# Precision Pendulum Clock Mechanica M1

Building instruction,
development
and technology

UHRENBAUSATZ

# BUILD YOUR OWN PERSONAL PIECE OF HISTORY

Walnut

Black varnish

Cherry

**Dear clock enthusiasts!**

Thank you for your interest in our unique clock kits and for taking a little time to look at them in more detail.

Especially in today's hectic time, which is characterized by cell phones, computers and anonymity, more and more people find joy in mechanical clocks again. These are on the one hand of course wristwatches but also increasingly clocks.

The steady ticking of a clock and the smooth swinging of the pendulum radiate a pleasant atmosphere in any room and greatly increase the comfort of living. The fascination of the visible and also subtly audible mechanical processes has inspired us to the Latin name Mechanica.

Clock enthusiasts from all over the world have often expressed their wish to purchase individual parts such as gears, pendulums or clock cases from the Erwin Sattler program. We had to refuse such requests again and again, because parts from the Erwin Sattler Munich collection should only be available in clocks of the manufactory!

The wishes of the customers, however, did not let us go. We thought about how all 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 already historical models, such as the company Strasser & Rohde, which supplied individual components for precision clocks to clockmakers in the late 19th century.

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

Of course, it was and is our concern to maintain the values and skills of the classical clock making that have been developed in the past centuries and to further develop them with the methods that are available to us today. This know-how, our modern CNC-controlled machinery, an independent design and the use of contemporary material, made this project possible.

In the meantime, however, about 1000 satisfied Mechanica customers have already contributed enormously to both the existence and the continuous improvement of this unique clock kit idea through their suggestions and also by purchasing a kit clock.

All movements of the Mechanica series, from the first Mechanica M1 to the latest Mechanica M5 consist of about 100 movement parts and are designed to be easily assembled even by technically less experienced enthusiasts of fine timepieces. Nevertheless, they are characterized by the same high technical quality features that are also a part of an Erwin Sattler precision movement.

Valuable clocks are an ornament to any room and delight their viewer day after day, they are the pride of every owner, especially if, as in this case, he also assembled the clock himself. A clock of this quality, given proper care, will outlast us all and can be proudly passed down from generation to generation.

Your clock kit team!

UHRENBAUSATZ

# MECHANICA
# M1

# ACKNOWLEDGEMENTS

Our thanks go to all,
who have contributed to this book.

Production of the entire movement:
Clockmakers, Master Clockmakers, Engineers
and Mechanics of Erwin Sattler

Production of the case:
Fa. Josef Wochner, Heiligenzimmern

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

Photos:
Atelier Schrader, Gräfelfing

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

Price: EUR 25,–

# TABLE OF CONTENT

## II. CHAPTER TECHNIQUE AND FUNCTION

# INSTRUCTIONS
# MECHANICA M1

# IMPORTANT INFORMATION BEFORE STARTING

Before you start assembling your Mechanica M1, please read the following information carefully.

Your Mechanica M1 is a precision pendulum clock.*. All the parts were produced very accurately to extremely close tolerances. It is necessary therefore to be careful when unpacking, handling and assembling the components to avoid damage. Some of the parts are delicate.

Carrying out the procedures in the order described will save unnecessary work and ensure success.

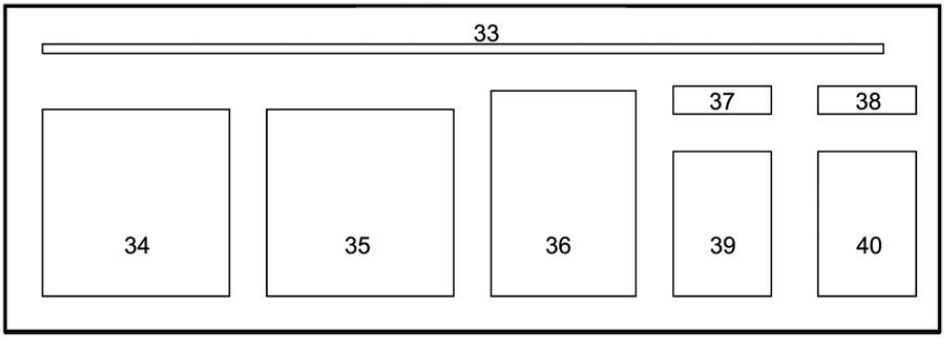
***Accessory***

The assembly instructions for the numerous options available are added as variants to the relevant steps and highlighted to make them distinguishable.
You will find a clear list of the accessories currently available for the technical and visual enhancement of your Mechanica M1 at the end of this book on page 132, together with a short description of each one.

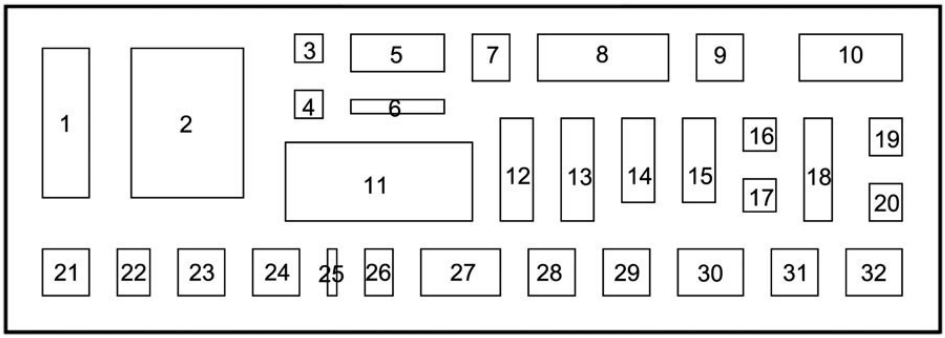
We have tried to avoid using technical terms in this manual. When the use of special terms was unavoidable, we explain them in a GLOSSARY at the end of the book. They are marked in the text with an asterisk *.

Your Mechanica M1 assembly kit is clearly divided into three levels and organised using numbered compartments. The corresponding compartment numbers are listed next to the relevant components, tools and aids for clarity. An overview of the compartment numbers in the levels is provided on the pack list and in the figures that follow.

# Upper level




# Middle level




# Lower level

- [ ] Case back
- [ ] Bottom plate
- [ ] Cornice (upper) plate
- [ ] Side piece left with magnet
- [ ] Side piece right
- [ ] Top Frieze
- [ ] Shelf cover with bottom frieze
- [ ] Door complete
- [ ] Felt inlay
- [ ] 2 side glasses
- [ ] Block for pendulum scale

Verified date: ----------

# IMPORTANT INFORMATION BEFORE STARTING

Let's start with the case. The versions which have a natural wood finish are first treated with woodcare oil. Make sure the room used has good ventilation. Between uses store the oil-soaked cloth firmly closed in the jar provided. This will prevent potential combustion due to the volatile gases. The treated case takes some time to dry, so you have plenty of time to continue with the next steps.

When assembling the case, handle the glass with care to avoid possible injury.

Choose and prepare your work place carefully before continuing with the assembly of the pendulum*- and movement. It must be clean at all times and should have good illumination.
We clean and pack the components carefully before despatch. To avoid contamination unpack parts just before assembly. Check for damage in transit.

The ball bearings* for the bearing of the gear train* are made of stainless steel*. To ensure very low friction they are not sealed bearings and must be kept away from dust and dirt.

The steel shafts* of the gears are not surface-protected due to the better material properties in terms of hardness and durability and could therefore rust. The gears may therefore only be handled with the enclosed gloves over the teeth of the gold-plated gear or gripped and mounted on the shaft* with the aid of tweezers.

If you drop a gear wheel, check the toothing carefully with the enclosed magnifying glass. A slight burr or crooked tooth can hinder the smooth running of the gear train. A component damaged in this way must be replaced.

Pay attention to the possible risk of injury from the cannula of the enclosed oil syringe. Therefore, you should also keep the syringe safe from children.

With the pendulum rod, we must point out a risk of injury from the pointed end.
Unscrewing the dial and pendulum scale involves a certain risk of scratching the surfaces. Therefore, we would like to remind you to proceed with caution.

After all, the dial is the face of your Mechanica M1.

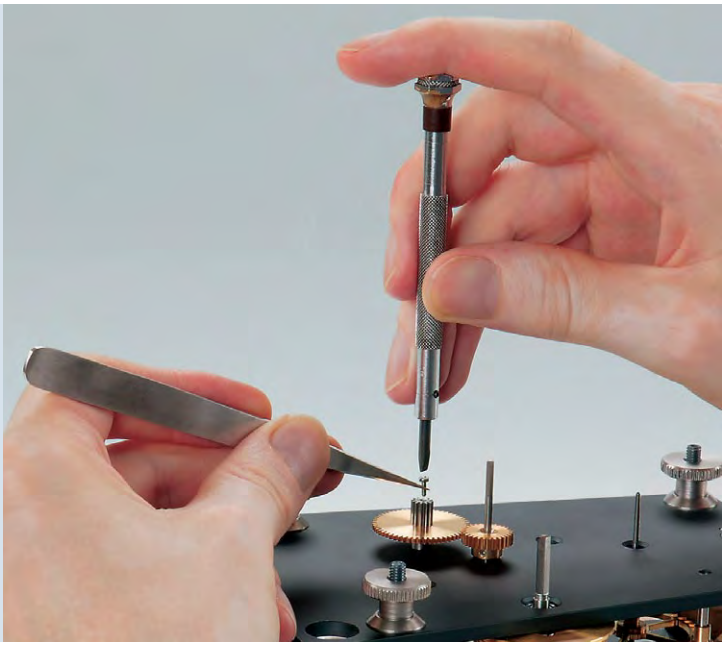
If you have a problem with the assembly or starting of your precision clock, please contact us by phone.

You can reach us on weekdays from 9.00 - 16.00
o'clock under the telephone number

**+49 (0)89 / 8955 806-20**

# TOOLS HANDLING

If you are highly motivated to get to work, you should handle the supplied special tools properly.



This is how the clockmaker works with a screwdriver and tweezers.

The syringe is used for metered oiling of the escapement parts*, the rope pulley and the anchor fork*. Avoid an "oil bath". The gear train* is fully ball bearing mounted and does not receive any oil.

*Now enjoy the project!*

To oil correctly: Carefully press the plunger of the syringe until a small drop of oil forms at the tip of the cannula. Only now guide the cannula to the oil spot and wipe off the drop.

# OILING THE CASE

If you have chosen the black lacquer case you can begin the assembly immediately.

The following tools are available for the professional surface treatment of the natural wood cases:

**Tools**

| | |
|---|---|
| ✔ Auro Natural oil | Box 11 |
| ✔ Polishing cloth | Box 11 |
| ✔ Steel wool | Box 1 |

Furthermore, you will need a screwdriver to disassemble the housing door.

**Components**

You will find the case components in the lowest level of the packaging. Place the following parts ready for surface treatment:

| | |
|---|---|
| ✔ Case-back | Lower level |
| ✔ Bottom plate | Lower level |
| ✔ Cornice (upper) plate | Lower level |
| ✔ Two side pieces | Lower level |
| ✔ Top frieze | Lower level |
| ✔ Shelf cover with bottom frieze | Lower level |
| ✔ Door | Lower level |
| ✔ Block for the pendulum scale | Lower level |

**Safety notice**

*When handling the case glasses be aware of the danger of injury.*

Before treating the wood the door must be dismantled. The glass fits in a groove and is secured with a screwed fillet. Unlock both screws with a crosstip screwdriver (not included) at the inner side of the upper door fillet and remove it. Pull the glass carefully from the groove and store it safely in the packaging provided.
Take care when handling the glass.

The maintenance oil included in the kit is a natural-based product. Nevertheless, you should carry out the steps described below in a well-ventilated room.

**Surface treatment of natural wood cases**

The case of your Mechanica M1 is made of solid wood, with the exception of the back panel. The back panel is glued several times for stability.

Except for the black lacquered version, the cases are untreated and therefore still need to be soaked with the supplied maintenance oil.

This type of surface treatment protects the wood from moisture, particularly emphasizes the natural grain of the wood and has the advantage that damage to the surface can be reworked at any time without any problems.

***Safety notice***

*Oil your case only in well-ventilated rooms. To prevent possible spontaneous combustion due to the linseed oil content, only store the oil-soaked wool cloth tightly closed in the enclosed can in a safe place.*

With regard to the oil-wax mixture, please observe the enclosed warnings.

# OILING THE CASE

**Let's go**

**This is the best way to proceed when oiling the case:**

To prevent staining your workspace, cover it with cardboard or unprinted paper, as the oil will be difficult to remove once it dries. The case parts are already pre-ground and ready for oiling. To apply the care oil, use the cloth provided. Apply the oil to all parts of the case. Nach ungefähr 20 Minuten sollte das Holz das aufge-brachte Öl aufgesaugt haben. After about 20 minutes, the wood should have absorbed the applied oil. In places where the oil is still clearly on the surface, you need to remove it with the cloth. Now the treated wood parts should dry for 12 - 24 hours and the oil should harden.

If the surfaces feel dust-dry, you can use the steel wool to smooth the surfaces again before the second oiling, as the oil will cause the wood fibers to stand up slightly. The smoother the surfaces are before oiling, the nicer the case will look later.

To remove the raised wood fibers, it is sufficient to glide only lightly over the surfaces with the steel wool during intermediate sanding.

For the second oiling, proceed exactly as you did the first time. Since the wood is now no longer as absorbent, look for places where the oil has not been completely absorbed. Only oil your case in well-ventilated rooms. You can see these areas particularly well in good lighting. Now you should let the case parts dry for at least 24 hours before mounting.

***Tip***

*Allow the case plenty of time to dry. To do this, move it to a warm, dry and well-ventilated place.*

The surfaces should feel dry and no longer sticky. If you feel that the surfaces still absorb the oil well, you can also treat the case parts a third time after another intermediate sanding.

# ASSEMBLING THE CASE

# ASSEMBLING THE CASE

Start the assembly with the case. This way you can later fit the finished movement parts straight into the protective case.

Prepare the following tools for assembling the case:

**Tools**

| | |
|---|---|
| ✔ Screwdriver | *Box 8* |
| ✔ Allen key 3 mm | *Box 8* |
| ✔ Allen key 4 mm | *Box 8* |
| ✔ Allen key 6 mm | *Box 8* |
| ✔ Oil injector | *Box 8* |

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

**Components**

| | |
|---|---|
| ✔ Door glass | *Untere Ebene* |
| ✔ Inlay fleece | *Untere Ebene* |
| ✔ 2 x Side glasses | *Untere Ebene* |
| ✔ Sealing strip | *Obere Ebene* |
| ✔ 2 x Hinge pins | *Box 15* |
| ✔ 8 x Corpus screws M6 x 30 with Washers | *Box 15* |
| ✔ Pendulum scale | *Box 5* |
| ✔ 2 x Counter sank screws 2,5 x 10 | *Box 5* |
| ✔ 4 x Case adjusting screws | *Box 19+20* |
| ✔ Pendulum cock | *Box 16* |
| ✔ Counter sunk Allen screw M6 x 30 | *Box 16* |
| ✔ Washer | *Box 16* |
| ✔ 2 x Case pillars* | *Box 12+13* |
| ✔ 2 x Counter sunk Allen screw M8 x 30 | *Box 17* |
| ✔ 2 x Washers | *Box 17* |
| ✔ Cable pillar | *Box 14* |
| ✔ Counter sunk Allen screw M6 x 30 | *Box 14* |
| ✔ Washer | *Box 14* |

## BEVELLED PANES OF MINERAL GLASS

*Accessory*

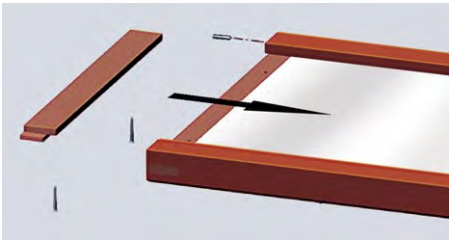
To enhance the appearance of the case, we offer a set of bevelled* mineral glass panes as an alternative to the standard panes. These are used instead of the standard panes. Please note that the bevels are always on the outside. The bevelled panes are slightly thinner at the edges and may therefore have some play in the case grooves. To avoid this play and the associated noises, an assortment of rubber strips is included with each set of panes. These strips are inserted into the glass groove of the case using the tweezers.

***Tip***

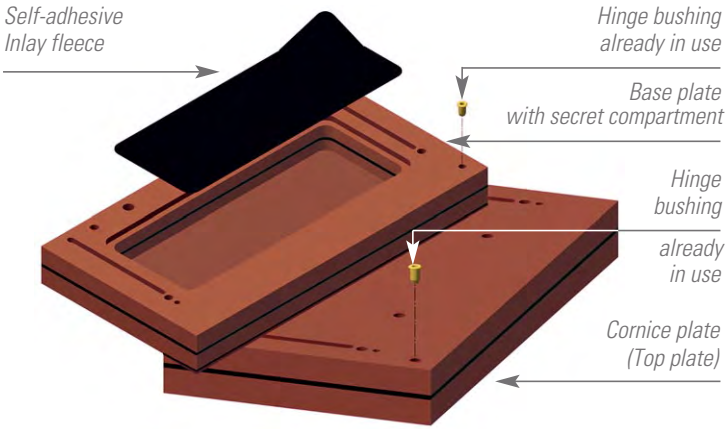
*For optical reasons, place the strips for the side glass in the strips and the strip for the door glass on the front side of the pane.*

**Assemble the case door first**

Slide the door glass back into the glass groove of the case door. Insert the crossbar into the groove. The upper edges of the crossbar and the case door should be flush. Then screw the crossbar from the back again with the two counter sunk screws. Push the two hinge pins into the holes on the front sides of the upper and lower door crossbars.



**Now the bottom and the cornice plate are pre-assembled.**




Use the enclosed oil syringe to put a small drop of watch oil into each hinge bush. Follow the instructions for handling the tools at the beginning of this book.

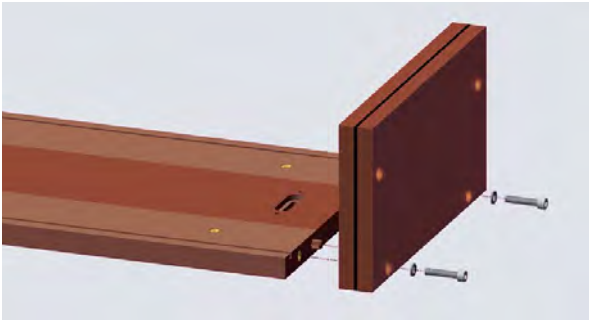
The secret compartment milled out in the base plate is covered with a self-adhesive inlay fleece. Peel off the protective film on the back of the fleece and position the fleece in the cut-out. Press the fleece firmly.

