known to us as the tick and tock of a timepiece and result from the varying lengths of the two arms of the pallet fork.

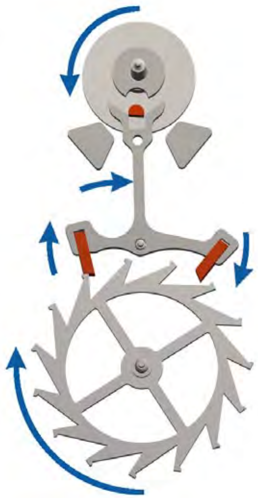
The different lengths of the two arms of the pallet fork are necessary to make sure that the distance between the locking plane* at the entry and exit pallets is the same distance to the pallet fork's fulcrum and thus symmetrical.



The following illustrations show the most important phases of the interplay between the escape wheel*, pallet* lever, and balance*.

Discharge
The balance* comes from its left supplementary arc and oscillates counterclockwise. Shortly before Dead center*, the Impulse pallet* engages the pallet fork and takes the pallet lever with it for a bit (discharge*).

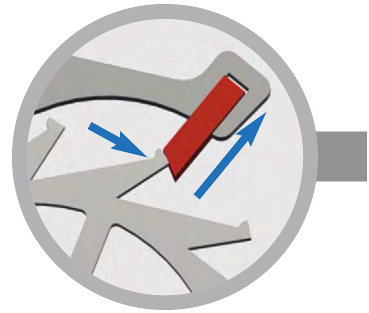
Lift (impulse)
When the balance oscillates counterclockwise and approaches dead center*, the escape wheel glides from the locking plane of the entry pallet to the slanted impulse plane. The entry pallet is then pushed upward (lifted), moving the shaft of the pallet lever and guiding the pallet fork to the right. Using the motion of the pallet fork (impulse), during its short rotation the escape wheel transmits the impulse energy from the spring barrel* and the gear train* to the pallet* fork and further accelerates the balance* in a counter-clockwise direction via the impulse pin.



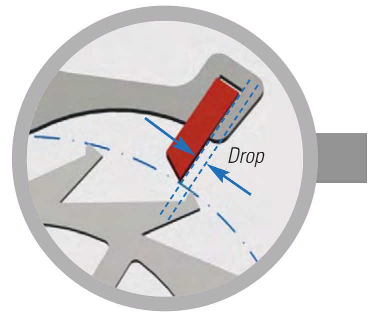
Drop
Together with the impulse, the exit pallet drops the short rotation of the escape wheel into the radius of the escape wheel teeth and guides the pallet fork to the right until it hits the banking stud. The escape wheel is once again obstructed after the short rotation. The semioscillation with its complete cycle of events (discharge-lift-drop) is thus complete.
The balance now oscillates further to the right inversion point, changes its rotational direction there, and then completes the next cycle in a clockwise direction during the next semioscillation.

Explanation of the motion sequence
The motion sequence of movements described here take place during every semi-oscillation of the balance, which alternately goes through dead center* from the left and the right.

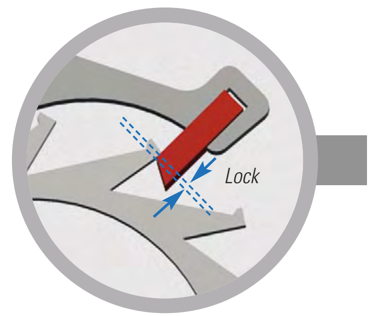
Let's begin with the lift.
The lift* is one of the most important functions of the escapement. During the lift the balance* receives the energy necessary to maintain the oscillation. This occurs when the escape wheel glides across the impulse plane of a pallet*. At this point, the pallet lever, which engages the Impulse pallet* of the balance near dead center via the pallet fork, is put into motion. In the Swiss club-tooth lever escapement* used here, the lift is achieved both through the pallet of the pallet lever and the escape wheel tooth itself.



After the lift comes the drop
The drop* is the free rotational motion of the escape wheel, after which the escape wheel tooth is dropped from the pallet. It represents a big point of security necessary to maintain the functioning of the escapement. This means, it allows the pallet to plunge back into the toothed wheel of the escape wheel during the next semioscillation without touching down on the back of the tooth. In order to guarantee the largest possible functionality, the drop of both pallets needs to be the same.
After the escape wheel tooth drops onto a pallet, another escape wheel tooth drops onto the locking plane* of another pallet. In this moment, the escape wheel stands still and the gear train* is blocked. The escapement thus fulfills its second important task.



The last term to be explained is locking
The locking motion is also important for the secure functioning. Locking can be described as the small distance located on the locking plane* of the pallet, which the escape wheel tooth traverses from the moment it touches down on the locking plane until it glides onto the lifting plane. This small surface is only a fraction of a millimeter, and it prevents the escape wheel tooth from directly touching down on the lifting plane, thus preventing the balance from oscillating further.

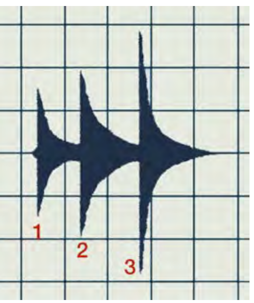


Determination of the accuracy

Determining the rate of the accuracy of a timepiece is done by observing and comparing it with another timepiece that is known to be precise; in the past this would have been a so-called precision regulator. This is a boring and time-consuming affair and for the precision movements of modern watchmaking no longer necessary. For the determination of rate and the adjustment of the escapement, watch makers now use the so-called Timing machine* in the measuring process.

In order to immediately determine the momentary rate of a movement, in principle the Timing machine measures the time passed between the tick and the tock and calculates it taking the frequency into consideration. The balance* of your Mechanica M5 oscillates at 18,000 semi-oscillations per hour, making for a frequency of 2.5 Hertz. This corresponds to a time of oscillation of 200 milliseconds between a tick and a tock. If this time were only one millisecond longer (corresponding to 0.05%), it would result in a rate deviation of 1 millisecond x 5 semi-oscillations x 86,400 seconds per day, which would equal a deviation of 43.2 seconds per day, or three-quarters of a minute.

Timing machines for mechanical timepieces use a highly sensitive microphone as a sensor, which records the sounds of the escapement*. This microphone generally also serves as the holder for the wristwatch, but a clamped microphone can also be used.