### Attaching the door seal

To protect the movement from dust later, the case is fitted with door seals. The seal consists of a self-adhesive velvet strip that is glued into the grooves provided accordingly.

### Attaching the bottom plate

Place the back wall on the work surface and put the base plate on the wooden dowels in the back wall. The base plate is screwed in place with two M6 x 30 Counter sunk allen screw and the corresponding washers.

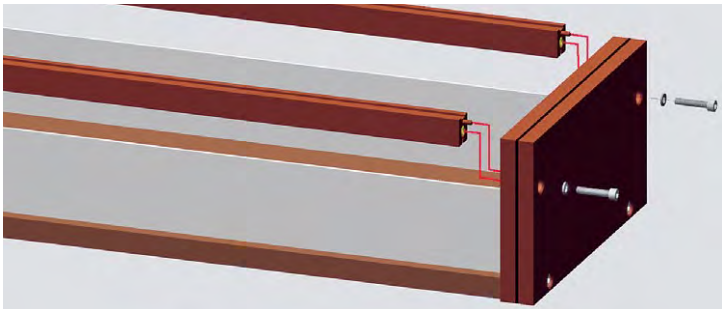


### Installing the side glasses

Then place the side glasses in the grooves of the case back and the base plate. Place the side rails with the glass grooves on the edges of the side glasses. The side rails are moved on the side glasses so that the wooden dowels inserted in the side rails are in the holes in the base plate.

Please note that the side strip with the magnets is installed on the left-hand side of the case (from the front). The magnets are inserted symmetrically in the enclosure rail, so the installation direction does not have to be observed.

Screw the side rails and base plate together with the Counter sunk Allen screw M6 x 30 and the corresponding washers.



### Mounting the upper cornice plate

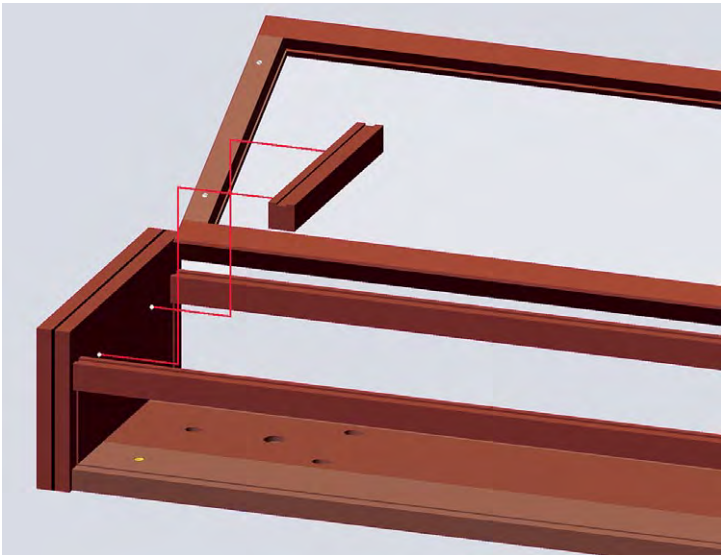
Now place the case door on the corpus that has been pre-assembled so far. The hinge pin fitted in the lower door frame engages in the hinge bush of the base plate. When attaching the cornice plate, make sure that the upper hinge pin is also guided into the corresponding bush. Then connect the cornice plate and the corpus with the four cylinder head Allen screws M6 x 30 and the corresponding washers.

*Accessory*

### UPGRADE KIT - GLASS WINDOW IN THE TOP OF THE CASE

Incorporating a pane of mineral glass into the top allows a spotlight to illuminate the movement.

Now open the case door and check whether it can be moved without resistance.



***Note***

*To avoid damaging the door strip, support the open case door on the workbench for the following work steps with a suitable object, for example with the enclosed movement assembly base set on edge.*

The top frieze must now inserted into the cornice plate of the opened case.

**Installing the pendulum cock, case pillars and cable pillar**

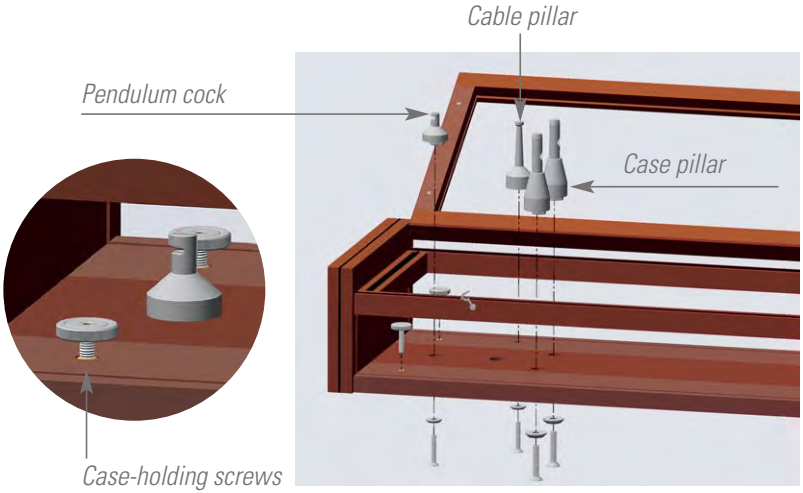
Assemble the pendulum cock, case pillars* and cable pillars with the enclosed Allen countersunk screws in the corresponding recesses in the back of the case. The different fitting shapes prevent confusion.

Screw the case retaining screws into the pre-assembled threaded sleeves on the case back panel until the tips of the screws are flush with the case back panel. This will allow you to align the case precisely on the wall later.

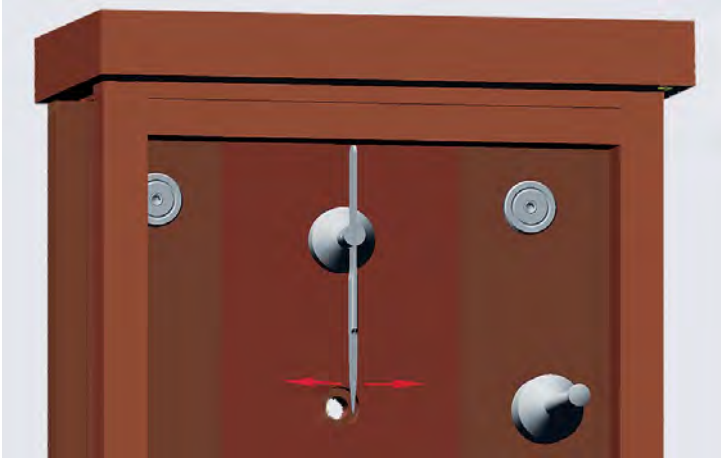
## UPGRADE KIT - POLISHED CASE-HOLDING SCREWS

***Accessory***

A further detail to add an elegant appearance to your M1, are the four case fitting screws with polished and blued center and two polished movement fixing screws.

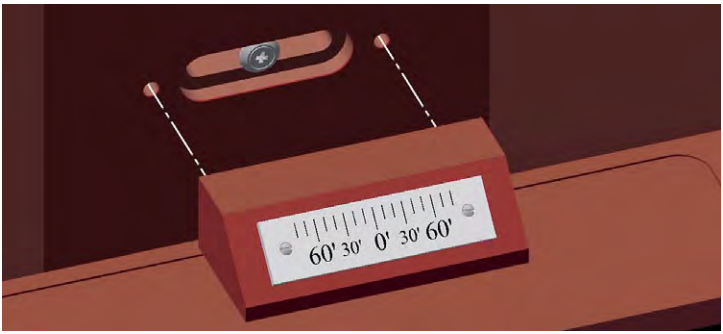


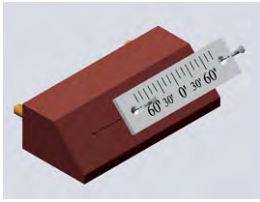

To ensure that the pendulum spring* hangs truly vertically in the assembled case, before finally fixing the pendulum cock in position, place the tweezers included in the assembly kit in the slot of the pendulum cock and move them left or right to determine the correct position. The tip of the tweezers must then point exactly at the central stepped drill hole below the pendulum cock. Tighten the screw of the pendulum cock only once you have aligned it.



### Installing the pendulum scale

Fasten the scale plate to the pre-drilled wooden scale holder with the two 2 x 6 countersunk head screws. Insert the scale holder with its wooden dowels into the back of the case.




## UPGRADE KIT - ADJUSTABLE PENDULUM SCALE

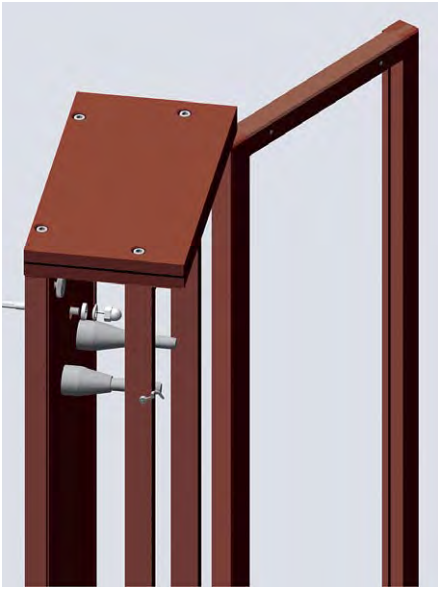
*Accessory*

The horizontally adjustable pendulum scale is characterised by its attractive appearance and enables the pendulum tip to be set precisely to the "0 point".

### Hanging up the case

Choose a stable wall to hang your Mechanica M1 on in order to support the weight of the clock. To avoid damaging the case during installation, follow the instructions carefully.

To hang up your case:
Drill a hole in the wall at eye level for the enclosed 10 mm universal dowel. This hole will later be in the centre behind the dial. Now screw in the socket screw with the Torx wrench supplied so that the thread still protrudes by about 35 mm. Then drill the hole for the 6 mm universal dowel of the lower casing screw 78 cm below the socket screw. Then hang your case on the stock screw with the hole in the upper part of the case. Thread on the conical socket and conical washer and tighten the stock screw slightly with the help of the cap nut.



Before you align your case on the wall and finally fix it in place, we recommend that you first mount the pendulum, as you can use it as a plumb bob when aligning it.

***Note***

*Levelling the case is described* *on page 39.*


XII
I
II
III
IV
V
VI
VII
VIII
IX
X
XI
60
10
20
30
40
50
MECHANICA
BY ERWIN SATTLER
M1

# ASSEMBLING THE PENDULUM

A clean workplace should be available for pendulum mounting.

First prepare the tools required for the pendulum assembly:

**Tools**

- ✔ Allen key 0,9 mm — *Box 8*
- ✔ Allen key1,5 mm — *Box 8*

Also keep the packed pendulum components nearby:

**Components**

- ✔ Invar steel pendulum rod* with screwed-on tip protection — *Box 33*
- ✔ Table for fine regulation* — *Box 4*
- ✔ Allen grub screw M2 x 2 — *Box 4*
- ✔ Beat adjustment lever — *Box 5*
- ✔ Bushing — *Box 5*
- ✔ Allen cylinder head screw M2 x 12 — *Box 5*
- ✔ Knurled screw — *Box 5*
- ✔ Coil spring* — *Box 5*
- ✔ Pendulum bob* — *Box 1*
- ✔ Compensation tube* — *Box 6*
- ✔ Allen grub screw M3 x 6 — *Box 5*
- ✔ Regulation nut* with scale — *Box 7*
- ✔ Lock nut* — *Box 7*
- ✔ 2 Suspension springs* (one is spare part) — *Box 3*

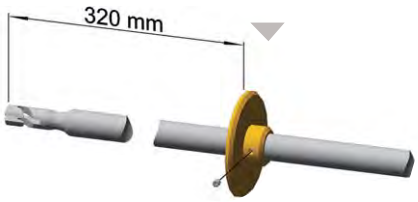
**Safety notice**

*When handling the pendulum rod, be aware of the possible risk of injury from the tip of the pendulum.*

**Mounting the fine regulation table***

Place the pendulum rod on the work surface and mount the fine regulation table with the enclosed M2 x 2 grub screw. The screw should be on the side of the pendulum hook opening, facing the back wall in the case.

The surface of the regulating table is 320 mm from the upper end of the pendulum in versions without a barometer instrument.



To avoid accidents when handling the pendulum, never lift the pendulum by the fine regulation plate*.

To avoid injury, never hold the pendulum by the regulation table*. The grub screw only clamps the table to the rod, it cannot support the full weight of the pendulum.

## ASSEMBLING THE BAROMETRIC INSTRUMENT

*Accessory*

*Component*

✔ Barometric instrument *Box 2*

To compensate for brief changes in rate caused by fluctuations in pressure and to further improve the accuracy of your Mechanica M1, we offer an optional barometric instrument.

The changes in rate shift by approximately a tenth of a second per day and can, in favourable conditions, balance out within a month.

A detailed description of how the barometric instrument works can be found in Section II – »Technology and workings of the Mechanica M1«.

Pay attention to the position of the fine regulation table* and barometric instrument, which differ depending on the pendulum design. The relevant dimensions are shown in the figures on page 35.

Now carefully remove the shrink wrap from the aneroid capsules* and securely fit the barometric instrument using the two M2 x 2 grub screws, either 215 mm or 235 mm away from the top end of the pendulum, depending on the pendulum model.

*Accessory*

## VERSION OF THE PENDULUM BOB

With double cylinder and lens pendulums, the barometer instrument is in the same position but has different counterweights. The upper edge of the screw-on flange serves as the reference surface for measuring (see figures). The screw connection should be located on the side of the pendulum hook opening, facing the back panel of the case.

The fine regulation table* should have a distance of 365 mm from the upper end of the pendulum to the surface of the regulating table for pendulums with a barometer instrument - in deviation from the pendulum without air pressure compensation described above.

Different variants of the barometer instrument are used in the various pendulum versions:

| Version | Counterweight | Position |
|---|---|---|
| Cylinder pendulum | 16 mm | 215 mm |
| Double cylinder | 16 mm | 235 mm |
| Lens pendulum | 12 mm | 235 mm |

The side-mounted barometer instrument slightly changes the center of gravity of the pendulum.

Please note that when retrofitting a pendulum with a barometer instrument, the case - as described on page 39 - must be realigned with the centre of the pendulum scale.


215 mm
365 mm


235 mm
365 mm


235 mm
365 mm

Accessory

## VERSION OF THE PENDULUM BOB

As already shown when assembling the barometric instrument, in addition to the standard cylindrical pendulum bob, we also offer two more optional designs:

✔ Double cylinder pendulum *Box 11*

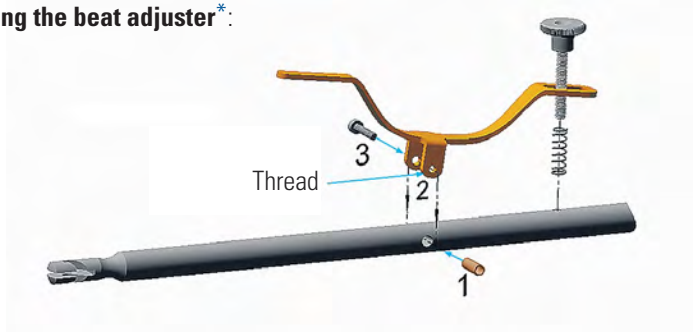
Corresponding to the great classical models, there is also available an elegant pendulum in the Glashütter design for your Mechanica M1 according to Professor Strasser. With the open design, the free compensation tubes are surrounded by the ambient air and enable the optimum temperature compensation of the temperaturedependent changes in the length of the pendulum rod due to the faster temperature adjustment. The double-cylinder, available in bicolor or nickel-plated, appreciates the overall appearance of your Mechanica M1.

✔ Lens pendulum *In a separate box*

The lenticular pendulum has a special position amongst pendulum variants because it has the best rate results. Its aerodynamically optimised shape creates less air resistance and makes the lenticular pendulum run more steadily. This results in a greater amplitude of oscillation and a smaller deviation between oscillations. Fluctuations in air pressure also have a reduced impact.

The pendulum bob is finely turned from solid bronze* and polished. A nickel-plated version is also available on request. The consecutive numbering milled into it is of particular interest to collectors.

**Installing the beat adjuster***:



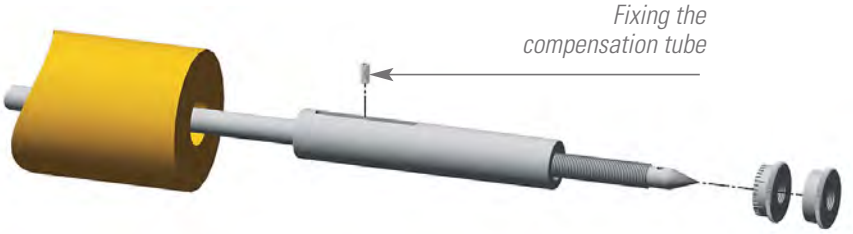
**1.** Put the bushing into the cross hole in the upper quarter of the pendulum rod.

**2.** The beat adjuster is pushed on and

**3.** and attach it with the Allen screw M2 x 12 mm inserted through the bushing. With the opening of the pendulum hook facing to you, the beat adjusting lever must be on the right of the rod (see figure). The beat adjusting lever must be free to move, but not too free. Position the coil spring* and the knurled screw. The screw is used to adjust the beat.

**Assembling the pendulum bob and compensation tube**

Now unscrew the tip protection. Pass the tip of the pendulum into the smaller longitudinal hole of the pendulum bob*.




The compensation tube* is pushed on and fixed with the M3 x 6 grub screw through the oblong hole of the compensation tube in the threaded hole of the pendulum rod.

The grub screw is used to guide the compensation tube, which must be axially movable. First screw the adjusting nut* with the scale division against the compensation tube and then screw on the lock nut* (without scale division) second.

The pendulum bob is pushed over the compensation tube. As a guide for the position of the pendulum bob, a distance of about 60 mm between the lower edge of the pendulum bob and the pendulum tip applies.

### Hanging the pendulum

**Note**

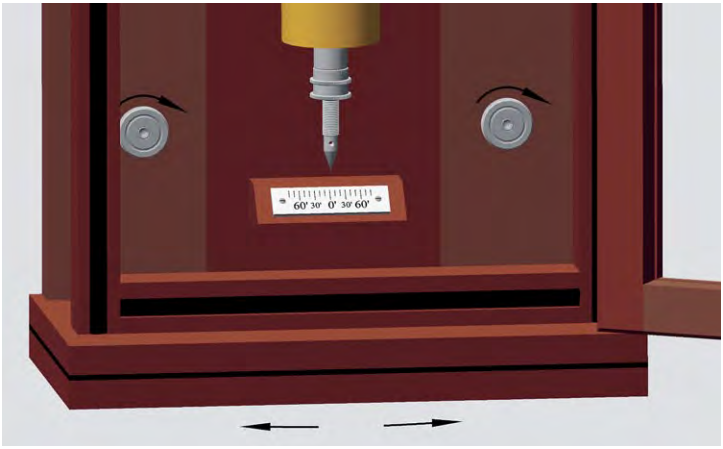
*The pendulum must be adjusted to the respective location during the first weeks of operation.*

Put the suspension spring* with its thin cross pin into the pendulum hook. Hang the pendulum by the suspension spring in the pendulum cock with the beat adjuster facing left.

Take care not to bend the suspension spring.

## Levelling the case

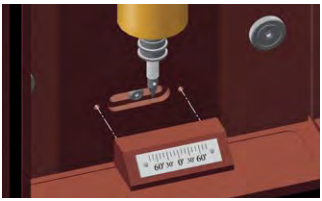
As soon as you have hung the pendulum in the case, you can align the case. Use the pendulum as a plumb bob and turn the case sideways on the wall around the upper suspension point so that the tip of the pendulum points to 0 on the pendulum scale.




To fix the case permanently in this aligned position, pull off the scale holder and screw the case through the oblong hole in the back of the case with the second case screw..

Finally, to hide the fixing screw, put the pendulum scale with scale holder back into the positioning holes.

You can compensate for unevenness of the wall with the help of the four case adjusting screws. Turn the case adjusting screws clockwise one after the other until the case lifts slightly off the wall.



***Note***

*Make sure the case back remains vertical and the pendulum does not touch the case back.*

Take your time to assemble the movement with concentration and care. The workplace should be particularly clean and well lit for this work.

All the components are manufactured with care. Each group of parts is packed separately. To avoid loss, dirt or damage, the bags should only be opened immediately prior to the assembly stage at which they are required.

First prepare all the tools needed for assembling the movement:

***Tools***

| | |
|---|---|
| ✔ Allen key 0,9 mm | *Box 8* |
| ✔ Allen key 1,5 mm | *Box 8* |
| ✔ Allen key 2,5 mm | *Box 8* |
| ✔ Allen key 4 mm | *Box 8* |
| ✔ Tweezers | *Box 8* |
| ✔ Clockmaker's screwdriver | *Box 8* |
| ✔ Screw driver, big | *Box 8* |
| ✔ Magnifying glass (loupe) | *Box 8* |
| ✔ Assembly block | *Box 2* |

It is best to keep the sensitive parts packed dust-protected and ready to hand in the compartments of the foam packaging to protect them from damage.

***Note***

Please always proceed according to the ecommended order of the assembly instructions.

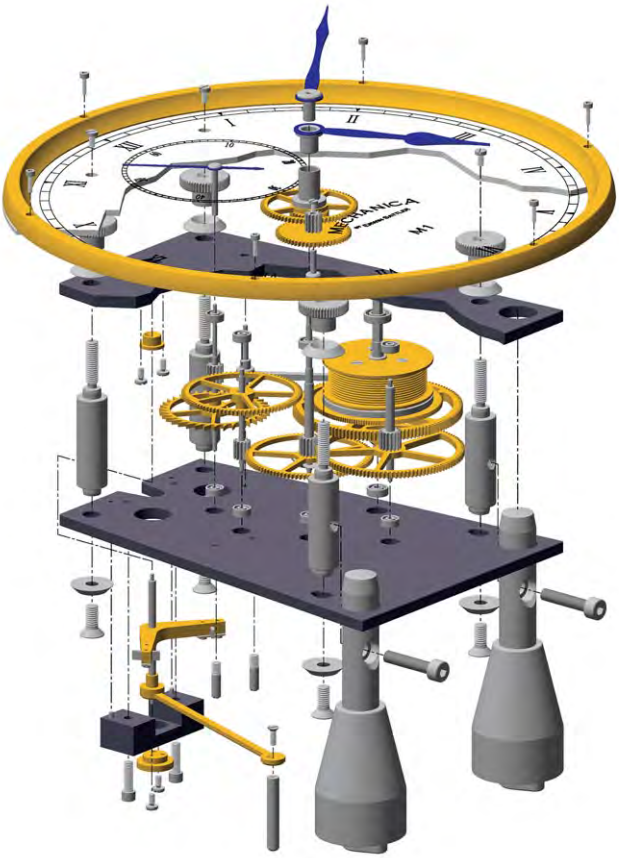
An assembly block is available for the mounting work. Its use is shown in the respective illustrations.

To allow the assembly to proceed smoothly the instructions which follow do not include descriptions of function.

The functioning of your Mechanica M1 is explained in detail in Chapter II - "Technology and Functioning of the Mechanica M1" starting on page 83.

# MECHANICA

*by Erwin Sattler*



### Assembling the back plate

**Components**

You will need the following parts:

- ✔ Back plate — *Box 39*
- ✔ 4 x Movement pillars* — *Box 25*
- ✔ 4 x Washers — *Box 24*
- ✔ 4 x Counter sunk Allen head screws M4 x 10 — *Box 24*
- ✔ 2 x Banking pins — *Box 24*
- ✔ 5 x Ball bearings* for the back plate — *Box 22*

**Accessory**

## FINE POLISHED SET OF SCREWS

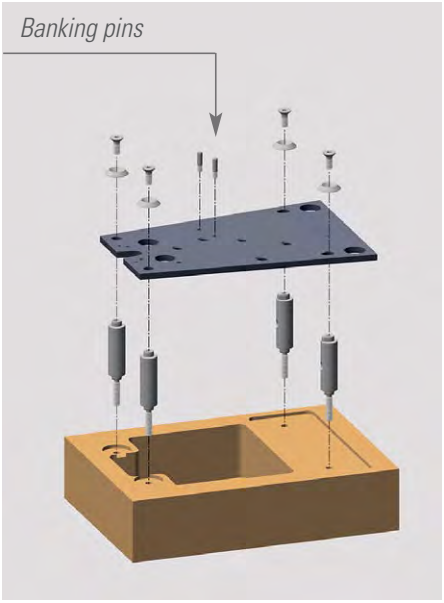
A finely polished screw set is available as an accessory for your Mechanica M1. These 24 finely polished or finely turned stainless steel screws*, four bronze washers* and two banking pins significantly enhance the appearance of the movement and replace the corresponding standard parts for movement assembly.

**Components**

- ✔ 4 x Cylinder head screws M4 x 6 (replace the four standard Allen head counter-sunk screws M4 x 10) and four gold-plated bronze washers for screwing the back plate with the movement pillars*. — *Box 11*
- ✔ 9 x Cylinder head screws M2 x 4 for screwing on the intermediate wheel stud, the two arbor bearings and the dial. — *Box 11*
- ✔ 4 x Knurled nuts M4 for screwing the front plate. (no washers are needed here) — *Box 11*
- ✔ Cylinder head screws M1,4 x 4 for screwing the intermediate wheel*. — *Box 11*
- ✔ 2 x Allen head screws M3 x 10 for screwing the pallet arbor bridge*. — *Box 11*
- ✔ 2 x Allen head screws M4 x 20 for screwing the movement at the case pillars — *Box 11*
- ✔ 2 x Banking pins for the pallet arbor* — *Box 11*

Insert the 4 movement pillars in the holes of the assembly block. Put the plate* on the shoulders of the movement pillars. The engraving »Mechanica W1« on the rear of the back plate should be facing upwards. Note the differently shaped pillar shoulders to avoid confusion.

Place the four washers and screw the pillars* with the 4 counter sunk Allen screws M4 x 10 mm.



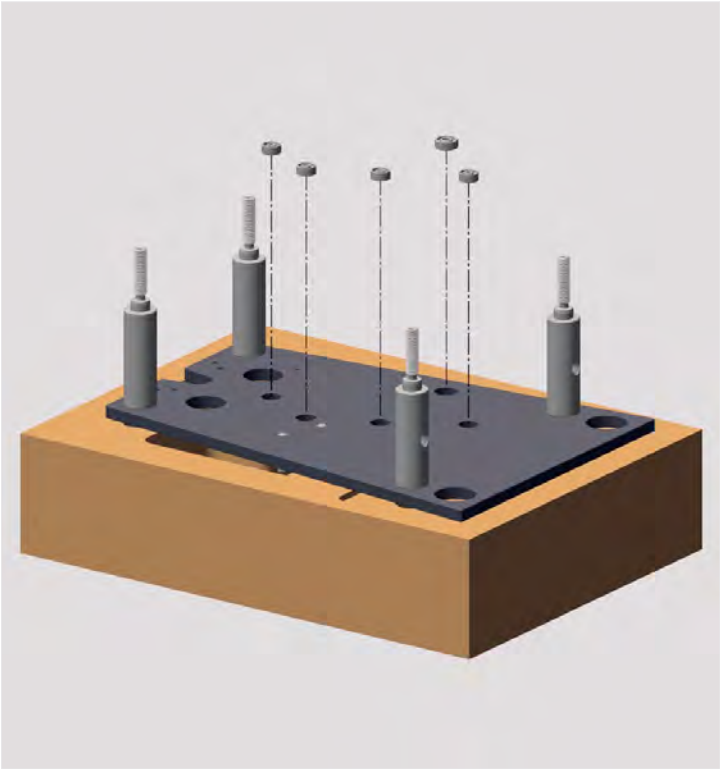

Screw in the two banking pins which limit the swing of the crutch*.

### Turn the plate over

Insert the five rustproof ball bearings* for the back plate in the milled recesses of the back plate. Because of the different diameters, the bearings only fit in the right place. The side on which the roller cage of the ball bearings is located is not important.

***Note***

*The ball bearings are not oiled!*



## Assembling the gear train

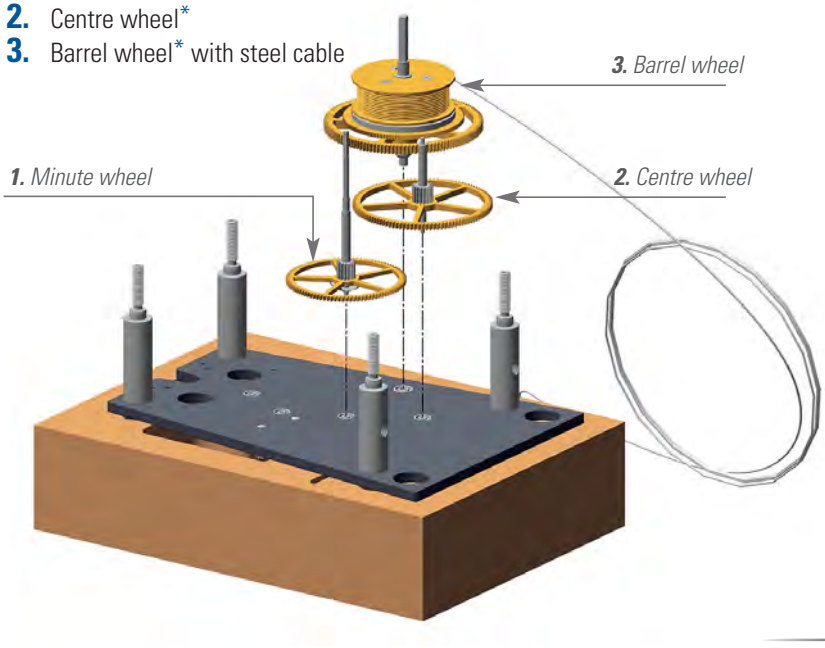
As the hardened steel arbours* are not surface-coated, please use the enclosed gloves. The gold plating of the wheels can be scratched if touched with the harder steel tweezers.

The pre-assembled gear train parts are inserted into the ball bearings with the pivots in the following order and noting the installation position:

- ✔ Minute wheel* — *Box 30*
- ✔ Centre wheel* — *Box 31*
- ✔ Barrel wheel* with steel cable — *Box 32*
- ✔ Maintaining ratchet click* — *Box 21*
- ✔ Escapement wheel* — *Box 28*
- ✔ Fourth wheel* — *Box 29*

***Components***

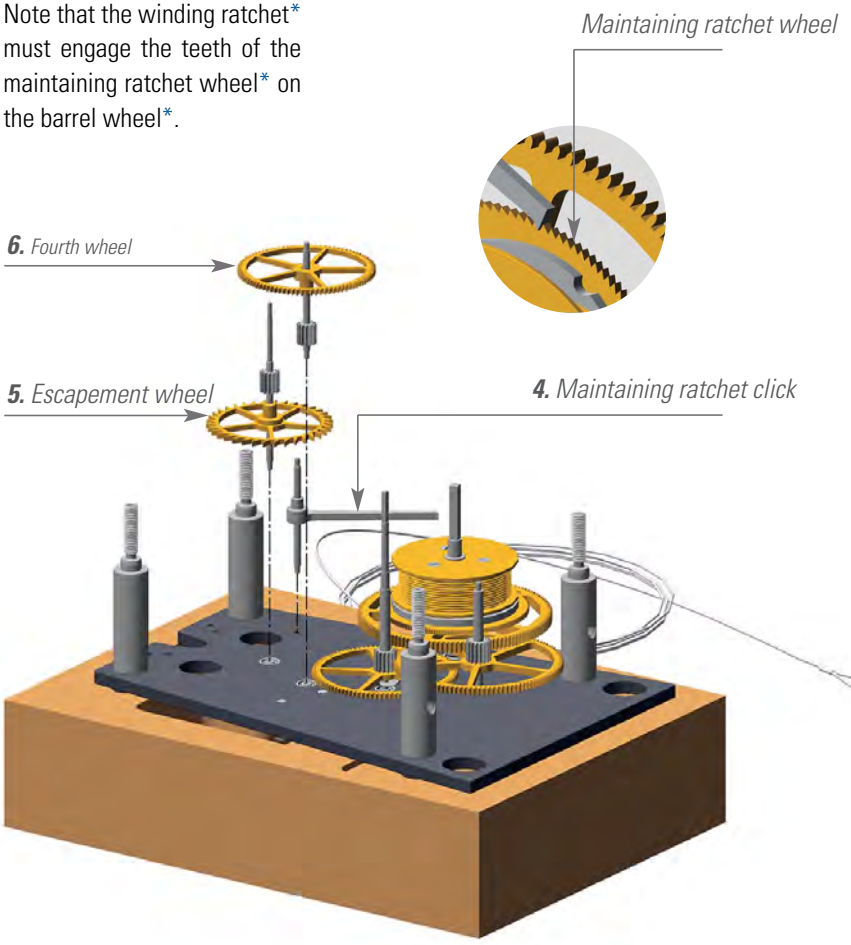
1. Minute wheel*
2. Centre wheel*
3. Barrel wheel* with steel cable



**To place the pre-assembled parts in the respective bearings**

**4.** Maintaining ratchet click*
**5.** Escapement wheel*
**6.** Fourth wheel*

Note that the winding ratchet* must engage the teeth of the maintaining ratchet wheel* on the barrel wheel*.



## Preparing and placing the front plate

You will need the following parts:

**Components**

| | |
|---|---|
| ✔ Front plate | *Box 40* |
| ✔ Pallet arbor bearing | *Box 24* |
| ✔ 2 x Cylinder head screws M2 x 4 | *Box 24* |
| ✔ Intermediate wheel stud | *Box 24* |
| ✔ Cylinder head screws M2 x 4 | *Box 24* |
| ✔ 5 x Ball bearings* front plate | *Box 22* |
| ✔ 4 x Washers | *Box 24* |
| ✔ 4 x Knurled nuts | *Box 24* |

Put the assembly block with the partially assembled movement aside to prepare the second movement plate, the so-called front plate, for installation:

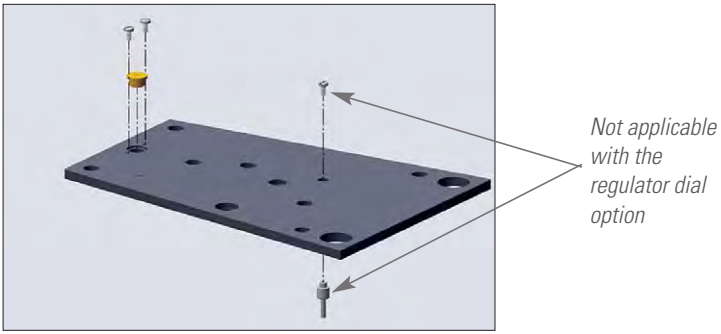
Insert the chaton* with the pallet lever bearing into the milled recess of the front plate, flush and position it with the two screws M2 x 4 mm.

**Note**

*For the next steps place a sheet of pager underneath the plate to avoid scratches.*

## Inserting the intermediate wheel stud

Install the intermediate wheel stud (stainless steel) on the opposite side of the plate (dial side), attach it with the screw M2 x 4 mm.



*Not applicable with the regulator dial option*

*Accessory*

## RUBIES FOR THE ESCAPEMENT LEVER

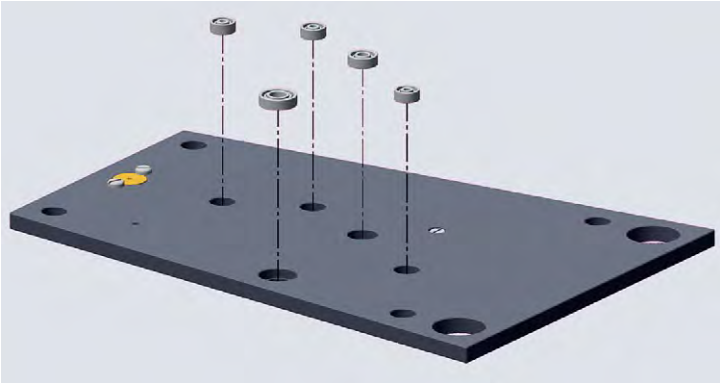
As with its great predecessors, the longevity of your Mechanica M1 can been significantly increased by using jewels for the pallet lever bearings.
The standard brass chaton* will be replaced with non-wearing ruby bearings.

### Putting the ball bearings into the front plate

Insert the ball bearings in the milled recesses in the front plate. As with the back plate place the bearing so that the balls are visible to the outside of the plate. They have different diameters so they cannot be put in the wrong place.