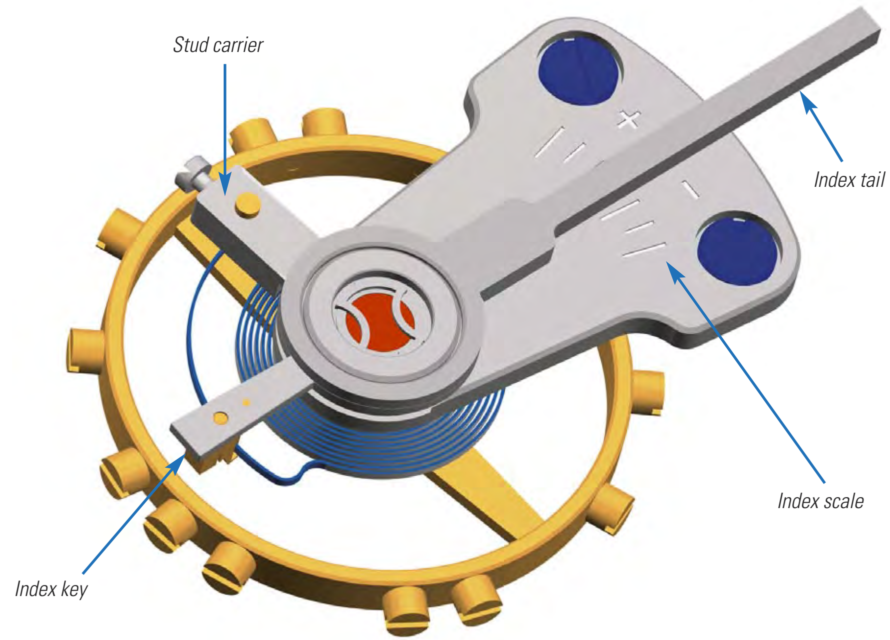
The illustration shows the signal of a tick (or tock) as an oscillogram*. Every sound comprises a sequence of three events:

1. The impulse pallet* meeting the pallet fork: **discharge**
2. The escape wheel tooth meeting the impulse plane of the pallet: **lift**
3. The escape wheel tooth meeting the Locking plane of the other pallet: **drop**

It is easy to see here that a tick (or tock) is composed of all three phases of the escapement: discharge - lift - drop.

Regulating the timepiece

There are several devices available to adjust and regulate the escapement*. In this chapter, our goal is to simply describe their functions. The escapement of your Mechanica M5 has already been adjusted and pre-regulated in our factory, so you only have to worry about the Fine adjustment* using the index*. The adjustment of the beat should only be performed by an experienced watchmaker.

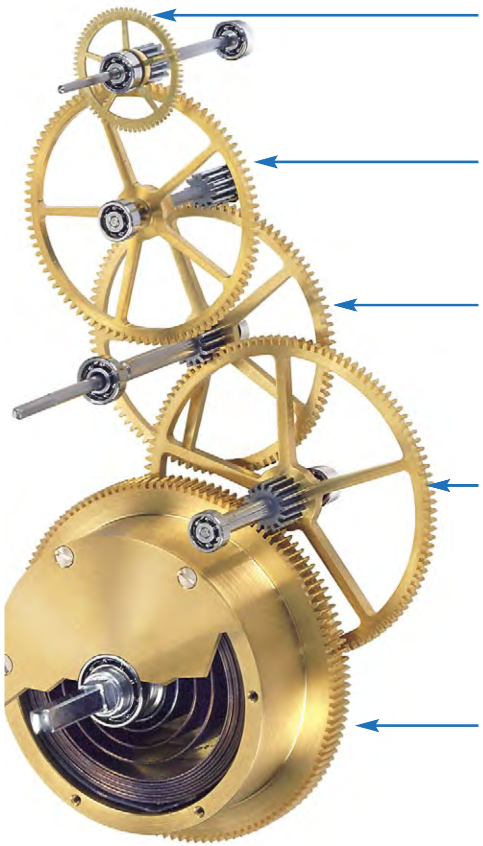


Regulating organ	Change	Adjustment
Stud carrier	Symmetrie/Nulllage	Rate symmetry/beat
Index tail with index key	Effective length of the balance spring	Fast/slow rate

Changing the effective length of the balance spring* during regulation with the index system (guiding the balance spring using the index tail) by only a tenth of a millimeter already leads to a rate change of more than one second per day

Driving unit and gear train

The driving unit in conjunction with the gear train* has the task of providing the escapement* and thus the balance* with energy. Additionally, the gear train* moves the hands via the dial train*.



Seconds wheel
70 teeth,
1 revolution per minute

Fourth wheel
90 teeth,
0,13 revolution per minute

Minute wheel
96 teeth,
1 revolution per hour

Center wheel
112 teeth,
0,125 revolution per hour

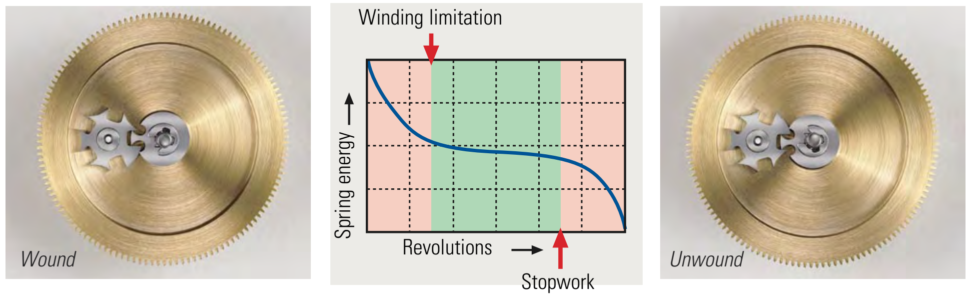
Spring barrel
128 teeth,
0,375 revolution per day

Driving unit

As already described in the section on the escapement*, the most even power source possible is needed to maintain the most even oscillation possible. This force is obtained from a mainspring*, which exerts the most even impulse energy possible on the spring barrel* with its tension.

Since the resulting torque* is supposed to remain as constant as possible, some provisions must be made.

When fully wound, the spring barrel* makes only 3.5 revolutions within about seven days. If the mainspring* is fully wound and allowed to completely release its tension, the impulse energy released would vary greatly. In order to avoid this, the spring barrel of your Mechanica M5 is outfitted with so-called stopworks*. With its stop wheels and blocking studs, it builds two banks. One bank guarantees that the mainspring can't be wound too far while the other prohibits its tension from easing too strongly.



The varying impulse energy influences rate precision very strongly. For this reason, the mainspring is only driven by the stopworks in the middle of its tension. The diagram shows the course of the spring's energy of a fully wound Spring barrel. The beginning and the end, as shown in the illustration, are not utilized. Thus, the power reserve is clearly reduced but the mainspring is driven by a nearly linear energy flow. The spring's energy is thus nearly constant over the course of seven days and builds the basis for optimal rate precision.