***Note***

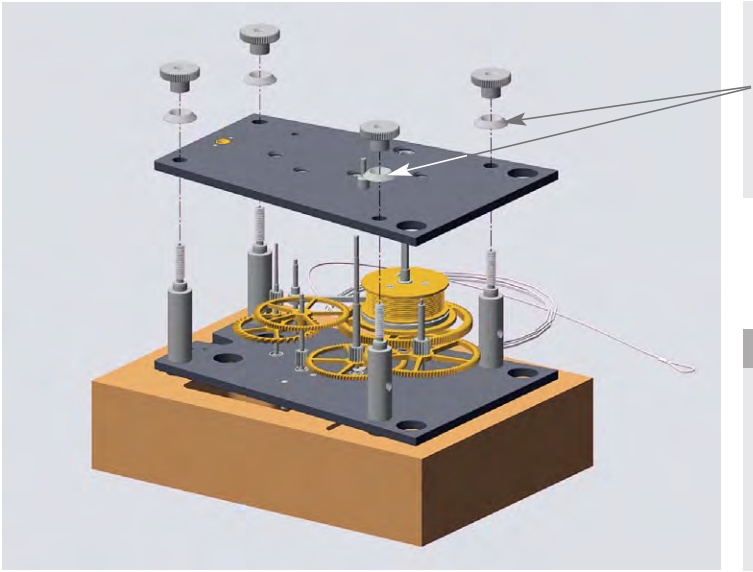
*Do not add any oil to the bearings.*



If the ball bearings are not adequately held in the recesses, they can alternatively be placed on the corresponding pivots. This prevents them from falling out when the front plate is turned.

## Adding the front plate to the movement frame

Now fit the front plate with the already partly assembled movement on the mounting base. To do this, place the front plate in the correct position, on the partially mounted movement.
In this case, the pivot* and the pillars are carefully inserted into ball bearings and boreholes.
The front plate is fixed to the pillars by four washers and four knurled nuts. The two lower washers are omitted when mounting the regulator dial*.



*These two washers are omitted with the regulator dial option.*

***Caution***

*With the accessory »Fine polished set of screws« omit all 4 washers.*

To rule out jamming in the bearings, check the vertical play of the arbors* after screwing the plates*. To do this, carefully grasp the arbors with the tweezers and make a movement in the direction of the axis. When you turn the movement over, the arbors must audibly fall against the bearings facing the bottom.

Accessory

## FITTING THE REGULATOR PLATE

You will need the following parts for fitting the regulator plate* :

**Components**

- ✔ Regulator plate, Regulator-Intermediate wheel* with intermediate wheel stud and countersunk screw M2 x 6 — *Box 2* / *Box 23*
- ✔ Regulator-Hour wheel* with hour wheel stud and countersunk screw M2 x 6 — *Box 23*
- ✔ Cylinder head screw M1,4 x 3 with washer — *Box 23*
- ✔ Cylinder head screw M2x4 — *Box 2*
  Cross drilled screw nut — *Box 2*
- ✔ Regulator-Canon pinion with counter weight — *Box 23*
  including a grub screw M2 x 2 (are not needed until the next section»Setting up the motion work«)

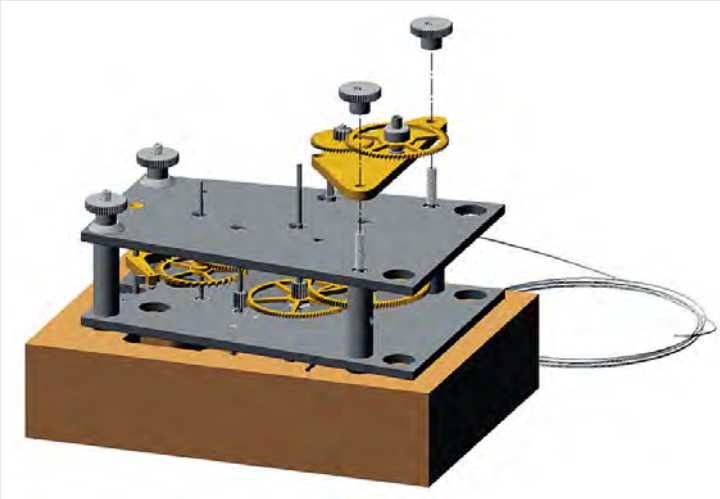
First, as shown in the following illustration, screw the studs for the two motion work wheels to the plate of the regulator module with the corresponding countersunk screws.

Now you can put the intermediate wheel* on the intermediate wheel stud of the regulator module. Please take care of the correct installation position. Then place the hour wheel* on the hour wheel stud.
To secure the intermediate wheel on the stud, screw the cylinder head screw M1.4 x 3 with washer into the intermediate wheel stud.

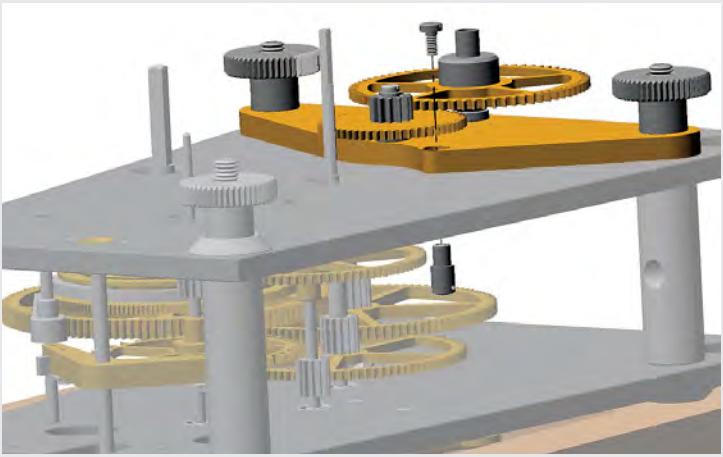
**Note**

The hour wheel is not secured on the hour wheel stud!

Place the pre-assembled regulator plate on the two lower movement pillars and screw the two lower knurled nuts tight. The regulator plate is now fixed to the front plate by an additional screw (see illustration next page).



You can put the cross-drilled screw nut on the Allen key width 0.9 mm and thus easily place it in the intended position under the front plate.
Now screw this screw nut through the front and regulator plate with the cylinder head screw M2 x 4.



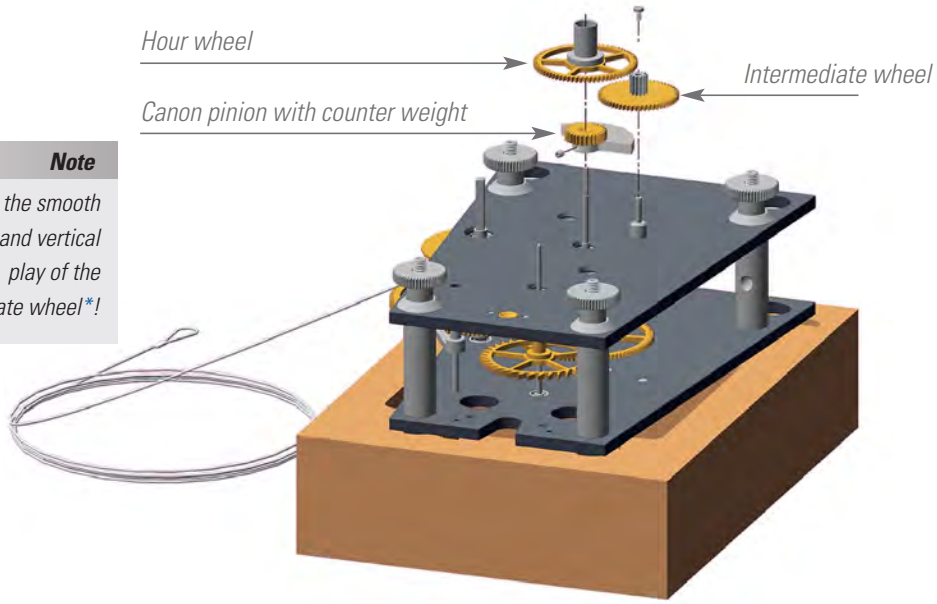
## Assembling the motion work

**Components**

You will need the following parts for fitting the motion work*:

- ✔ Intermediate wheel* — *Box 23*
- ✔ Cylinder head screw M1,4 x 3 — *Box 23*
- ✔ Canon pinion* with counter weight* — *Box 23*
- ✔ Hour wheel* with hour pipe — *Box 23*
- ✔ Grub screw M2 x 2 — *Box 23*
- ✔ Minute hand — *Box 37*

Put the intermediate wheel on the intermediate wheel stud. Please take care of the correct installation position. By screwing the cylinder head screw M1.4 x 3 into the intermediate wheel stud, you secure the intermediate wheel in the correct position.




**Note**

*Check the smooth running and vertical play of the intermediate wheel*!*

To avoid an imbalance at the minute wheel shaft, the canon pinion* is compressed with a counterweight suitable for the minute hand.

### Installing canon pinion with counter weight

Put the canon pinion with counter weight on the arbor of the minute wheel. Then push the hour pipe with the pressed-on hour wheel* onto the minute wheel arbor.

**Caution**

*When turning the movement, note that the h our wheel on the minute wheel shaft is not secured!*

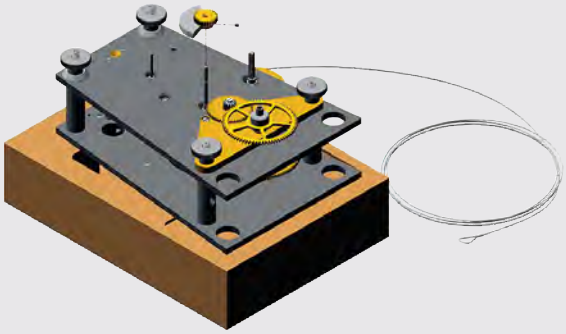
### Adjusting the minute hand with respect to the counter weight

Before fixing the canon pinion with the grub screw M2 x 2, put the minute hand on the square of the minute wheel arbor and align the counterweight to the hand (see illustration).

The Allen key 0.9 mm can be of help if you insert it into the Allen grub screw M2 x 2 that has only been loosely screwed into the thread. This must be positioned exactly under the hand.

**Accessory**

As can be seen in the illustration opposite, the quarter wheel for the regulator dial* is mounted in the same way as the standard dial.



**Note**

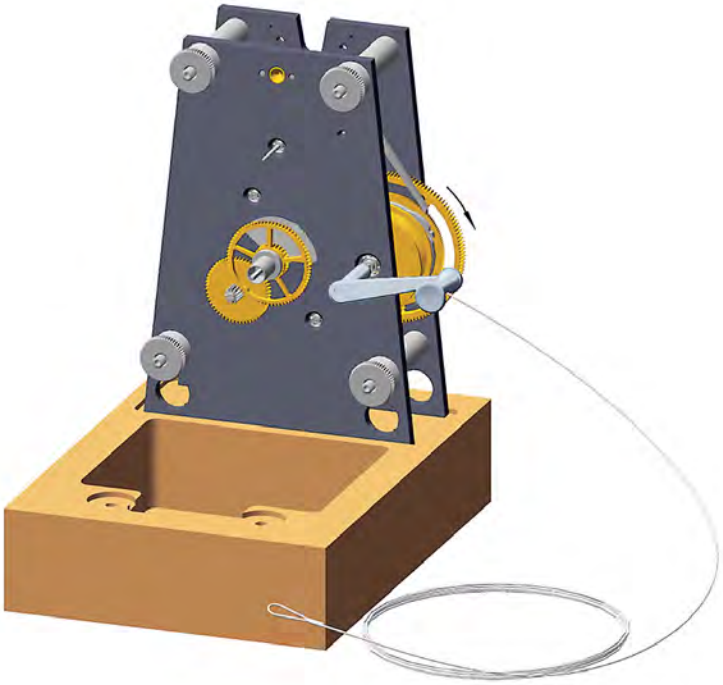
*The Regulator upgrade kit includes a smaller counterweight!*

### Checking the gear train for smooth running

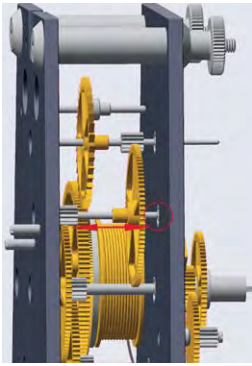
After setting the relationship between the motion work and the gear train by tightening the grub screw M2 x 2 mm, remove the minute hand and place the movement in an upright position.
By turning the barrel wheel, check the complete gear train for smooth running.
Alternatively use the winding crank, turning it clockwise on the winding square of the barrel arbor. The gears should continue to turn for a while after applying a little force to the barrel wheel or crank.

***Note***

*By turning the barrel wheel*, check that the motion work is freemoving!*



## CHECK LIST: GEAR TRAIN



### Axial free play of the arbors*

All arbors need to be able to move back and forth a little between the plates. You should be able to see it and feel it.

☐ OK

### Motion work

The intermediate wheel and hour wheel must sit loosely on their shafts or studs and have axial play.

☐ OK

### The maintaining ratchet click

The maintaining ratchet click must always engage in the teeth of the maintaining ratchet wheel, taking into account the axial play of the click and the barrel wheel. The click must not touch the teeth of the barrel wheel.

If the maintaining ratchet is engaged, the gears should run smoothly and slow down steadily.

☐ OK

If, however, a component does not fulfil its function properly and one of the test criteria listed above is not guaranteed, please contact us by telephone.

This will enable us to help you quickly and without complications. You reach us on weekdays from 9am-4pm.

**Phone number +49 (0)89 / 8955 806-20**

***Note***

*All parts of your Mechanica M1 are checked carefully before despatch.*

### Fitting the escapement

Once you have assembled and checked the gear train, prepare the escapement parts for installation.

To place the escapement* you need:

**Components**

- ✔ Pallet arbor bridge* — *Box 26*
- ✔ Eccentric bearing* — *Box 26*
- ✔ 2 x Cylinder head screws M2 x 4 — *Box 26*
- ✔ Escapement lever with pallet arbor and crutch* — *Box 27*
- ✔ Crutch pin — *Box 26*
- ✔ Counter sunk screw M2 x 6 — *Box 26*
- ✔ 2 x Allen cylinder head screws M3 x 10 — *Box 26*

**Accessory**

### EXCENTRIC BEARING WITH RUBIES

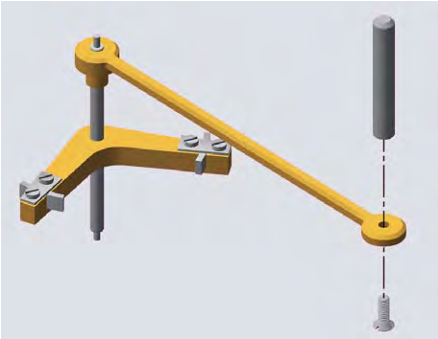
With a set of rubies for the escapement lever bearings, available as an accessory, the standard brass bushings are replaced by chatons* with wear-free ruby bearings.

Put the movement with the mounting base aside. Insert the eccentric* bearing into the milled recess of the pallet arbor bridge*. The eccentric bearing must be installed in such a way that the milled notch marking corresponds to that on the pallet arbor bridge. The eccentric bearing is held in this position with two cylinder head screws M2 x 4.

**Note**

*The function of the escapement* is explained in the chapter »Escapement« on page 94.*

**Caution:**
The eccentric bearing is already mounted!



Now prepare the pre-assembled escapement lever for installation in the movement by firmly screwing the crutch pin onto the crutch with the M2 x 6 countersunk screw.

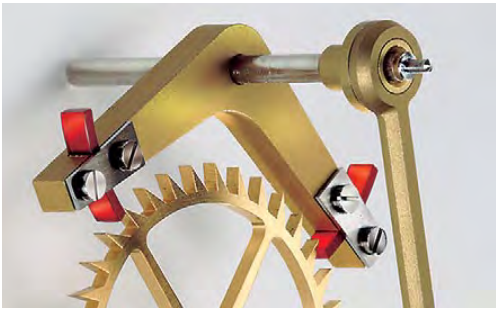
## ESCAPEMENT LEVER WITH AGATE PALLETS

***Accessory***

Another option for your Mechanica M1 is an anchor body with agate jewel pallets. As with the classic high-quality precision pendulum clocks*, the agate pallets* reduce friction and thus ensure that your Mechanica M1 runs with a minimal wear. In addition, the bright red pallets are an adornment for every movement.

***Caution***

*In order to ensure the safe running of your Mechanica M1 when retrofitting the anchor body with jewel pallets, you have to disassemble the movement again and install the escapement lever with jewel pallets belonging to the escapement wheel!*



Remove the loosely fitted hour wheel. Put the movement on the assembly block with the engraving »Mechanica W1« facing upward.

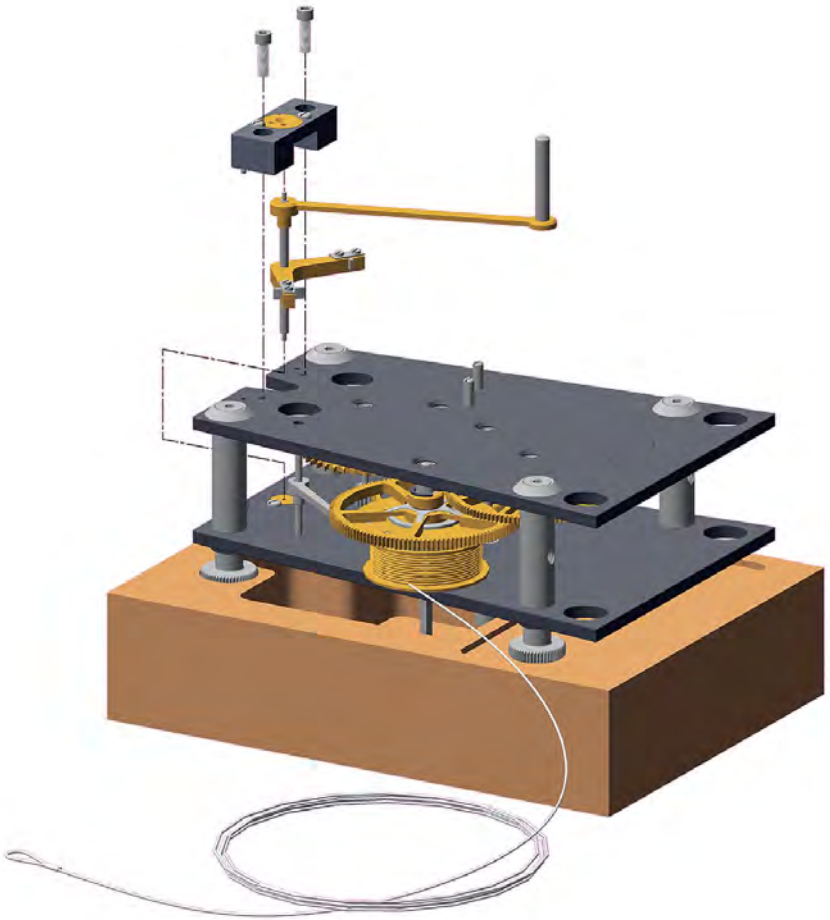
Insert the pallet arbor pivot into the jewelled bearing fitted on the front plate.

The crutch* must lie between the two banking pins on the back plate. The pallets of the pallet arbor must fit into spaces between teeth of the escapement wheel.