The Gear train* receives energy from the Spring barrel, which it passes on to the escapement* and thus sets the balance to oscillating.

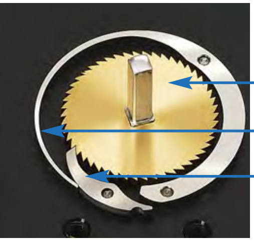
The spring barrel may not be opened. The lubricated mainspring is found inside and only needs maintenance about every five to seven years. To complete this, please send us the mainspring. In our workshops the mainspring will be examined, cleaned, and re-lubricated. This ensures that it will once again reliably drive your Mechanica M5 over the course of the following years.

Safety notice

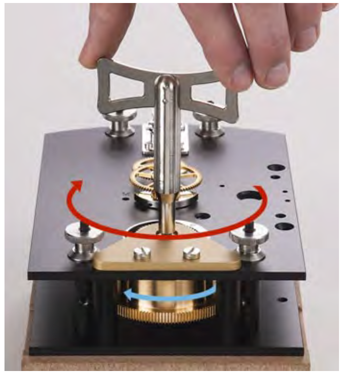
The spring barrel may not be opened.
You could be injured if the mainspring jumps out.

The click

The click* makes it possible for your timepiece to be wound using the winding key. It is located on the spring barrel* and comprises the following components:



- ✔ Ratchet wheel
- ✔ Click spring
- ✔ Ratchet



The click represents a blockade of the core energy of the movement. The energy saved in the spring can thus only be transmitted to the gear train* via the teeth of the spring barrel.

So that your timepiece can be wound via the mainspring in the spring barrel (red arrow), the click allows it to only move in one direction (blue arrow).

The gear train

If we observe the gear train's large transmission* ratio of 1 to 38,400 between the spring barrel and the escape wheel*, we can certainly gauge the small amount of energy with which a precision movement works.

This observation also provides design prerequisites for a good Gear train:

We need a low-loss gear train that transmits energy to the escapement* with as little friction as possible and without fluctuation. Additionally, it should complete this task with low wear and tear over the longest possible period of time.

Thanks to the materials available today and our experience over he course of 30 years in manufacturing precision clocks, we can fulfill the criteria mentioned with our own gear train.

The wear and tear in a watch is the effect of friction. This is created in the bearings and the individual wheel-pinion gearing meshing.

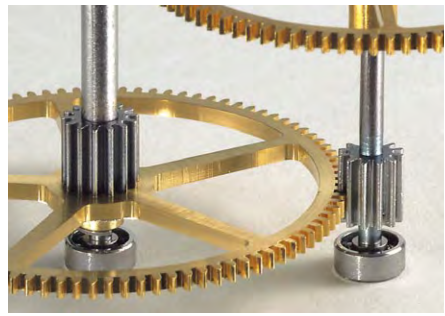
Mesh* is the word we use to describe the engaging of the teeth of a wheel with the teeth of another wheel. We watchmakers call a large toothed wheel the »wheel*«, while the smaller toothed wheel that is being driven is described as the »pinion*«.

Very important: the bearing friction

The greatest friction* in normal timepieces is created in the bearings of the gear shafts. In these timepieces, the thin pivots* of the arbors* glide directly in the bearing holes of the front and back plates made of brass*; these are lubricated with oil. This type of bearing has proven reliable for normal everyday timepieces, but does have the disadvantage that the oil loses its lubricating element as a result of soiling through metal abrasion and grit as well as evaporation. This raises wear and tear, the bearing holes wear out and the and the result is increased energy loss and eventually the timepiece stops working. The widened bearing holes alone are not the cause of energy loss, but rather the distances of the wheels engaging one another is changing and thus impeding the transmission* of energy. For these reasons, the pivots of the escapement* do not run in brass* bearings, but rather ruby. These bearings hardly show wear and tear, even after decades. However, all bearings should be checked every five to seven years in order to avoid damage to the components.

The friction of the bearings described here is called sliding friction, as the range of the pivot's* body glides along the walls of the hole during its rotational motion.

Your Mechanica M5's gear train* is outfitted with miniature corrosion-resistant stainless steel ball bearings*. The abrasion of a ball bearing is called rolling friction. This type creates considerably less friction and also has the advantage of getting along without oil if the ball bearing only has a small load to bear.



Depending on their dimensions, the maximum permissible amount of revolutions of these bearings is about 100,000 per minute. The fastest wheel in our clock - the escape wheel - only revolves ten times per minute. We can thus be assured that our bearings are not being overworked. It is only soiling of the ball bearings - such as by dust - that will hamper the functionality of our gear train. Our movement is, however, adequately protected from dust by its specially sealed case.

The excellent clock bearings make it possible for us to now work with less impulse energy as the ball bearings create very little friction, thus resulting in less loss of energy. Less energy also means less strain on the toothing, which aids the longevity of the gear train.

The friction, occuring in every single wheel-pinion engagement

The amount of this friction is determined by several factors:

- ✔ The materials used, or more precisely, the paired materials
- ✔ The shape of the teeth
- ✔ The number of teeth
- ✔ The size of the individual gearing of each mesh*

The materials used:
We use hardened steel pinions* and brass wheels in your Mechanica M5.

This has two reasons:

- ✔ The teeth of the pinions are often strained due to their higher number of revolutions and are thus crafted in hardened metal.
- ✔ The friction created by different materials is smaller than the friction created by the same materials rubbing on one another. In watchmaking, the pairing of brass* and steel has proven reliable.

The tooth shape
In comparison to other technical transmissions*, watchmaking works with high transmission ratios*. Making even and low-friction energy transmission* possible precludes a special geometry for the individual teeth. The theoretically perfect tooth shape for this was already developed more than one hundred years ago, but could not be manufactured neither then, nor now. For this reason, we use a tooth shape very close to the ideal shape in your clock, whose individual teeth mainly roll off each other during meshing* and hardly rub one another. We speak of circular arc toothing, which is close to the ideal of cycloid* toothing.

The number of teeth utilized and the size of the transmission ratio are dependent upon one another.

Time has shown that it is advantageous if the highest number of teeth possible mesh at the same time. Energy transmission then takes place very evenly and with little friction. This is achieved by a high number of pinion teeth. A good figure for precision timepieces is a pinion with more than ten teeth.

Experience has also shown that a transmission ratio that is too high results in more friction during meshing*. Transmission ratios of less than 1:10 are considered ideal.

The gear train of your Mechanica M5 is outfitted with pinions gears containing 12, 14, and 16 teeth.
The corresponding individual transmission ratios are 1:8 and 1:7.5. It is only the gear reduction of the fourth wheel to the escape wheel that is 1:10.