***Note***

*Please take care to assemble these components correctly!*

Insert the rear pivot of the pallet arbor into the eccentric bush of the pallet arbor bridge and position the bridge over the matching holes in the back plate.
When you are sure both pivots and the pallet arbor are inserted in the bearings, fix the bridge in place with the Allen screws M3 x 10 mm at the back plate.



## CHECK LIST ESCAPEMENT

### Axial free play of the pallet arbor and escapement wheel*

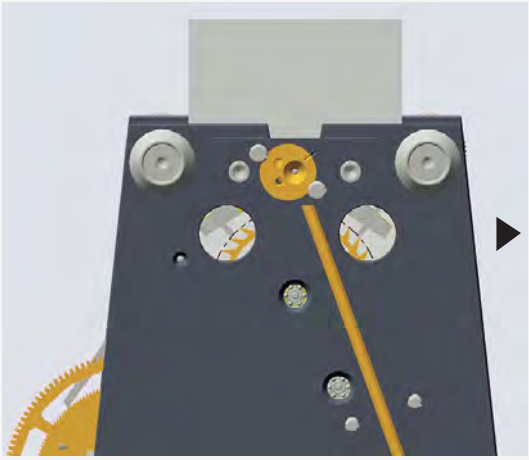
The axial free play between the plates or the front plate and the pallet arbor bridge* should be visible and clearly noticeable.

☐ OK

### Position of the crutch to the pallet arbor

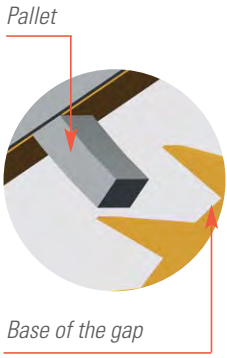
Hold the crutch centered between the banking pins. The pallets* should now engage the escapement wheel at the same depth.
Carefully guide the crutch to the banking pins. Neither of the two pallets* between the teeth of the escapement wheel must hit the base of the gap. In order to have a better contrast of the parts to be controlled during the visual inspection, insert the white visual background, which you can cut out of the bookmark, between the anchor body and the front board.

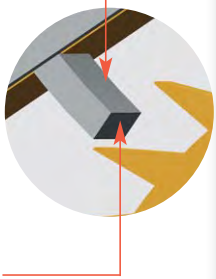
☐ OK



***Note***

*You will find the bookmark at the end of the book.*

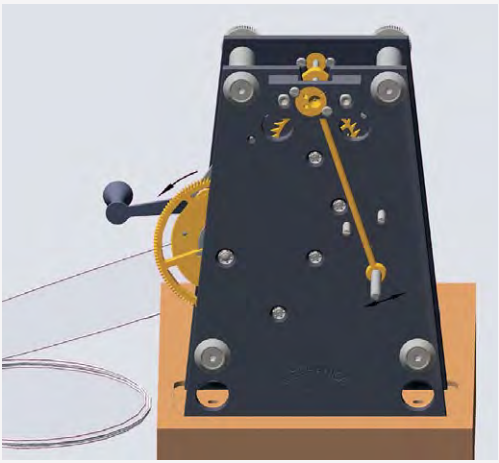


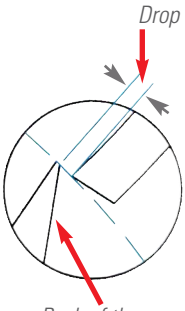



## CHECK LIST ESCAPEMENT

Slightly pre-tension the gear train with the winding crank against the winding direction via the maintaining power mechanism*. Now move the crutch carefully and slowly back and forth. With each movement one tooth of the escapement wheel must pass a pallet without blocking the action of the pallet arbor.

☐ OK






### Checking the drop*

The drop is the free motion of the escapement wheel* after one of its teeth has passed the impulse face* of the pallet and the locking face of the second pallet stops another tooth.

The size of the drop can be noted when you check the gap between the tooth tip and the pallet after the tooth has left the impulse face.

This distance should be equal at all the teeth of the escapement wheel at both the entry and exit pallets.

☐ OK

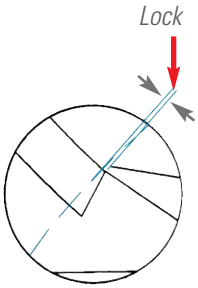
## CHECK LIST ESCAPEMENT

### Checking the lock

When the drop is equal on both pallets, every tooth must rest safely on the locking* face of both pallets. The lock is the small distance between the edge of the impulse face and the point on the locking face where the escapement wheel tooth lands after the drop.

Guide the crutch carefully back and forth when the gear train has power and observe each tooth of the escapement wheel with your loupe.

☐ OK




The escapement components of your Mechanica M1 have been carefully adjusted in the manufactory.

If, however, the escapement does not function properly and one of the test criteria listed above is not guaranteed, please contact us by telephone. You can reach us on weekdays from 9.00 a.m. - 4.00 p.m. at the

**telephone number +49 (0)89 / 8955 806-20**

## Lubricating the escapement

The gear train of your Mechanica M1 has ball bearings and is not oiled.

The escapement however does need lubrication. Give a little oil into the oil sinks* of the pallet arbor bushes as well as the locking face* of the pallets.

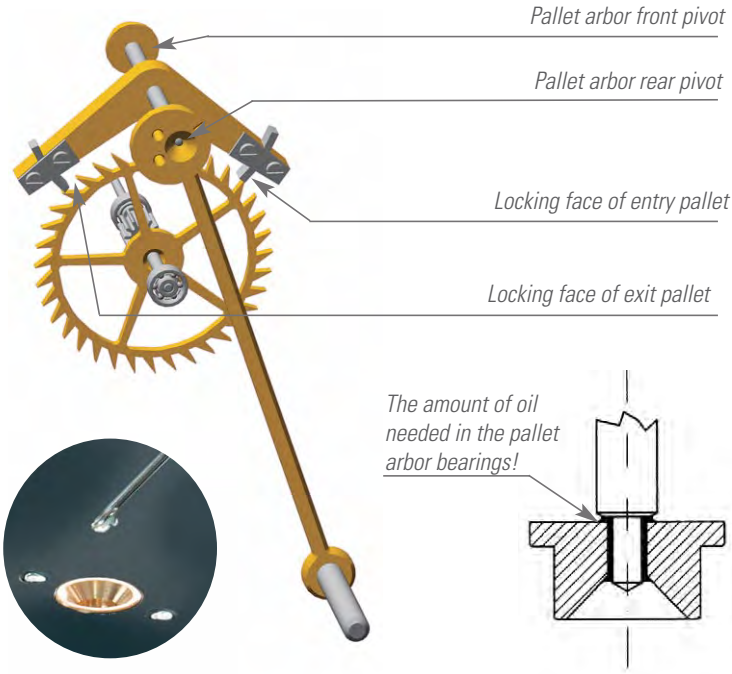
**Caution**

*Ruby bearings and agate pallets must be oiled in the same way as standard parts!*

Caution: Too much oil is just as bad as no oil at all!
Superfluous oil may eventually run off and dry out the bearing.

Only use the special Möbius Microgliss D5 clock oil supplied in a syringe with the clock kit.

Only here is oil applied:




**Safety notice**

*Be aware of the possible risk of injury from the syringe needle. Therefore, the syringe should be kept out of reach of children.*

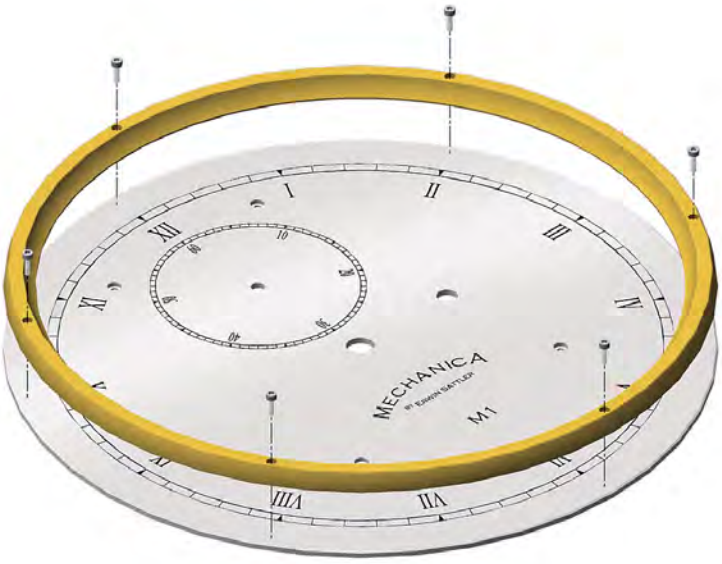
## Assembly of the standard dial

In order to complete the movement installation, you must finalize your timepiece by attaching the dial and hands of your Mechanica W1 precision movement.

You will need:

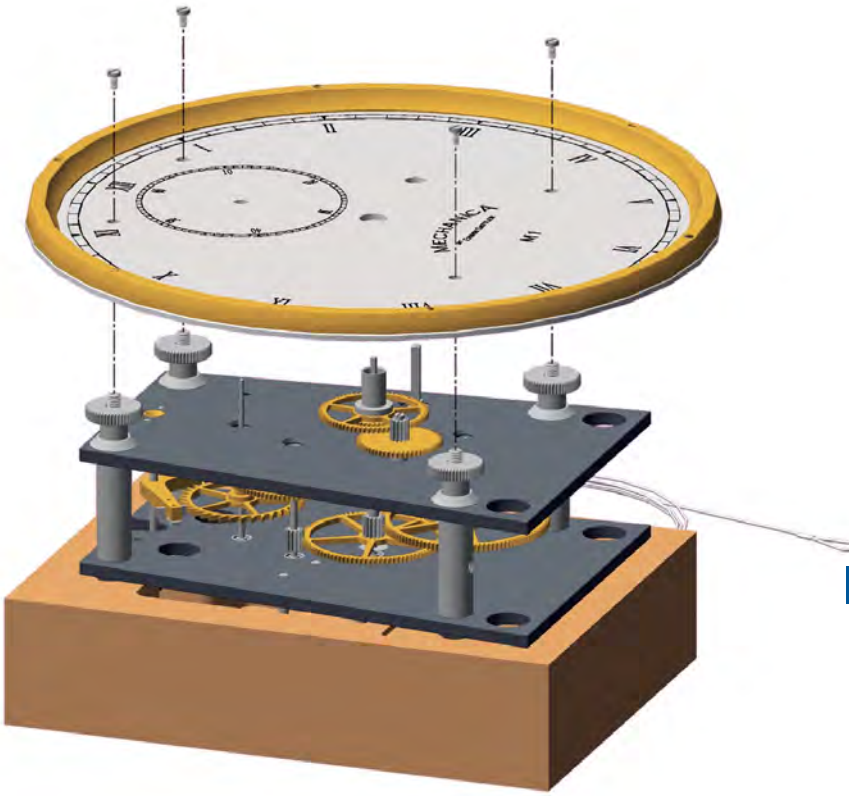
- ✔ Dial — *Box 34*
- ✔ Bezel* — *Box 35*
- ✔ 6 x Allen cylinder-head screws M1,6 x 6 — *Box 24*
- ✔ 4 x Cylinder head screws M2 x 4 — *Box 24*
- ✔ Set of hands — *Box 37 + 38*

First prepare the dial for installation by placing the bezel* on the dial and screwing it in from the front with six M1.6 x 6 Allen cylinder head screws.



Please replace the hour wheel before mounting the dial!

Carefully place the pre-assembled dial on the four knurled nuts of the movement pillars* and fasten it with four cylinder head screws M2 x 4.



### Fitting the hands

Then fit the hands to their respective arbors* in the following order:

1. Second hand (make sure that the hand is not touching the dial)
2. Hour hand (push onto the arbor as far as possible)
3. Minute hand (push onto the arbor as far as possible; make sure that the hand is parallel to the dial)


***Note***

*Make sure the minute hand is oriented correctly in relation to the counter weight, see illustration page 53.*

## HAND-FINISHED SET OF STANDARD HANDS

***Accessory***

The elaborately hand-domed*, polished and blued* hands, available as accessories, are small masterpieces that enhance the dial of your Mechanica M1.

Please ensure that hand-finished hands are treated with a special wax spray to protect them against corrosion.

To bring out the full gloss of the finish and the doming, carefully rub the wax layer using a soft cotton or leather cloth.

### Aligning the hands

The hands still need to be aligned now. Dazu halten Sie die Ankergabel gegen einen der beiden Move the crutch against one banking pin back and position the second hand so that it is aligned with a division on the seconds scale. When turning it, hold the hand as close as possible to the shaft to avoid bending it.

Apply some power to the gear train by turning the winding crank and move the crutch from side to side. Check that the second hand jumps precisely from one index to the next and does not touch the dial.

Gently move the minute hand to exactly 12 o'clock.

Hold the minute hand and turn the hour hand carefully to the nearest hour marker.

Turn the minute hand through a full rotation and check that the hands don't touch or rub the dial.

***Note***

*The minute hand should not project axially beyond the dial.*

## MOUNTING THE REGULATOR DIAL

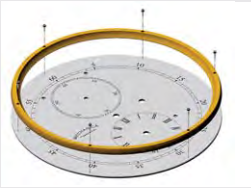
*Accessory*

The design of the regulator dial* is based on the classic precision pendulum clocks* from the previous century and thus visually approximates the current model and great role model Classica Secunda 1985 from the Erwin Sattler clock manufactory.

You will need:

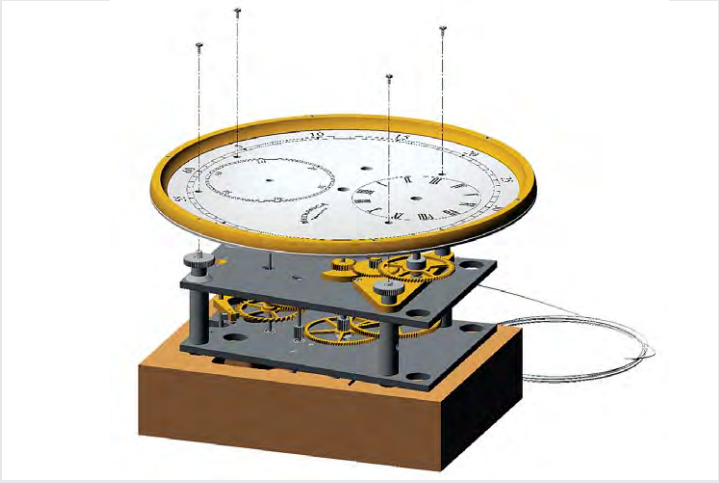
*Components*

- ✔ Regulator dial* — *Box 34*
- ✔ Bezel* — *Box 35*
- ✔ 6 x Allen cylinder-head screws M1,6 x 6 — *Box 24*
- ✔ 4 x Cylinder-head screws M2 x 4 — *Box 24*
- ✔ Set of regulator hands — *Box 37 + 38*



First prepare the regulator dial* for installation by placing the bezel* on the dial and screwing it in from the front with six M1.6 x 6 Allen cylinder head screws.

The pre-assembled dial is now carefully placed on the four knurled nuts of the movement pillars* as described before for the standard dial and fastened with four M2 x 4 cylinder head screws.



*Accessory*

### Putting the hands on

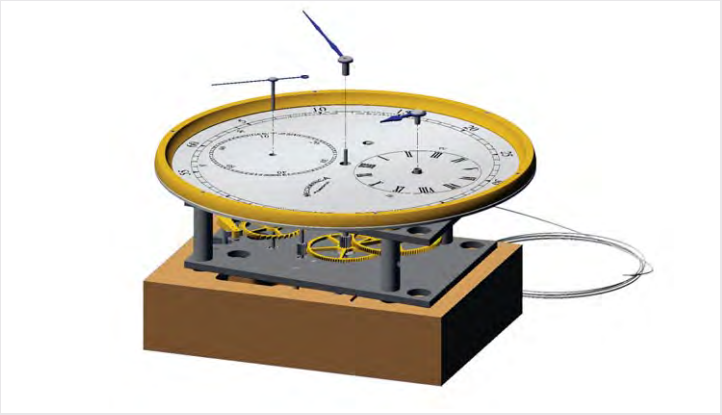
Now the hands are placed on the respective shafts* in the following order:

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

The hands are aligned in the same way as described for the standard dial in the previous section.

*Note*

*When positioning the minute hand, ensure that it is correctly positioned in relation to the counterweight (see illustration on page 53).*



## HANDMADE SET OF REGULATOR DIAL* HANDS

As before for the standard dial, elaborately hand-domed*, polished and blued* hands are also available as accessories for upgrading the regulator dial*.

Please note with the handmade hands, they are treated with a special spray wax to protect them from corrosion.

To reveal all the shine of the polish and the doming, gently rub the wax layer with a soft cotton cloth or leather rag.

# PLACING THE MOVEMENT IN THE CASE

To install the movement you will need:

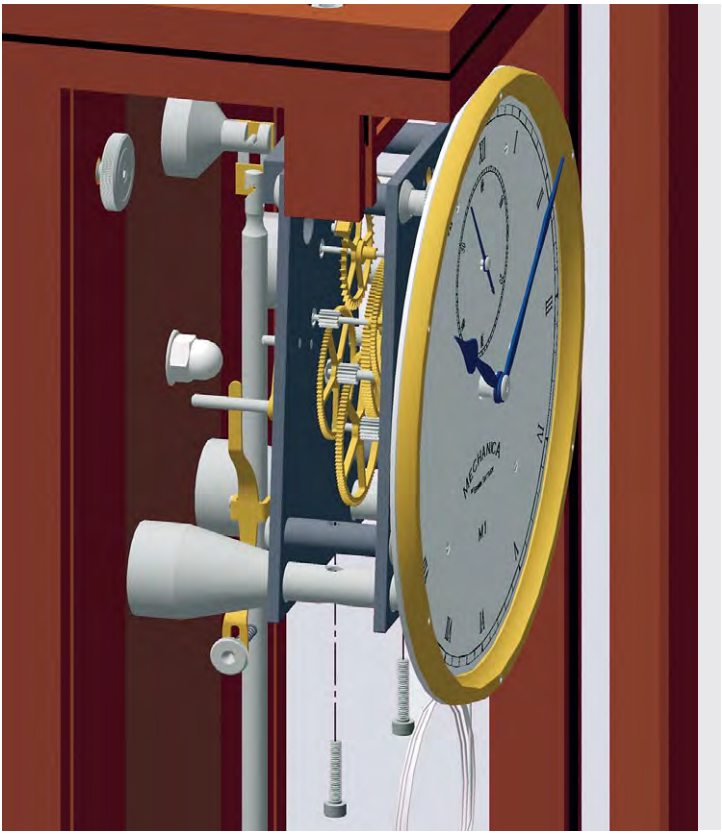
**Components**
**Werkzeug**

- ✔ 2x case Allen screws M4 x 20 *Box 24*
- ✔ Inbusschlüssel Schlüsselweite 3 mm. *Box 8*

Hold the finished movement by the bezel* and place it on the two case pillars*.