The Dial train

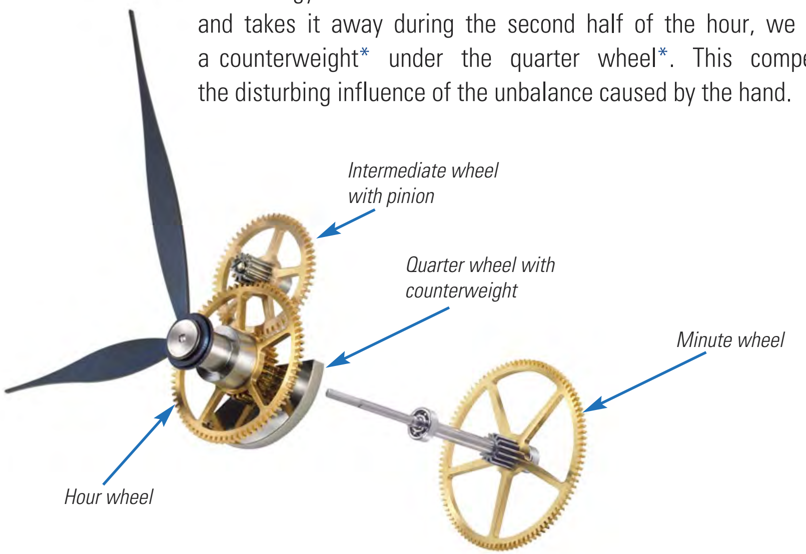
The last subgroup of our Mechanica M5 that needs discussing is the dial train*.

The dial train has the task of reducing the precisely defined number of rotations of the minute hand to that of the hour hand in a ratio of 12:1.

In order to guarantee the same direction of motion of the two hands as well as the concentric display, we use gearing with two meshes* and individual reductions of 2:1 and 6:1.

The minute hand is perched directly upon the center wheel* arbor. In order to set the hands, it is necessary to decouple the center wheel arbor from the rest of the gear train*. This is solved by the so-called friction of cannon pinion on the center arbor*, which is found between the center wheel with its riveted pinion* and the center wheel arbor. This friction* is created by a pre-tensioned, five-legged friction spring between the center wheel and the center wheel arbor and corresponds to a slipping clutch.

Since the minute hand constitutes a one-armed lever, which lends the gear train energy over the course of the first half of an hour with its dead load and takes it away during the second half of the hour, we have added a counterweight* under the quarter wheel*. This compensates for the disturbing influence of the unbalance caused by the hand.



Out of all these points a solid gear train is created that meets the standards of a table clock in every way.

The Movement

- ✔ Plates* crafted in 4 mm high-strength aluminum with permanent surface protection from an extra-hard anodized* layer.
- ✔ Gear train* mounted in 10 Stainless steel* precision ball bearings
- ✔ Pinions crafted in hardened steel
- ✔ Gear wheels crafted in brass* with fine legs, milled, finely polished, and gold-plated
- ✔ Minute hand with counterweight*

The spring barrel

- ✔ Core mounted in 2 stainless steel* precision ball bearings
- ✔ Even spring tension via stopworks*
- ✔ Eight days power reserve

The escapement

- ✔ Swiss lever escapement* with 11 ruby jewel bearings
- ✔ 18,000 semi-oscillations* per hour (corresponds to 2.5 Hertz)
- ✔ Pallet* lever with jewel pallets
- ✔ Incabloc shock protection
- ✔ Nivarox*- flat hairspring with Terminal curve*
- ✔ Regulating index* on engraved scale

The dial

- ✔ Dial made of hardened anodized* aluminum
- ✔ Screwed on seconds scale made of hardened anodized* aluminum
- ✔ Hands crafted in blued* steel

The clock

- ✔ Case crafted in solid, untreated precious wood in cherry wood, and walnut or in black painted alder
- ✔ Case is sealed to protect the movement from dust
- ✔ Hidden drawer in the cornice for the winding key
- ✔ Rate precision: under optimal conditions pprox. +/- 5 seconds per day

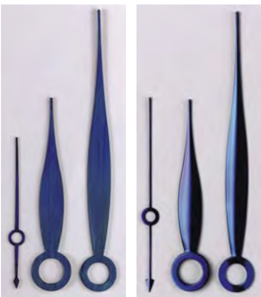
To give you the opportunity to upgrade your Mechanica M5 both visually and technically, the following accessories are currently available:

Upgrade kit -
Date indication
The date on the dial adds a useful complication to the basic clock kit version.

Page 30

Upgrade kit -
Moonphase indication
A hand painted moon passes behind a cutout in the dial within 29,5 days.

Page 30



Upgrade kit -
Hand-domed and polished hands
The domed, polished and blued hands for hour, minute and seconds are completely hand crafted.

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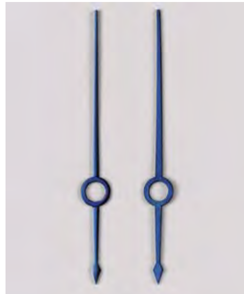

Upgrade kit -
Hand-domed and polished date hand
The domed, polished and blued hand for the date is completely hand crafted.

Page 48

Upgrade kit -
Anti-reflective mineral glasses
Allows a glare-free view of the clockwork.
Cannot be retrofitted!

Page 51

Upgrade kit -
Set of fine-polished screws
The look of the movement can be further enhanced using these 4 gold-plated washers and the 20 fine-polished stainless-steel screws.

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www.uhrenbausatz.de

Fine, elegant lines - **Metrica** - a timelessly classic table clock.

The »Role Model« of your Mechanica M5 is the Metrica table clock from the Erwin Sattler Manufacture in Munich.

The modern case crafted in wood with inlaid wood is the result of a permanent evolution of existing models and the use of contemporary materials. On the basis of a gold-plated gear train that was fully developed in the last five years at Erwin Sattler, Sattler's clockmakers realized their vision of a reliable, low-maintenance, long-lasting table clock movement in Caliber 1385.

As the energy saved in the mainspring continuously dwindles over the course of its fifteen-day power reserve, the movement was outfitted with a mechanical clockwork compensator. As with classic marine chronometers, this subgroup includes a fusee calculated to compensate spring energy, a fine wire cable, and a spring barrel. A handmade, blued steel hand clearly displays the tension status of the mainspring in an additional segment on the dial.

The silver-plated dial also shows the time including the seconds and the date. The movement is not only hidden, it is visible through the paned case. One's gaze automatically falls upon the elegant milled gear wheels, gold-plated for permanent protection from oxidation and manufactured by Erwin Sattler. These are perched upon hardened solid steel arbors with precisely milled pinions that are mounted in low-friction stainless steel ball bearings. A clock outfitted such as this fulfills all demands on the traditional art of horology. It is classy and discreet, not overpowering, and still remains the highlight of any room.

The precious, hand-polished wooden case demands about two weeks to apply up to thirteen layers of varnish and several intermediate hand-sanding steps and is available in black piano lacquer or walnut.

The Metrica model shown, as well as all other models in the Sattler collection, is not available as a kit. These clocks are only sold through select specialized shops.

If you share our joy and enthusiasm in the fascinating world of clocks, we would love to send you a free copy of our current Erwin Sattler catalogue including a list of dealers.

Erwin Sattler GmbH & Co.KG

Clock manufacture
Lohenstraße 6
D-82166 Gräfelfing
www.erwinsattler.de

The clock kit - precision pendulum clock Mechanica M1
For the last seventeen years, the number of enthusiastic owners of the Mechanica M1 has continuously grown—and there is no end in sight. If you are also interested in our precision pendulum clock with temperature-compensating pendulum and a rate deviation of only 3-5 seconds per month, we would love to send you our brochure.

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www.uhrenbausatz.de

Amplitude* Anodize* Archimedian b
Balance* Bezel* Ball bearing* Bregue
Center wheel* Collet* Counterweigh
Cycloid* Dial train* Discharging pallet*
Drop* English lever escapement* Fac
Fine adjustment* Foliot* Fourth whee
Friction* Friction bearing* Galilei Gali
Gear train* Glucydur* Graham escap
Hour wheel* Impulse pallet* Invar* Is
Lift* Mainspring* Meshing* Minute w
Nivarox* Oscillogram* Pallet stone* P
Pillar* Pinion* Quarter wheel* Ratche
Recoil escapement* Riefler escapeme
Safety roller* Screw balance* Stainles
Timing machine* Torque* Transmissio
Tungsten* Unbalance* Verge escapem
Weight-spring system* Wheel* Windin

A

Arbor Shaft or axis in a movement.

Agate Hard mineral used in high-quality clocks for pallets*.

Amplitude The Semi-oscillation* of the balance spring or pendulum* as it moves from dead center* to one of the inversion points.

Anodize Electrochemical alteration of aluminum. This special treatment sees the material's surface treated in an acid bath, during which a very resistant oxide layer is formed.

Archimedian balance spring Helical proportional spring invented by Greek mathematician Archimedes (285-212 BCE). Base shape of the modern balance spring.

B

Balance Together with the balance spring, the balance builds the oscillating system and, with the escapement, guarantees the even rate* of a timepiece.

Balance cock Part of the escapement upon which the index*, index key* and carrier stud are secured.

Balance spring A filigreed, rolled-up spring in the form of an Archimedian balance spring*. Both ends are connected with the balance by the Stud carrier* on the Balance cock* and the collet*. Together with the balance, it makes up the oscillating organ*.

Balance spring stud Secures the outer end of the balance spring and is screwed to the Stud carrier*.

Ball bearing An anti-friction bearing in which balls roll in a groove between the inner and outer ring. The rolling friction* created is very low, which is why Ball bearings have very low friction and display almost no wear. Because the Stainless steel* Ball bearings used in your precision clock have very little load, they need no lubrication.

Banking stucks Also known as curb pins. The pallet* fork rests on them during the supplementary arc of the balance*.

Bezel A decorative ring encircling the dial.

Bimetal A strip of metal made of two (bi = two) metals attached to one another and that expand in varying strengths when heated and contract in varying strengths when cooled. It is used for the balance wheel* of a compensation balance.

Blocking stud Part of the stopworks* of the spring barrel*. It makes it possible to bank the winding and unwinding of the mainspring*.

Blued, tempered See to blue or temper.

Brass Alloy of copper and zinc. Gears are made of brass and gold plated to protect them from corrosion.

Breguet, Abraham-Louis (1747-1823) Breguet is one of the most important watchmakers in history and supplied both the English king and Napoleon I with his timepieces. He improved rate* results with the Breguet hairspring with terminal curve* named for him. Additionally, he invented the tourbillon and manufactured high-quality chronographs and Marine chronometers*.

Bronze An alloy comprising more than 60 percent copper and tin, in stark contrast to brass*, which comprises copper and zinc.

C

Caliber Description of a type of movement.

Canon Pinion A component of the Dial train* upon which the Minute wheel arbor is placed. It drives the Intermediate wheel*.

Chaton A brass* bushing or bearing used in fine watchmaking with a pressed-in ruby bearing jewel. It is screwed into the base plate and can be easily exchanged.

Chronometer escapement A very precise but very complicated and sensitive escapement for precision chronometers.

Click Allows winding and prevents the mainspring* from immediately draining its energy via the ratchet* and ratchet wheel*. It sees that the mainspring* only releases its energy through the gear train*.

Click spring Please see click.

Club-tooth lever escapement In contrast to the English lever escapement*, the Swiss Club-tooth Lever escapement does not only see lifting occur on the impulse surfaces* of the pallets*, but also on the escape wheel* teeth.

CNC Stands for »computer numeric controlled«. The manufacture of precision movement components for your precision clock is done in our factory with the aid of computer-controlled lathes and milling machines.

Collet Positioned on the balance staff and secures the inner end of the balance spring.

Counterweight Thanks to the effects of gravity, the minute hand is a one-armed lever that provides the movement with energy for the first half of every hour before taking energy away for the second half of every hour. To prevent this, a counterweight is positioned on the minute hand arbor underneath the dial, moving the subgroup's center of gravity to the rotational axis where it can no longer exert negative effects on the timepiece's precise rate*.

D

Crown wheel Using a crown wheel as an escape wheel* allows the composition of simple conical gearing. It was previously used in the Verge escapement*.

Cycloid A geometrical curve that is created by rolling a circle on a geometrical contour. The cycloid has served watchmaking well for generations in movement toothing as the optimal contour.

Cylinder escapement The Cylinder escapement was the first frictional-rest escapement* and was a great improvement over the Recoil escapements* commonly used before it. However, during the complementary arc the tips of the teeth rub the cylinder, thus preventing free oscillation.

Dead center Resting position of a balance or of a pendulum*.

Deadbeat escapement Improvement upon the recoil escapement* and predecessor of the detached escapement. In the deadbeat escapement, the oscillator* was not in permanent contact with the escape wheel* for the first time, but rather rested during the complementary arc. Thus, it only moved forward in steps.