Make sure the crutch pin is on the left side of the beat adjusting lever.

Insert both case screws into the vertical holes of the case pillars and tighten gently.



**Note**

*When fitting the movement into the case, please protect the case bottom with a strip of foam material. Then, if you drop parts or tools, they will not damage the case.*

## ASSEMBLING THE PULLEY AND WEIGHT

To drive the movement you need to install the weight.
You need:

***Components***

| | | |
|---|---|---|
| ✔ | Pulley stirrup | *Box 9* |
| ✔ | Allen grub screw M6 x 18 | *Box 9* |
| ✔ | Pulley | *Box 9* |
| ✔ | Pin | *Box 9* |
| ✔ | Allen grub screw M2 x 2 | *Box 9* |
| ✔ | Tungsten driving weight* | *Box 10* |

**1.**
When the clock is in operation, the pulley slides with its bushing on a hardened pin. Put a drop of oil into the bearing bore of the pulley bushing before mounting.

**2.**
Slide the pulley into the notch of the pulley stirrup. The pin is pushed through the cross hole of the pulley and through the pulley bush and clamped from above using the M2 x 2 Allen grub screw.

**3.**
Screw the M6 x 18 Allen grub screw into the tungsten weight* as far as it will go. Attach the pulley to the still protruding threaded piece.

## PULLEY WITH BALL BEARINGS

*Accessory*

A pulley with ball bearings, available as an accessory, offers two technical advantages in addition to its attractive appearance.

- Ball bearings* are particularly low wear
- Friction losses are minimized and thus enable a higher accuracy of the clock.

For assembly are needed:

*Components*

- ✔ Pulley with ball bearings — *Box 9*
- ✔ Weight hook — *Box 10*
- ✔ Tungsten driving weight* — *Box 10*

**Tools**

✔ Winding crank *Box 8*

### Hanging the weight

Develop the previously coiled steel cable of the movement and thread the loop at the end through the slot in the pulley. Then hook this loop into the groove on the pulley. Under no circumstances should the steel cable be kinked. Make sure that the steel cable runs in the groove of the pulley.

### Adjusting the beat

**Note**

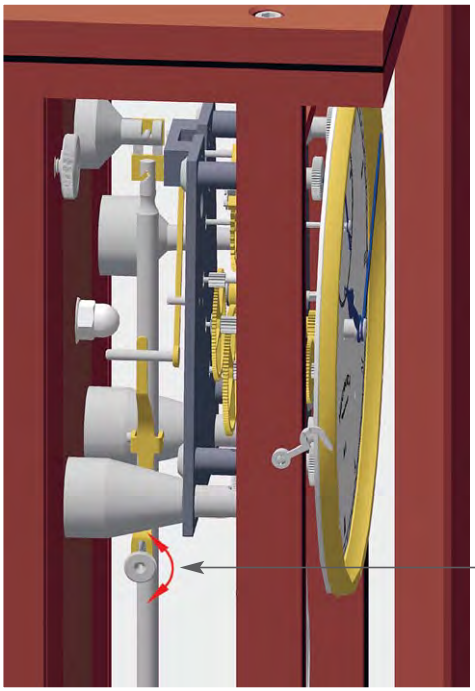
*Always wind the clock counter-clockwise!*

Put the winding crank on the winding square. The clock is always wound counterclockwise, as is the case with all clocks with a 30 days power reserve from Erwin Sattler.

First, wind only one turn. Watching the tip of the pendulum and the pendulum scale, move the pendulum to one side until you hear a "tick''. The number of angular minutes on the scale must be remembered. Then move the pendulum to the other side until you hear the "tack". Ideally, the same number of angular minutes should be read on the scale on both sides. However, if the pendulum had to be moved further on the right side than on the left, for example, you can correct this by turning the knurled screw on the beat adjustment lever* to the left accordingly.

### Winding the clock

When the beat is adjusted, you can wind the clock completely. Stop winding before the weight disappears behind the dial.



*Adjusting the beat*

**Setting the time and starting the clock**

Set the clock to the correct time. The minute hand can be turned forward and backward as required. Don't touch the second hand. To synchronise your clock with a reference time, stop pendulum when the second hand points to the 60, hold the pendulum to one side until the reference clock has reached the 60 and let it swing back during the 1st second of the next minute.

## Enjoy now your Mechanica M1!

## REGULATING YOUR MECHANICA M1

***Tools*** ✔ Regulation pin* *Box 8*

Once you have set in motion your Mechanica M1 and set it to the correct time, place a regulation weight* on the regulation table* in the center of the pendulum rod. Check the time after 24 hours. Now the clock has to be regulated by adjusting the centre of gravity of the pendulum so that it will keep time precisely.

After an observation period of 24 hours, compare the time displayed on your Mechanica M1 (the watchmaker refers to this as drift* with that of a reference watch (such as a radio-controlled watch). From this you determine the daily rate* of the clock, i.e. how far ahead or behind your Mechanica M1 is compared to the official time.

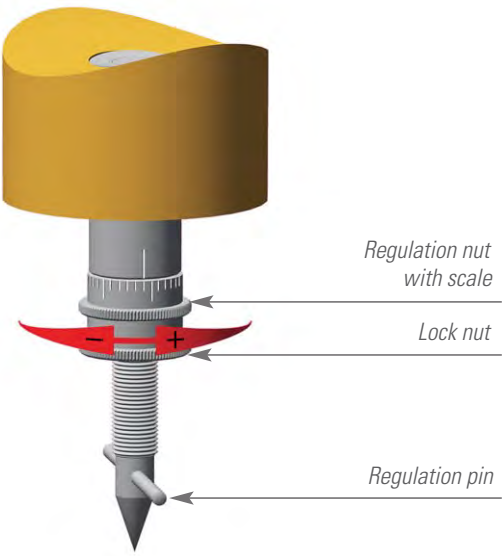
At the beginning of the adjustment*, your Mechanica M1 will most likely show a considerable deviation. This should not bother you further, because you can easily adjust the clock with the help of the regulation nut* at the tip of the pendulum.

- Stop the pendulum for the adjustment. Insert the regulation pin* supplied with the clock through the hole in the pendulum rod located below the lock nut.
- Hold it firmly so as not to twist the pendulum and thus the delicate pendulum spring* during regulation.
- Loosen the lower nut, the so-called lock nut*, and turn the upper nut, the regulation nut, to the left one index to correct a gain of one second per day.
  The resulting increase in the effective length of the pendulum will slow down the rate* of the clock.

Proceed in the opposite way when the clock is running down and turn the regulation nut one graduation mark to the right for each second of error. If you have previously accurately determined the daily rate* of the clock, you will quickly have roughly regulated the clock.

- When this basic regulation has been achieved, tighten the lock nut gently against the regulation nut.

Observe the rate* of your clock over several days. If necessary, you have to readjust a little again in the manner described above. As a basis for the subsequent fine-regulation*, your clock should loose about 1 second per day.



## FINE REGULATION OF YOUR MECHANICA M1

**Parts**

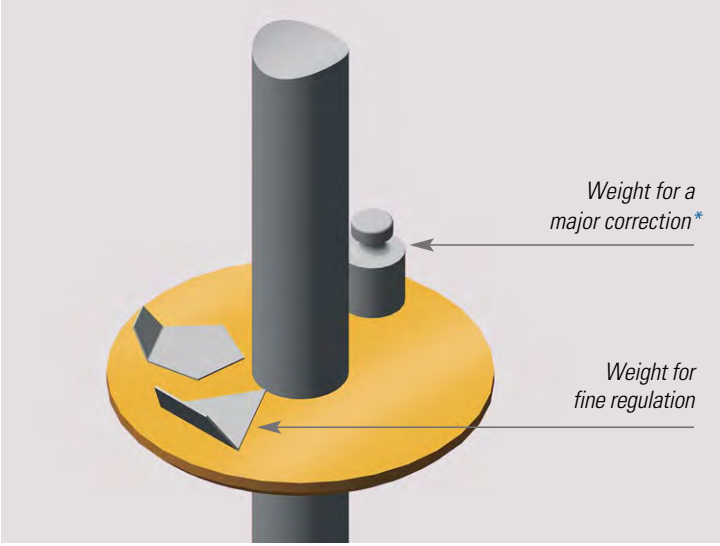
✔ Stainless steel wheights *Box 8*

While the adjustment on the regulating nut serves for the adjustment in the rough range, the pendulum of the Mechanica M1 additionally offers you the possibility to correct the smallest rate differences without stopping the clock.

In the centre of the pendulum rod you find the fine regulation table. When you add the small stainless steel weights supplied to this table the clock will gain.

**Note**

*To place and remove the weights, use the tweezers, which you can always keep available in the secret compartment of the case.*



The heavier the added weight, the greater the acceleration of the pendulum and the faster the clock.

Removing a supplementary weight, on the other hand, will increase the period of oscillation of the pendulum and the clock will move more slowly.

*Accessory*

A 12-part set of fine adjustment weights is also available as an accessory for your Mechanica M1 and is described in detail in the section that follows.

**Correcting the rate:**

You can correct daily rates of 1-2 seconds using the two weights provided. To do this, you do not need to touch the pendulum or the second hand. One of the weights should therefore always be on the fine regulation table.
If the second hand deviates from normal time by about minus one second, simply add the second weight. Once the difference has been made up, remove the additional weight again. Any deviation of more than a second can be corrected by temporarily decreasing the weight on the fine regulation table.

*Accessory*

## CERTIFICATED WEIGHTS FOR FINE REGULATION

✔ Precision fine adjustment weights *Box 11*

For the fine adjustment* of your Mechanica M1, we offer a twelve-piece set of fine adjustment weights as an accessory, with which the adjustment can be carried out in even more precise steps.
It includes twelve precision weights in the following graduations:

Aluminium
1 mg
10 mg

Nickel Silver*
10 mg
20 mg (2x)
50 mg
100 mg
200 mg (2x)
500 mg


An additional accessory is a noble wooden case with magnetic closure for storing the precision regulation weights (see in the picture above right).

**Certified precison weights**

Our weights are certified and comply with weight tolerance level M1. The metrological properties of each weight are determined in a German Calibration Service (DKD)-accredited laboratory and certified. This certification originates from the ISO 9000 quality assurance standard and has international validity (unlike official verification exclusively recognised in Germany). Recalibration is not necessary as the weights are not subject to mechanical wear.

Now nothing stands between you and finely regulating your timepiece!

## Having completed the assembly and regulation you have now made yourself a precision timekeeper.

Like any other precision instrument whose accuracy is subject to great demands, your Mechanica M1 requires careful handling and a certain amount of maintenance. We therefore recommend that you never leave the case open for long periods of time to prevent dust from settling in the movement.

Thanks to its design and the use of a large number of ball bearings*, your Mechanica M1 has an extremely low-maintenance movement. Nevertheless, individual components, such as the escapement*, must be lubricated. Oil is subject to a certain aging process, which greatly limits the lubrication properties after several years.

For this reason, cleaning of individual clock components in a special cleaning procedure is necessary after an operating period of about 5-7 years.

We offer you to carry out the maintenance in our manufactory. The components that may be affected by wear and tear are either refurbished or replaced with original parts.

***Note***

*Never leave the case open unnecessarily!*

***Maintenance***

*Maintenance can always be carried out in our manufactory.*

Cared for in this way, your Mechanica M1 will serve tirelessly for decades and will be proudly handed down from generation to generation as a valuable timepiece.

If transport is necessary, please be sure to observe:
The weight has to run down complete. At first take out the weight, then the movement. Afterwards the pendulum and the scale.
For transportation, the movement is protected best when you put it back into the case. To protect the back panel of the case from damage please save the pulley (i.e. wrap with foam). Please package the weight, the scale and the pendulum separately.

The movement must be removed in order to retrofit the majority of accessory parts. Make sure that you have enough time to modify your Mechanica M1 as intended. This will allow you to carry out the work described without having to rush.

Whenever you are carrying out work on the movement, the instructions from the section »Important information before beginning work« at the beginning of this book apply. The series of work steps to be carried out, which is specified in these modification instructions, should save you from exerting unnecessary effort and enable you to achieve a successful outcome in a safe manner.

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

**Tools**

The following tools are required to remove the movement:

- ✔ Allen wrench 3 mm — *Box 8*
- ✔ Allen wrench 0,9 mm — *Box 8*
- ✔ Tweezers (pincers) — *Box 8*
- ✔ Assembly base — *Box 2*

**Note**

*The steel cable must remain taut under all circumstances after unhooking the weight.*

We recommend removing the movement once it has run down, i.e. when the driving weight is at the bottom of the case.

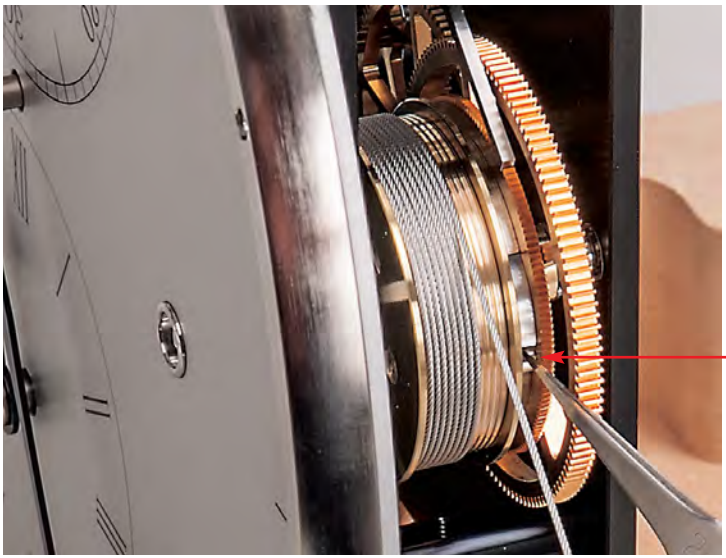
Loosen the M2 Allen grub screw that fixes the pulley shaft with the Allen key width 0.9 mm. When doing so, keep a firm hold on the weight and ensure that the steel cable is never slackened because if this happens, its own spring force would cause it to become caught in the movement. Then push the rope pulley pin out of the hole in the pulley using the Allen key. For the ball-bearing pulley, only the weight must be unhooked. Put the driving weight and pulley safely aside.

You must keep the steel cable taught at all times – both prior to this point and throughout the following steps.

Loosen the two movement-holding screws using the Allen wrench (3 mm width across flats). Remove the movement from the case carefully and slowly towards the front and safely place the movement on the assembly base. You should now wind down the move-ment if the clock was removed before it had not fully run down.

To do so, proceed as follows:

Press on the notch in the ratchet on the barrel wheel* with the tip of the tweezers (see figure) and, while doing so, pull on the steel cable until this is fully unwound from the cable roller*. When the clock is running, the barrel wheel turns once every two and a half days. This means that the notch in the ratchet may unfortunately be located at a point that is difficult to access. In this case, the steel cable must be unthreaded twist by twist.



*Notch in the ratchet on the barrel wheel*

**Disassembling the movement**

For inspection or subsequent installation of accessories, it may be necessary to disassemble the movement. Note that disassembly must be carried out in the reverse order of the assembly instructions:

1. Removal of the hands
2. Removing the dial with bezel
3. Removal of the motion work
4. Disassembly of the pallet arbor bridge and removal of the escapement lever
5. Removal of the front plate

# CHAPTER II

## TECHNICAL INFORMATION AND FUNCTION OF THE MECHANICA M1

The following descriptions are intended to give you an insight and the special design features of your precision clock.

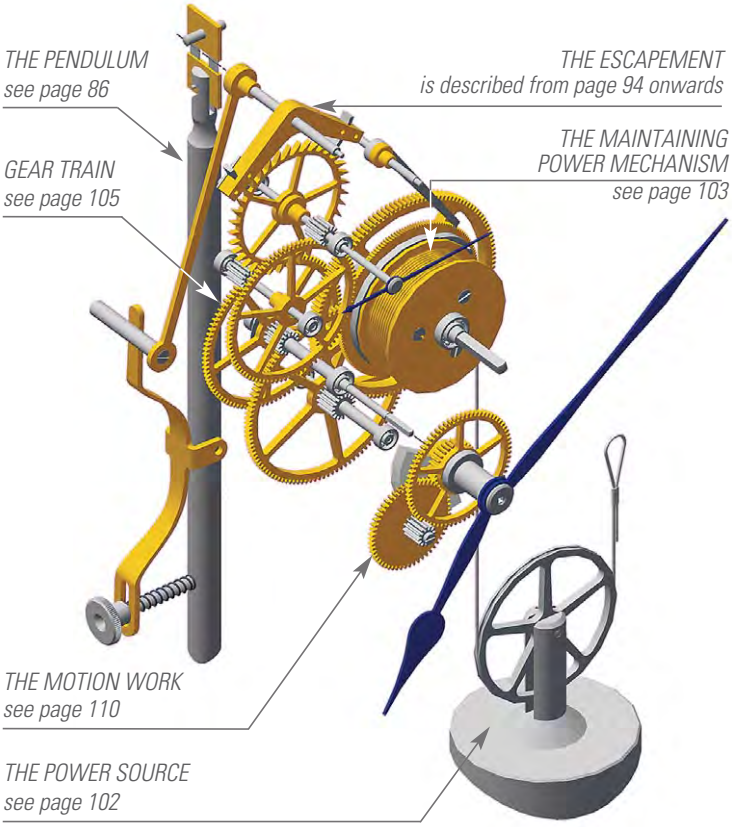
It is, of course, a demanding task to bring the complex interrelationships of pendulum, escapement* and gear train* closer to the interested clock enthusiast in relatively short and comprehensible texts. After all, we clockmakers have three years to learn the basics of this craft.

Nevertheless, it is an important concern for us not only to give you the possibility to assemble a precision pendulum clock* with this kit, but furthermore to share with you our enthusiasm for this type of clock. It is the fascinating interplay between the laws of nature and what at first glance appears to be simple mechanics that allows us to measure the passing of time with enormous precision. Over the last centuries, clockmakers have made great efforts to increase the accuracy of precision pendulum clocks with the means at their disposal.

Today, we are committed to this tradition and are therefore constantly striving to improve our purely mechanical clocks with the help of new materials, modern manufacturing methods and new clock design solutions.

The fascination of a precision pendulum clock today lies not only in its accuracy, but also, on closer inspection, in its simple and clear construction. Thus, we can observe and understand the effects of the laws of nature on the clock. A mechanical clock is something vivid and, in the case of your Mechanica M1, even something comprehensible in the literal sense.

Now, if you take the time to try to understand the processes in your Mechanica M1, you can share our enthusiasm for clock making and look at your clock knowingly with different eyes.



## THE PENDULUM

The pendulum* is still today's most accurate mechanical oscillation device. It divides time into precisely defined units. These are defined by the length of the pendulum and the force of gravity. This time-keeping breakthrough was discovered by Galileo Galilei in 1585. According to his observations, a pendulum has always the same oscillation time (period) regardless of its amplitude. This principle is called 'isochronism'*. Strictly speaking it only holds at very small amplitudes.

In conclusion one can say that the accuracy of a clock pendulum is determined by constant length, constant small amplitude and a constant force of gravity.

But the length of a pendulum is dependent on external influences like temperature. An increase in temperature results in the expansion of almost all solid materials. This means the pendulum rod becomes longer. When temperature falls the effect is reversed. The result is a longer period at higher temperatures and a shorter period at lower temperatures.

In order to keep the oscillation angle or amplitude* of the pendulum constant, it is necessary to supply the energy, that is lost with every swing due to the resistance of the air and in the suspension spring*.

The question now arises as to how the clockmakers have managed over the last 400 years to compensate for these influences, which prevented the pendulum clocks from running accurately. To do this, we must first take a closer look at the construction of our pendulum.

It consists of the pendulum rod, a compensation tube* on which the pendulum weight rests, the regulating nut* and its lock nut*. The fine regulation table is located approximately in the middle of the pendulum rod and the beat adjuster* at the upper end.

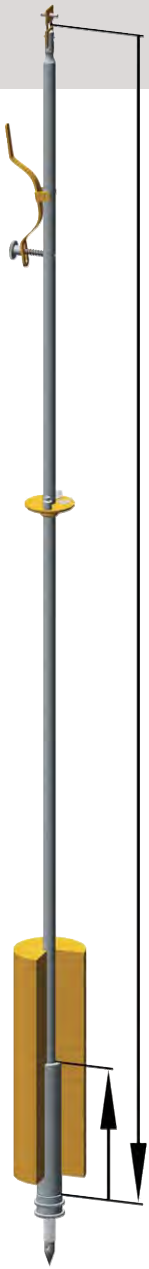
***Accessory***

A barometer instrument for compensating for accuracy changes caused by air-pressure fluctuations is available as an accessory and is described in detail in the following section.

As we know, the pendulum rod expands as it heats up and our clock slows down.

Therefore the use of a material with very low thermal expansion is important. At the end of the 19th century the French scientist Charles Edouard Guillaume discovered a Iron-Nickel alloy whose expansion is 10 times less than normal steel and 5 times less than wood. It is called Invar*.

For normal clocks, excellent timekeeping results of a few seconds per week were already possible with the wooden rod pendulums used. However, to increase the accuracy to a few seconds deviation per month, it is not sufficient to simply use an invar rod, but it is also necessary to compensate for the already very small linear expansion of the invar rod.



This is why the so called 'compensation tube' sits on top of the regulation nut supporting the pendulum bob. This short tube is made of normal steel and has a precisely calculated length, so that its expansion is the same as the complete pendulum rod and suspension spring (see illustration on the left). Any change in the length of the rod is balanced by a similar change in the tube and the pendulum bob.This method of temperature compensation was invented by Siegmund Riefler in1896 and is used in a number of precision clocks.

Now that we have explained the subject of the constant pendulum length, or more precisely, the constant center of oscillation, we must go into the constant of gravity. In addition to the length of the pendulum, the force of gravity is decisive for the period of oscillation. This force, which we know all too well, is constant in one place, but changes when we move from north to south or change our altitude relative to sea level. For this reason, a pendulum clock must be adjusted at the respective installation place, i.e. we adjust the pendulum length to the local gravitational force.

To do this, we use the regulation nut and change the center of gravity of the pendulum by screwing it up or down. This procedure allows us to adjust the clock to a deviation of one to two seconds per day. However, in order to achieve a rate accuracy of two to three seconds per month, we now have to correct the center of oscillation of the pendulum with the help of fine adjustment weights weighing just a few milligrams. To do this, we place the weights on the fine regulation table in the center of the pendulum baton and thus achieve a minimal upward shift of the center of gravity and a small acceleration of the pendulum swing.

When we remove a weight, the oscillation time is longer and the clock runs slow.

In conclusion one can say that the pendulum of the M1 has all attributes that make a first class precision pendulum clock*.

The last unanswered requirement is the provision of a constant pendulum amplitude. This is not provided by the pendulum but is due to the power that is supplied to the pendulum to keep it oscillating.

This is delivered by the escapement* which is the connection between the gear train* and the oscillation system.

The structure and function of the escapement are explained in detail starting on page 94.

However, we already know that this has the task of keeping the pendulum swinging. Since the friction of the air and the suspension system is almost constant, the force applied to the pendulum must also be kept as constant as possible. This is the task of the movement and its driving force.

At this point, it should only be mentioned that the driving force is achieved by means of an outgoing weight which exerts a constant force on the gear train due to the constant force of gravity at the place of installation.

This is explained in the section »driving force and gear train« on page 102.

Accessory

## AIR-PRESSURE COMPENSATION USING A BAROMETER INSTRUMENT

In addition to temperature changes, whose effects are counteracted by temperature compensation, air-pressure fluctuations also cause accuracy changes. This accuracy deviation, also known as the pendulum's airpressure constant, equates to approximately one to two hundredths of a second per mbar (millibar) per day, depending on the shape of the pendulum body and its specific weight. This error is caused by a change in air resistance and the pendulum's lift. The mean air pressure at sea level (NN) is 1013 mbar and varies between 930-1070 mbar (hPa, hectopascal). As a result, in the event of extreme pressure changes of 100 mbar, a pendulum clock's accuracy can change by approximately one to two seconds per day, as shown by measurements on our own pendulum test stand.

To counterbalance these deviations, Riefler developed the concept of airpressure compensation using aneroid capsules*, as can already be seen in aneroid barometers and barometric altimeters. Air-pressure fluctuations are generally short lived. As these fluctuations may balance out, if the accuracy is monitored over an extended period of around a month, they have very little impact. Nevertheless, using air-pressure compensation is worthwhile.

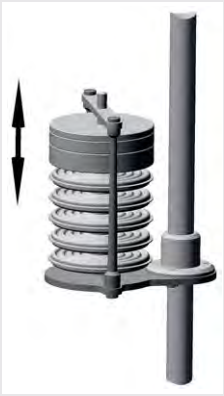
We cannot assume that the air pressure has balanced out exactly between the times* when the state of the clock is checked. However, a good precision pendulum clock* is characterised by steady motion and is not affected by outside interferences.

The barometer instrument, available as an accessory for your Mechanica M1, compensates for accuracy fluctuations that are caused by air-pressure changes. To be more precise, we are referring to changes in air density or air weight that are proportionally related to the air pressure. Accuracy fluctuations caused by increasing air density result from the pendulum's increased lift.

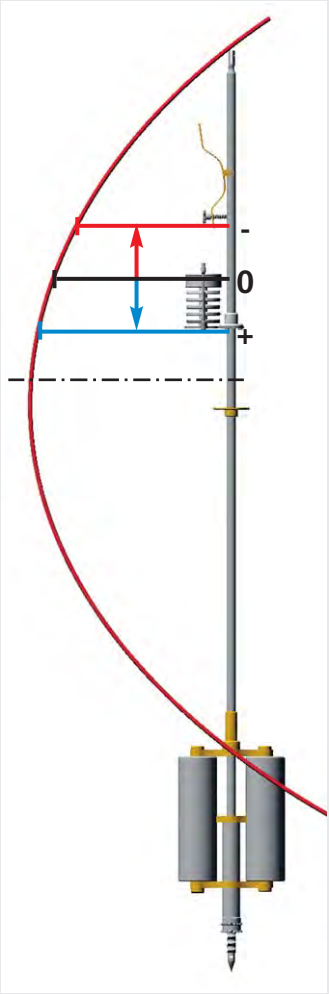
Together with other influence factors, such as increased air resistance, this causes the pendulum swing to slow down. The impact this error has on the pendulum depends on the shape of the pendulum and its specific weight. This impact cannot be adequately calculated and must be determined using very time-consuming measurements on a pendulum test stand housed in a sealed glass tank and isolated from environmental influences. For these measurements, a series of monthly tests were carried out for all components of your Mechanica M1, at our own laboratory of the manufactory Erwin Sattler GmbH & CO. KG.

The compensation function depends on changes to the pendulum's moment of inertia caused by moving a mass on the pendulum rod, and causes the period of oscillation to change. When using this kind of compensation, movement is caused by the five aneroid capsules* or barometer capsules with the weight on them. Each of these capsules consists of two thin metal membranes that are soldered together in a vacuum. If the air pressure outside these capsules increases, they are pushed together and the counterweight lowers. This results in a total displacement of 1.5 mm with a pressure change of 100 mbar. Thanks to the capsule design, temperature influences do not affect the total stroke. The instrument is fitted between the pendulum pivot (pendulum spring*) and the centre of the pendulum rod. Comply with the position given in the assembly instructions, since the exact effect of the compensation depends on this.

**How barometer compensation works:**
When the air pressure increases, the pendulum has more lift and air resistance increases. Without compensation, the pendulum would swing more slowly and the clock would lose time. The aneroid capsules* for the air-pressure compensation are pushed together.



Accessory




As a result, the counterweight moves downwards and the pendulum speed increases. Attentive readers may ask themselves whether we have made an error here. After all, we are changing the pendulum's physical balance point and this must result in the movement slowing down! Have we not done precisely that when setting a precision pendulum clock? When moving the pendulum bob* downwards, the clock slows down.The same can be achieved by removing a fine adjustment weight from the support plate.To explain this slightly confusing fact, we can imagine a mathematical (ideal) pendulum, which consists of a massless pendulum rod and a point-shaped pendulum weight of any mass.

Increasing the mass of the pendulum weight on this pendulum has no influence on the period of oscillation. The same would happen if we were to add a mass to the pendulum's fulcrum point (suspension). Neither influences the pendulum's moment of inertia, and nor, therefore, the period of oscillation. Adding a mass at any other point on the pendulum rod between the fulcrum point and the pendulum weight accelerates the period of oscillation. This effect is most noticeable in the centre between these two points. It is exactly this concept that you use whe precisely adjusting* of your Mechanica M1. If we consider the extent of the effects in relation to the position on the pendulum rod, we will see the effect line illustrated by the parabola shown in the adjacent figure.

It crosses the pendulum rod at the fulcrum point on the pendulum spring and the balance point (central oscillation point) at the height of the pendulum body. The apex (maximum acceleration) is in the middle of the pendulum rod.

As shown in the schematic figure, this results in a mass above the middle that is being moved downwards causing the period of oscillation to accelerate. Your compensation system works in accordance with this principle . This also highlights the importance of the instrument's position. The higher it is mounted, the lower the slope of the parabola and the more the displacement of the counterweight has an effect on the period of oscillation. That means: The compensation effect can be changed by moving the instrument or by changing its counterweight. This effect can also be observed on your Mechanica M1 by, for example, moving the regulating plate on the pendulum rod downwards or upwards from the apex at the centre of the parabola. This reduces the period of oscillation!

**The air pressure constants of the different types of pendulums are:**

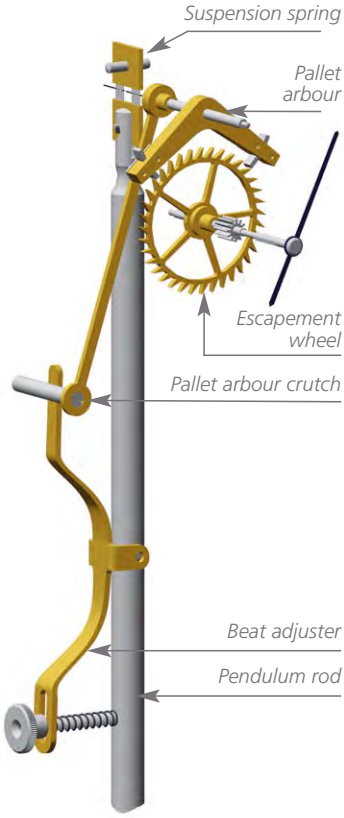
| Version | Constant | Added weight | Position |
|---|---|---|---|
| Cylinder pendulum bob | 0,021 sek/d | 16 mm | 215 mm |
| Double cylinder pendulum bob | 0,016 sek/d | 16 mm | 235 mm |
| Lenticular pendulum | 0,012 sek/d | 12 mm | 235 mm |

The position of the barometer instrument in the various pendulum versions can be seen in the illustrations on page 35.

## THE ESCAPEMENT

The escapement has two important tasks:

1. It is the connection between gear train* and oscillation system. It replaces the energy that the pendulum loses through friction.
2. In addition to this it controls the gear train.



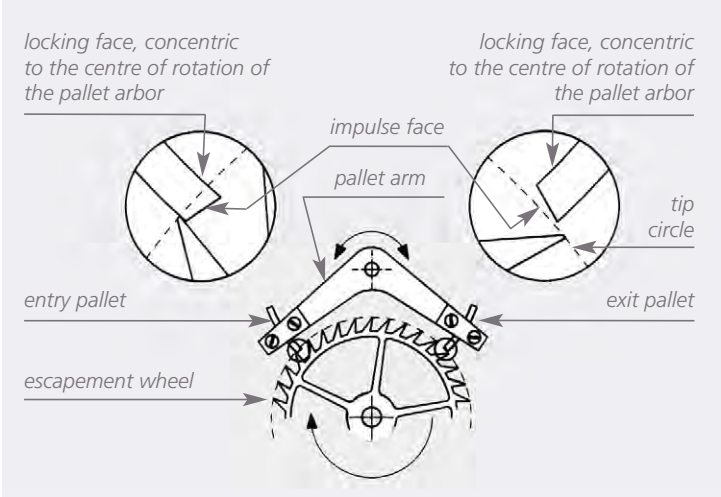

The action of the escapement is controlled by the pendulum, making it possible to »count« the oscillations of the pendulum with the gear train and display them with the hands.

Since the discovery of the pendulum as an oscillation device for clocks, different escapement systems were developed which worked more or less satisfactorily. In our M1 we use the so-called »dead beat« escapement invented by George Graham in 1720. This is why it is also called Graham* escapement. This escapement evolved from the earlier escapements and its simplicity and reliability is unmatched. In some cases escapements were invented that work more precisely but they are much more complicated and difficult to set up.

In order to understand the geniality of this escapement, we must first consider the construction and then, the physical principles.

The escapement and its parts are shown in Figure 1.

**FIGURE 1**




The actual escapement consists of the sharp-toothed escapement wheel* and the pallet arbour with its two pallets*. The escapement wheel is, like all the other wheels, mounted between the two plates* of the frame.

The pallet arm is mounted together with the pallet arbour crutch* on a rotatable shaft*, which is mounted between the front plate and the anchor bridge attached to the rear plate*.

Thus, the pallet arbour crutch extends behind the frame and can now connect to the pendulum. This connection is rigid, therefore the pallet arbour performs the same rotary motion as the pendulum.

However, a requirement for this is that the centre of rotation of the pallet arbour and the pendulum are on the same imaginary line.

We can see that the action of the crutch as the pendulum swings causes the entry and exit pallets to engage with the tip circle of the escapement wheel. The pallets are made of agate. They have a curved shape and are positioned so as to have the same centre of rotation as the pallet arbor. The ends of the pallets which engage with the tip circle of the escapement wheel are bevelled and polished. They are the impulse faces*.

The outer radius of the entry pallet and the inner radius of the exit pallet are the locking faces*. As we already know, the escapement gives a regular supply of energy to the pendulum to keep it oscillating.

It is an advantage if the impulse takes place when the pendulum has its highest oscillation speed and its highest kinetic energy. This is the case when it moves through the zero position. At this time interference with the pendulum will have the least effect on timekeeping .

One half of an oscillation is divided into five steps that are shown in figure 2 as angular stages.

The complete escapement function and the positions of the pendulum during one half oscillation of the pendulum are shown on table 3A-G »The escapement function« at the end of the book table.

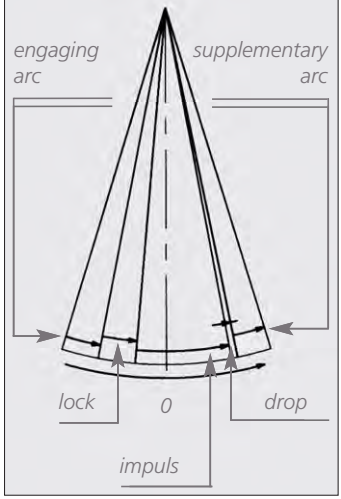
In order to be able to go into the individual sections in more detail, it is important that you first look at the function sequence in detail.

**Note**

*The »escapement function« (Figures 3A to G) is described on page 126 - 128.*

**FIGURE 2**

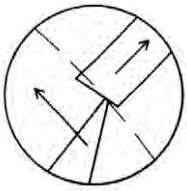
*One half oscillation of the pendulum from the left to the right extremes, divided into 5 angular steps*



**Now to the explanations of the individual swing.**

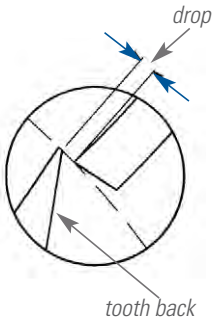
**Impulse**

The impulse* is one of the two important functions of the escapement. During the impulse the pendulum receives the necessary energy that is needed to keep it swinging. One tip of the escapement wheel* slides along the impulse face and gives a partial turn to the pallet arbor. In the Graham escapement* the impulse takes place as the pendulum moves through the zero position.



**After the impulse, the so-called drop takes place.**

The drop* is the free movement of the escapement wheel, after the escapement wheel tooth has left the impulse face. It is an important safety variable for the function of the escapement. The drop is necessary so that the pallet can engage with the tip circle without hitting the back of the escapement wheel tooth at the next half oscillation. In addition a bigger drop ensures that the escapement works correctly even if the escapement wheel has small* pitch errors. For a reliable escapement function it is necessary that the drop is equal on both pallets.




**The escapement wheel tooth**

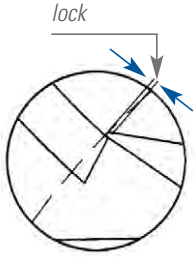
has dropped from the impulse face or the entry pallet, another tooth drops on the locking face of the exit pallet and the pendulum moves on to the end of its swing. During this time the escapement wheel is locked and the motion of the gear train is arrested. This is the second important function of the escapement and because of this it is called dead beat escapement.

The term »dead beat« refers to the escapement wheel which, while resting against one of the two locking faces, stands still and

also rests during the oscillation of the pendulum and thus also when a pallet is further immersed. This is possible because the pallets are positioned concentrically* and has the advantage that the friction on the locking faces is constant.