Detent arm Together with the Release spring* and discharging pallet*, it builds the characteristic part of the Chronometer escapement*.

Dial train A subgroup with two gear wheel* meshings*. It transmits the movement of the minute hands reduced by twelve to the arbor of the hour hand. The dial train comprises the quarter wheel*, the minute wheel*, the minute pinion*, and the hour wheel*.

Discharge The motion of the pallet* lever caused by the Impulse pallet in order to release the escape wheel*.

Discharging pallet See detent arm*.

Doming Cambering or curving. This is a popular method of increasing the visual attractiveness of hands of valuable timepieces.

Drop The free motion of the escape wheel* after the escape wheel tooth has slip-ped off the Impulse surface* of the pallet* lever. The drop is a necessary security measure to avoid the pallets striking the escape wheel teeth.

Duplex escapement An escapement without a pallet* lever but with a double wheel (locking teeth and impulse teeth) originally used for high-quality chronometers.

E

Ellipse Alternative name for impulse pallet* because of its shape.

English lever escapement An early form of the Jeweled lever escapement* with pointed teeth. Here the lifting motion only takes place on the pallets*. It served as a basis for the later development of the Swiss Club-tooth lever escapement*.

Escapement A component subgroup comprising the escape wheel* and pallet* lever. The escapement transmits energy to the regulating organ that is necessary to maintain its oscillation and at the same time hinders the gear train* from prematurely passing on its energy.

Escape wheel Part of the escapement, riveted to the escapewheel pinion. Is engaged with the pallettes of the escapementlever

F

Faceted glass Partially ground edges or surfaces of glass or gems is known as faceting. The faceting achieves a differentiated refraction of the optical path, thus creating interesting views of the objects behind them.

Fine adjustment Precise regulation* of the period of oscillation* by adjusting the index* on the escapement.

Finishing Visual refinement or decoration of high-quality movements.

Foliot A component with adjustable weights, it was used in early geared clocks with a verge escapement* as the oscillating organ*.

Fourth wheel A toothed wheel* in the gear train*. It is positioned on the fourth pinion* and transmits energy from the minute wheel* to the seconds wheel pinion*.

Free lever escapement At dead center*, for a short moment, the balance receives an energy impulse through the pallet* fork and the Impulse pallet*. During the resting phase of the escape wheel, the balance can freely oscillate and there is no mechanical connection to the gear train*.

Friction During the designing of the movement of your precision clock, great value was placed on decreasing friction. For this reason, most of the gear train* pivots and arbors are equipped with ball bearings*. Sometimes friction is necessary, for example in the dial train's* slipping clutch, which makes setting hands possible.

Friction bearing A bearing that sees the pivot borne in a hole. Since the material surfaces glide across each other, it is necessary to use lubrication alongside choosing different materials for each of the components.

G

Galilei, Galileo (1564-1642) Italian mathematician, physicist and astronomer. Around 1590 he examined the pendulum* and discovered that the period of oscillation* was not determined by its weight, but by its length. After that, and to his final days, he occupied himself with concepts for a pendulum* clock, but never made it.

Gear train The collection of toothed wheels* in a timepiece. The gear train transmits energy to the escapement. It is calculated to rotate individual arbors at certain speeds. There are five wheels in the gear train: the minute wheel*, the center wheel*, the spring barrel*, the fourth wheel* and the seconds wheel*. The escape wheel is not generally seen as part of the gear train.

Glucydur Derived from glucinum (French word for beryllium) and dur (French for "hard"). A very hard alloy of copper and 2-3 percent beryllium. It is non-magnetic, doesn't oxidize, and only expands slightly with heat. Also called beryllium copper.

Graham escapement Because of the special shape of the pallets*, the escape wheel* comes to a stop during its resting phase. Graham's escapement allowed for enormous progress in precision timekeeping and has served fine timepieces well for centuries.

Graham, George (ca. 1673 - 1751) After his apprenticeship, Graham worked with the influential English watchmaker Thomas Tompion* in London, with whom he was friends to his death. Graham became a partner of Tompion and married his niece, Elizabeth. Graham developed the quicksilver compensation pendulum* and, most importantly, the revolutionary lever escapement* named for him.

Guillaume, Charles-Edouard (1861 - 1938) The French-Swiss physicist worked among other things on the definition of the international prototype meter and discovered the Invar* alloy in 1896 with its extremely slight heat expansion. He received the Nobel Prize for it in 1920.

H

Harrison, John (1693 - 1776) Harrison was a carpenter by trade, but soon worked as a watchmaker. After beginning with the revolutionary manufacture of clock towers and grandfather clocks made of wood, from 1730 he concentrated for the rest of his life on making and optimizing Marine chronometers* for the British admiralty. In 1761 his son William proved the incredible precision of the ingenious H4 during a test run to Jamaica.

Hour wheel Part of the dial train*. The Hour wheel is driven by the minute wheel* pinion* and makes one full revolution in twelve hours. The hour hand is attached to the pipe of the hour wheel.

Huygens Christiaan (1629-1695) Dutch physicist, astronomer, and mathematician. He used Galileo Galilei's* knowledge for his investigation of pendulum* motion and discovered that the oscillation of the pendulum* is independent of its displacement. He ended up developing a pendulum clock and registered it for a patent in 1664. In 1675 he developed the balance oscillating system using an Archimedian balance spring* and utilized it in his own pocket watches.

I

Impulse pallet Called in French the ellipse because it used to be elliptical in shape, this is another name for the discharging pallet*.

Impulse roller Also called the great roller. It is perched upon the balance staff and bears the impulse pallet*.

Impulse surface A surface on pallets*. The escape wheel tooth glides along its inclined surface during the lifting phase, thus sending impulse energy to the balance.

Index Part of the escapement affecting the length of the balance spring, making it possible to alter the oscillation frequency.

Index key Part of the index* apparatus in which the outer end of the balance spring is conducted to adjust its effective length.

Intermediate wheel Part of the dial train*. Together with the pinion it is located on the stud for the intermediate wheel* and is driven by the quarter wheel* (located on the minute wheel* arbor). It drives the hour wheel*.

Invar The name is derived from invariable. It is a special iron-nickel alloy with 36.8% nickel. Tempered Invar has a thermal expansion ten times less than steel. This special alloy was invented by Charles-Edouard Guillaume* in 1896 following extensive studies. Sigmund Riefler* was the first to use it, and did so in 1896 as material for pendulum* rods in precision clocks.

Isochronism The constancy of the oscillation period of a regulating organ.

J

Jeweled lever escapement The umbrella term for all escapements whose pallet* lever contains jeweled pallets.

L

Le Roy, Pierre (1717 - 1785) French watchmaker and one of the exceptional pioneers in chronometer making. Among other things, he invented a free-sprung chronometer escapement* and a chronometer balance in bimetal*. In 1754, he began making marine chronometers*.

Lever escapement See Swiss lever escapement.

Lift An escapement phase during which the impulse energy is transmitted to the balance or pendulum*.

Locking Describes the small distance on the locking plane* that the escape wheel* tooth travels from the time it makes contact with the locking plane to its glide over to the impulse plane. This is a necessary security element that prevents the escape wheel* tooth from directly hitting the impulse plane and blocking the continued oscillation of the balance.

Locking plane Description of the outer radius of the entry pallet* and the inner radius of the exit pallet upon which the escape wheel* teeth fall.

M

Mainspring A spiral-shaped, rolled up steel spring located in the spring barrel* is used to drive the movement. A so-called stopworks* is added so that the spring's elasticity stays as constant as possible throughout the winding period*.

Marine chronometer A precision chronometer used in seafaring navigation, which made it possible to determine longitude using the precise time

Mass-spring system A mechanical oscillation system whose frequency is determined by the cyclical change between dynamic energy (motion of a weight) and static energy (positional energy of the pendulum* or elasticity of the balance spring).The engaging of wheel* and pinion* or two gear wheels*. The more teeth touch each other at the same time, the better the energy is transmitted.

Meshing The engaging of wheel* and pinion* or two gear wheels*. The more teeth touch each other at the same time, the better the energy is transmitted.

Minute wheel A gear wheel* on the minute hand arbor. Riveted to the center pinion*, it makes a full rotation once an hour, transmitting energy to the fourth pinion*.

Mudge, Thomas (1715-1794) Ingenious English watchmaker who invented the lever escapement* in about 1759. He was an apprentice to the legendary George Graham* and took over his business after his death. Mudge* was one of the first watchmakers to use jewel bearings and he optimized chronometer rates for marine chronometers.

N

Neutral passage An event in the escapement sequence when the impulse pallet* meshes with the pallet fork near dead center*.

Nivarox The name is derived from »nicht variable und oxydfest« (not variable and non-oxidizing). Non-magnetic, corrosion-resistant, and temperature-compensating iron-nickel alloy for manufacturing balance springs*.

O

Oil sink On frictional bearings a hemispherical cavity at the outer opening. The Oil sink hold a small amount of oil as a reserve.

One-month winding period See winding period.

Oscillating organ It divides the even motion of the gear train* into individual, equal sections. In mechanical timepieces the pendulum*, the balance, and the foliot* serve as the oscillating organs* providing the pulse.

Oscillator An organ that divides time. In mechanical timepieces this would be the pendulum* or the balance. Also known as the oscillating organ*.

Oscillogram A highly precise image of electric or temporal processes on the screen of a measuring instrument. It is used in watchmaking Timing machines* determining rate* precision.

P

Pallet fork Fork shaped arm of the escapement lever Is engaged with the Balance via the ellypse and is the link between escape wheel and balance.

Plates The base of a movement, it holds the bearings and serves as a point to secure the other components.

Pallet The functional part of the pallet* lever, usually made of hardened steel or synthetic jewel. The pallets are added to the body of the pallet fork. The inclined, polished interfaces are called impulse planes.

Pallet stone See pallet.

Pendulum Even today the most precise mechanical oscillation device. The oscillation period is determined by the length of the pendulum and the force of gravity.

Period of oscillation To be precise, this is the amount of time that the balance needs to get from one point of inversion* to the other and back. Traditionally seen, watch makers only look at the time needed from one point of inversion to the other and call this a semi-oscillation*.

Phillips, Edouard (1821- 1889) French engineer. Occupied himself intensely with Abraham-Louis Breguet's* experientially discovered terminal curves* for balance springs and delivered the mathematical proof.

Pillar Also called the movement pillar. Keeps distance between the plates*; both components create the movement frame.

Pinion A gear wheel* with less than 20 teeth, usually made of steel. Normally, there are five hardened steel pinions*, the center wheel* pinion*, the center pinion, the minute pinion, the escape pinion, and the third-wheel pinion.

Pinning point The point at which the inner end of the balance spring is secured to the balance spring collet.

Pitch The distance between the center of one tooth to the next one, measured by the circumference of the effective circle or pitch circle of a wheel*.

Pivot Thinner end of an arbor or stem. It is the part that guides the arbor into bearing holes. In precision timepieces, the pivots are hardened and make up a component together with the stem and the pinion*.

Platform escapement An exchangeable unit or subgroup comprising the balance and the escapement components.

Point of inversion At the end of the complementary arc the balance is decelerated by the balance spring* until it comes to a stop and then once again accelerated in the opposite direction.

Precision pendulum clock The unconditional timekeeper with excellently high rate* performance. pendulum* clocks with compensating pendulums were utilized well into the late 1960s as the timing norm for scientific purposes and the official time determination.

Q

Quarter wheel Part of the motion work. connected to the minute wheel arbor and drives the intermediate wheel*.

R

Ratchet Please see click*.

Ratchet wheel Please see click*.

Rate The daily rate of a timepiece is understood by the expert to mean the comparison to a reference clock (like a radio-controlled clock) for a period of 24 hours, which will show the difference in time display to the timepiece being examined.

Recoil escapement Early type of escapement that saw the oscillating organ* nearly permanently engaging the escape wheel*, thus forcing a recoiling motion with every oscillation.

Regulation Adjusting or regulating the period of oscillation* of a movement.

Release arm Together with the release spring* and discharging pallet*, it builds the characteristic part of the chronometer escapement*.

Riefler escapement In the detached Riefler escapement, the pendulum* is suspended in a knife-edged revolving frame and is powered by additional bending of the suspension spring. Riefler* used a special double escape wheel* for lifting and resting. The Riefler escapement made excellent rate* results possible, but the suspension of the knife-edges in jewel bearings is complicated to adjust and relatively sensitive.

Riefler, Sigmund (1847-1912) After the death of his father in 1876, Sigmund Riefler took over the drawing set company Clemens Riefler with the support of his brother. In 1877, he developed a revolutionary compass system with which he became world-renowned. In 1878 he moved to Munich where he decisively improved the detached escapement he developed in 1869 and had it patented in 1889. Riefler made the most exact precision pendulum* clocks of his time and for this was bestowed with the honorary degree Dr. phil. h.c. in 1897 by the University of Munich.

Ruby, jewel bearing Very hard mineral of the corundum family. Synthetic rubies are used in high-quality timepieces as bearing jewels.

S

Safety pin Also known as the guard pin. A component found in a Swiss lever escapement* that secures the meshing* of the pallet* fork and the discharge* pallet together with the safety roller*.

Safety roller Also called the little roller. A component of the Swiss lever escapement* placed directly on the balance staff directly above the Impulse roller*. Together with the safety pin* it secures the meshing* of the impulse pallet* and the pallet* fork.

Screw balance In classic high-quality watch movements the balance with screws used to change the moment of inertia.

Seconds wheel Gear wheel* on the arbor of the second hand. It is riveted to the pinion and makes a full rotation once every minute. The seconds wheel transmits the 18,000 hourly semi-oscillations* (2.5 Hertz) of the escapement to the second hand and transmits the energy from the fourth wheel* to the escape wheel pinion*.

Simplex escapement An escapement with a single escape wheel*. In sharp contrast to the double escape wheel of the duplex escapement*.

Semi-oscillation Displacement of a pendulum* or balance between two points of inversion.

Spring barrel Contains the mainspring*, which is needed to drive the movement. It is outfitted with the stopworks* and also constitutes the first gear in the gear train*. It directly drives the center pinion* and shares an arbor with the click*.

Stainless steel By alloying steel with other metals like nickel and chrome it displays special characteristics like increased resistance to corrosion.

Star wheels Along with the blocking stud*, these make it possible for the stopworks* on the spring barrel* to bank the mainspring*.

State The value which the display of your timepiece deviates from the reference time.

Steel arbor Shaft or axis in a movement.

Stopworks A device comprising stop wheels and a blocking stud* that is placed between the spring barrel* arbor and the Spring barrel. It makes it possible to bank the mainspring*.

Strasser, Ludwig (1853-1917) Professor Ludwig Strasser is the inventor of the free Strasser escapement* named for him. He was co-founder of the Glashütte company Strasser & Rohde and later director of the German School of Watchmaking in Glashütte.

Strasser escapement The special element of this detached escapement is that the gear train* is largely decoupled from the oscillating system via an additional mainspring*, allowing it to oscillate nearly fully freely. It allowed the already excellent rate* results of precision pendulum* clocks to be increased.

Straumann Dr., Rheinhard In 1931, the innovative Swiss engineer developed the self-compensating Nivarox* alloy to manufacture balance springs.

Stud carrier Usually an adjustable lever on the balance cock* upon which the outer end of the balance spring is attached.

Superinvar A particularly lavishly tempered Invar* with very even temperature behavior.

Supplementary arc Oscillation phase of the balance. The path from the end of the drop* to the inversion point is called the outbound supplementary arc*. The path from the inversion point to the discharge* is called the inbound supplementary arc.

Swiss Lever escapement A very popular detached escapement in widespread use for portable timepieces. The round dial with the cutaway in the seconds subdial available as equipment allows a free view of the escapement, the heart of your Mechanica M5, which is usually hidden from view. This free view is naturally especially attractive with the lavishly finished escapement with screw balance*, blued balance spring, and blued screws.

T

Temper Heat treatment of the Invar* pendulum* rods to relieve material stress. Only tempering can achieve constant thermal behavior for pendulum* rods.

Terminal curve Shaping of the end of a balance spring that ensures that the center of gravity remains in the center during the to and fro of oscillation.

Timing machine An electronic measuring device for the precise determination of the momentary precision of a movement. The sounds the escapement makes are recorded and evaluated with a very sensitive microphone.

To blue or temper Thermal treatment of carbon steel. The polished steel is heated to approx. 300°C, which causes an oxide layer to build up on the surface, which appears as an attractive blue to the human eye.

Tompion, Thomas (1638-1713) English watchmaker who is known as the inventor of the cylinder escapement*, the first frictional-rest escapement* for portable timepieces. This was improved more by Tompion's apprentice, friend, and later business partner George Graham*. Tompion made one of the first pocket watches outfitted with a balance spring.

Torque The product of energy and a lever arm.

Transmission The passing of torque* while meshing*. The rotational direction and number of revolutions change from one arbor to the next.

Transmission ratio This describes the transmission* of a pair of meshing* wheels and is calculated from the number of teeth of the wheel* and pinion*. The trans-mission ratio shows how often the pinion* rotates in comparison to that of the wheel.

Tripping, galopping Accidental passage of several escape wheel* teeth rather than just one. It usually occurs after shock to a chronometer or duplex escapement*.

Tungsten A very heavy metal. Density: 19.3 g/cm3.

U

Unbalance State* of a revolving part (such as the balance) when its center of gravity is not situated on the rotational axis.

V

Verge escapement First mechanical escapement for clocks. It contained a foliot* placed on a verge.

Verge escapement pallet Same function as escapement lever pallets in a swiss lever escapement.

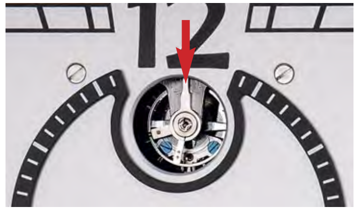
W

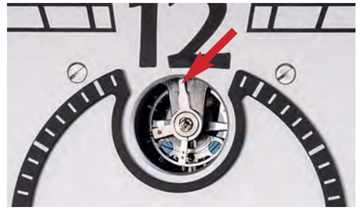
Wheel In watchmaking high gear ratios are used. The larger gear wheel* is usually just called the »wheel*« and the smaller gear is known as the pinion*.

Winding period The time a fully wound timepiece will run without rewinding. The winding period* depends on the gear ratios used and the mainspring*.

RATE TABLE
AS A TEMPLATE

This rate table serves to help monitor the rate precision of your M5. Additionally, the written records will be very helpful to you during regulation*. It makes sense to note the precise position of the index* on the index scale.





When regulating*, complete this carefully and move the index only in very small steps.
Otherwise the changes could become very extreme. After every correction, observe the rate of your table clock throughout the entirety of the winding period* of one week since the rate* of a mainspring-driven clock can compensate itself within a week.
A commercially available radio-controlled clock is fully sufficient as a reference clock. With a little practice you will soon be able to recognize differences on both clocks of less than 0.5 seconds with the naked eye.

Formula for calculating the rate

$$\frac{\text{Rate}}{\text{24 h}} = \frac{\text{Difference between states}}{\text{Time difference}} \text{ x 24}$$

RATE TABLE

DATE	TIME	STATE = DIFFERENCE TO THE REFERNCE OF TIME IN SECONDS	DIFFERENCE OF STATES FROM ONE RECORD TO THE NEXT	TIME DIFFERENCE OF THE RECORDS IN HOURS	RATE / 24H IN SECONDS	REMARKS

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