The path of the pendulum from the end of the impulse and drop to the inversion point is called supplementary arc*. The engaging arc is from inversion point to the locking. The engaging arc plus locking should be as big as the arc between the zero position and the end of the impulse.
This ensures proper function, even when the clock is not levelled perfectly and the drop is not symmetrical to the zero position of the pendulum. We clockmakers call this problem »beat error«. The beat error can be corrected by manipulating the beat adjuster* on the pendulum rod. The beat error is heard when the ticking of the clock is not balanced. By turning the knurled screw on the beat adjuster* the relationship of the pendulum to the pallet arbor can be changed so that the tick is even.

**The last term still to be clarified is the so-called lock.**
The lock is also a safety variable. The lock is the small distance between the edge of the impulse face* and the point on the locking face where the escapement wheel tooth lands after the drop.
It's only a fraction of a millimetre but prevents the escapement wheel tooth dropping onto the impulse face and stopping the oscillation of the pendulum.



**In conclusion we can say that, in addition to the drop the lock provides a safety margin when the escapement wheel has a small* concentricity error.**

The escapement wheel of your Mechanica M1 has been manufactured by us with such precision that we can guarantee a concentricity error* of less than two hundredths of a millimeter. The amount of lock can be adjusted by shifting one pallet in the pallet arm.

The lock of your clock is slightly bigger to ensure a proper function in serial production.

As you can see on figure 2, the lock moves the impulse a little out of the zero position. Theoretically it is useful to adjust the lock to be as small as possible and then to check that each escapement wheel tooth drops onto the locking face.

However, this is not necessary for proper function and should therefore only be done if you really dare to move the pallets by these small amounts.

**The same caution is necessary when making fine adjustments to the drop.**

The drop must be equal on both pallets. To check the drop and lock of the preadjusted escapement, you should apply power to the gear train by pushing the crank against the winding direction. Now you can move the lever* back and forth and watch with the eyeglass through the holes in the back plate how the escapement works. At first check the drop.

**The drop is the free movement of the escapement wheel, after a tooth leaves one pallet and another tooth is stopped by the other pallet.**

We can see this by observing at the distance between the end of the impulse face and the tip of the tooth which has stopped after leaving it. This distance is the drop, and can be seen on the entry and exit pallet while moving the lever fork* back and forth.

We admit that it is difficult to see any small differences and that it takes a little patience and practice, especially considering that the escapement is already preset and normally functions perfectly.

If you notice an unequal drop, it can be adjusted by turning the eccentric bushing* in the lever bridge* . When the drop on the exit pallet is too big, turn the bushing a little clockwise. If it is too small turn counter clockwise.

**When the drop is equal, check the lock. Check if every tooth drops safely on the locking face on both pallets.**

If one tooth drops on the impulse face* one of the two pallets has to be pushed deeper* into the tip circle of the escapement wheel.

When adjusting the escapement it is very important to work in the right order. First adjust the drop then the lock, because turning the eccentric bushing also changes the engaging distance of the pallets to the escapement wheel.

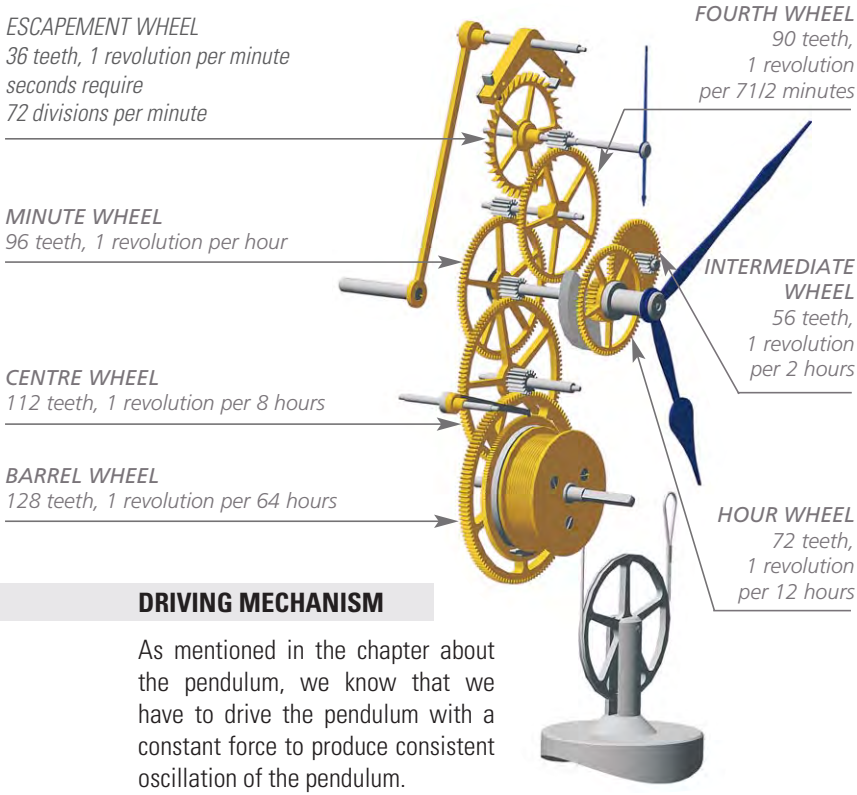
We can make a small calculation to get an idea of the remarkable precision of the pendulum and the escapement of your Mechanica M1:

60 seconds per minute,
60 minutes per hour and
24 hours per day results in: 86,400 seconds per day
or
7 days per week results in: 604,800 seconds per week.

If your Mechanica M1 now deviates by one second per day, this would correspond to an incredible accuracy of 99.9989%!
With a completely realistic deviation of only one second per week, this results in an accuracy of 99,9998%!

## DRIVING MECHANISM AND GEAR TRAIN

The driving mechanism together with the gear train* has to supply the escapement* and the pendulum with energy. The gear train also drives the hands.




## DRIVING MECHANISM

As mentioned in the chapter about the pendulum, we know that we have to drive the pendulum with a constant force to produce consistent oscillation of the pendulum.

This force comes from a weight which performs, thanks to gravity, a constant driving force on the barrel* wheel.
In this way we give a constant force to the gear train, which is transmitted to the escapement* and thus drives the pendulum.

The height of fall of the weight, determined by the clock case* and the diameter of the cable drum* results in twelve revolutions of the barrel wheel per month. The second hand is located on the shaft* of the escapement wheel and rotates over 43000 times during this time.

The gear train must gear up the revolutions of the barrel wheel to the escapement wheel. The energy must be transmitted uniformly and without fluctuation for a constant drive of the pendulum. The driving force is reduced in the same ratio due to the* transmission from the barrel wheel to the escapement wheel.

**The drive weight is made of tungsten*, which has a higher specific weight than the lead normally used in clock making.**

The weight is not suspended directly from the cable drum*, but works on the gear train via a pulley. Through this pulley, the weight force is divided equally between the attachment of the steel cable in the case and the cable drum, as with a pulley block.

**This has the advantage that we reach, at the same height of fall, which is limited by the length of the case, the double winding period.**

## THE MAINTAINING POWER MECHANISM

When you wind your M1, the steel cable winds on the drum and the weight moves upwards. During this time the weight cannot put force on the gear train and the clock stops.

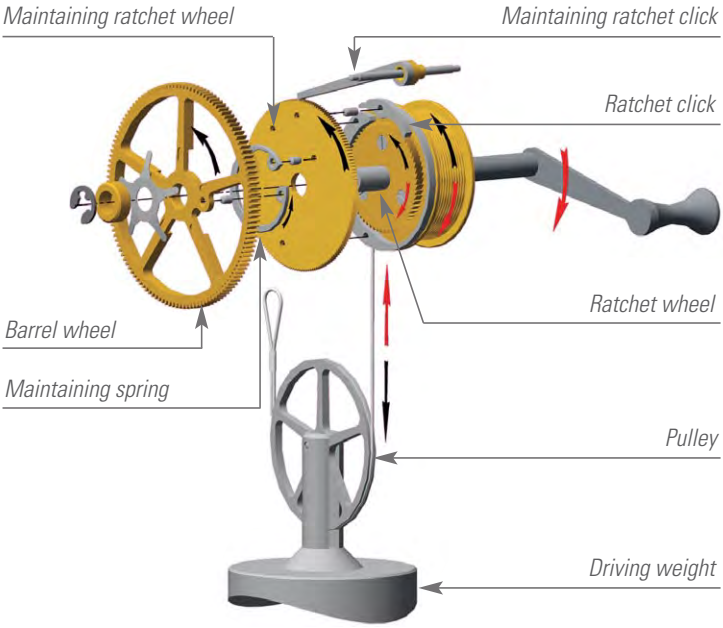
To avoid this your M1 is equipped with a maintaining power mechanism*.

**The maintaining power mechanism consists of the following parts:**

- Maintaining wheel
- Maintaining click
- Maintaining spring

The circular maintaining spring is positioned between maintaining ratchet wheel and barrel wheel and connects both parts. The maintaining ratchet wheel and barrel wheel can rotate freely on the barrelwheel arbor. The winding ratchet, pivoted on a separate shaft* between the plates, engages with the teeth of the maintaining ratchet wheel.

The operation of the maintaining power can be explained very simply with the adjacent illustration: Under normal working conditions the driving weight puts force on the barrel (black direction arrow). This, transmitted via the ratchet wheel and the click on the maintaining ratchet wheel, puts tension on the maintaining ratchet spring and drives the movement. When the clock runs down the maintaining ratchet wheel rotates freely underneath the maintaining ratchet click. When winding (red direction arrow), the weight moves upwards and cannot drive the movement, the maintaining spring wants to expand and the maintaining ratchet wheel ensures that the force is transmitted to the barrel wheel which drives the movement during winding.



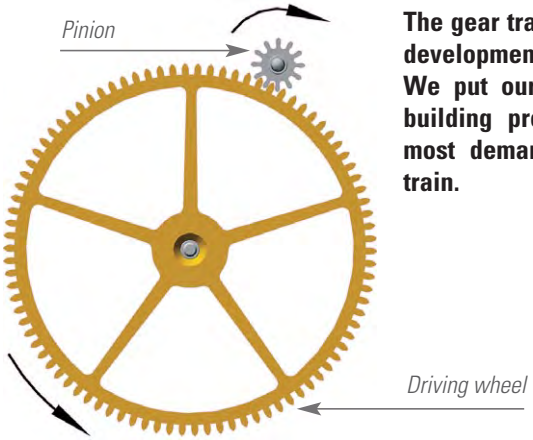

## GEAR TRAIN

The weight has a mass of 3000 g. Half of this, 1500 g, is effective because of the deflection at the pulley on the gear train.
If we look at the large transmission ratio* from the barrel wheel to the escapement wheel* in the gear train*, which is 1 to 3840, and divide the 1500 g by this value, we see that mathematically only 0.39 g can be effective at the escapement wheel.

Of course, this simple calculation does not take into account the lever lengths of the radii of the barrel wheel and escapement wheel, but it sufficiently illustrates the low forces with which a precision clock movement operates.
If we were to make an exact calculation of the torque*, taking into account the losses due to friction in the gear train, we would reach an even lower result.

This consideration results in the design specifications for a good gear train:

The gear train must transmit power evenly to the escapement with only small losses. In addition to this it should work for a long time without wear.




**The gear train of your M1 is a completely new development.**
**We put our more than 30 years experience building precision clocks into fulfilling the most demanding criteria for a perfect gear train.**

Wear in a clock is the result of friction. It takes place in bearings and the engaging surfaces of wheels and pinions.

Engagement is the mating of the teeth of a wheel with teeth of another wheel. In a gear train clockmakers call the bigger driving gear a »wheel« and the smaller driven gear a »pinion«*.

**But first, let's have a look at the friction.**

Most of the friction occurs in the bearings of the wheels. In common clocks the thin pivots* turns* directly in holes of the front and back plate* (most made of brass)* and are lubricated with some oil.

This type of bearing has proven itself for normal utility clocks, but has the disadvantage that over time the oil loses its lubricating properties due to contamination by metal abrasion and evaporation.

This increases the wear, the holes enlarge and there is a loss of driving force; the clock keeps stopping. However, the enlarged bearing holes alone are not the cause of the driving force losses, also the distances between the intermeshing wheels change and thus hinder the transmission of power.

**For this reason some precision clocks have jewelled bearings*, so called Chatons*.**

These bearings show hardly any signs of wear even after decades.

To avoid friction however these bearings need oil. But every oil ages and the bearings must be cleaned and relubricated regularly (5-10 years), to avoid damage.

The friction of the bearings described up to this point is called sliding friction, since the pivot* in the bearing hole slides along the wall of the hole during its rotation.

**Your Mechanica M1 is equipped with miniature ball bearings of stainless steel.**

The friction of a ball bearing* is called rolling friction because the inner bearing ring rolls along the outer bearing ring.The friction is very small and because of the small force the bearing needs no oil.

The maximum rotation speed of these bearings is 100 000 rpm (revolutions per minute).The fastest wheel of our clock, the escapement wheel*, makes one revolution per minute. We can be sure that our bearings don't have too much load. Only dust can cause friction, but the movement is installed in a sealed case.

This bearing is excellent for clocks and enables us to work with less driving force, as the ball bearings produce less friction, resulting in reduced loss of power. Less driving force also means less strain on the teeth, which in turn increases the longevity of the gear train.

**Next we focus on the friction in individual wheel-pinion engagements.**

A number of factors determine the amount of friction:

- The material, especially the combination of materials
- The shape of the wheel teeth
- The number of teeth
- The transmission ratio*

**The materials:**

Your Mechanica M1 is equipped with hardened steel pinions and brass wheels.

This is for two reasons:

1. First the higher rotation speed of the pinions* puts more load on the teeth, therefore the material must be harder.
2. The friction between two different materials is less than between identical materials. In clockmaking the combination of brass and steel serves well.

**The shape of the wheel teeth:**

Compared to other gears in technology, clockmaking involves working with high transmission ratios*. In order to enable even and low-friction power transmission, this requires a special geometry of the individual teeth. The theoretically perfect shape for this purpose was developed centuries ago, but it cannot be produced, not in the past nor in the present.

For this reason, we use a tooth shape in your clock that comes as close as possible to this ideal shape, in which the individual teeth mostly roll over each other in the mesh and hardly rub against each other. It's called involute gearing and comes close to the ideal cycloidal* gearing.

**The number of teeth, and the transmission ratio, have a close relationship.**

Experience shows that it is an advantage when as many teeth as possible engage with the other wheel at the same time. The transmission of power is then very smooth, with little friction. This is achieved by using pinions with a high number of teeth. More than 10 is ideal.

**It has also been shown that too high a transmission ratio in engagement* results in more friction.**

Experience also shows that a high transmission ratio produces more friction, and a ratio of less than 1 to 10 is ideal.

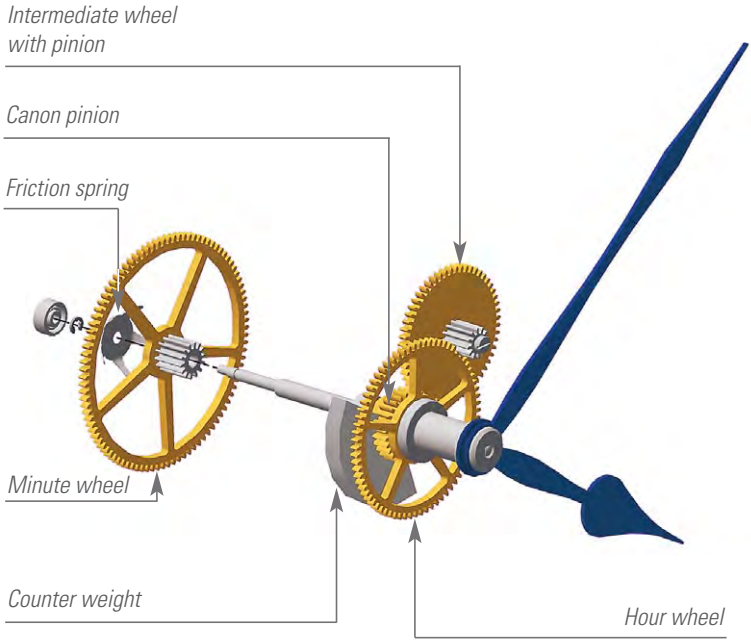
Your Mechanica M1has pinions with 12, 14 and 16 teeth. The transmission ratio is between any wheel/pinion pair is between 1 to 8 and 1 to 7.5.

## THE MOTION WORK

The last part of our Mechanica M1 to be explained is the motion work*.

The hand movement has the task of reducing the precisely defined number of revolutions of the minute hand to the hour hand in a ratio of 12:1.
In order to ensure the same direction of rotation of the two hands as well as the concentric* display, we use a gear with two engagements* and the individual reductions 2:1 and 6:1.
The minute hand sits directly on the minute wheel arbor. To be able to set the hands, it is necessary to be able to disconnect the minute wheel arbor from the rest of the gear train. This is done by the use of a friction* spring between the minute wheel and its* pinion.

This friction* is created by a pre-tensioned, five-armed friction spring between the minute wheel and the minute wheel shaft and thus corresponds to a slipping clutch. Because the minute hand is a one-armed lever that supplies power to the gear train by its own weight in the first half of an hour and withdraws power in the second half, we have attached a counterweight* under the canon pinion*. This compensates for the disturbing influence of the hand.




All these points result in a solid gear train that meets the requirements of a precision pendulum clock* in every sense.

# GLOSSARY

## A

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

To reduce friction and for a minimal wear, agate pallets* are available as accessories for the Mechanica M1.

**Amplitude** The angle through which a pendulum moves from is central position to one extreme. On the pendulum scale you can read the amplitude in minutes of arc.

**Aneroid barometer compensation** Device to compensate for the influence of the changing air pressure on the accuracy of a clock.

A specially designed air pressure compensation is available as an accessory for your Mechanica M1.

**Anodise** Electro-chemical treatment of aluminium. Surface is treated in acid-bath. The result is a very durable oxidation layer. The Mechanica M1 has a few anodised parts like plates, crutch and barrel.

**Arbor** Shaft in a movement.

## B

**Ball bearing** A bearing in which balls roll in a groove between the inner and outer ring. The rolling friction is very low. This is why ball bearings have very low friction and almost no wear. In the M1 the ball bearings have a very low load and need no oil.

**Barrel** Cylinder on the barrel arbor. When winding the weight the cable is wound around the circumference of the barrel. The barrel has grooves like a thread to prevent the cable from scratching.

**Barrel wheel** First wheel in the gear train. Mounted on the barrel arbor together with the barrel, the ratchet and the maintaining power device.

**Beat** The tick of the clock. Said to be in 'in beat' when the tick is even and occurs in the same position when the pendulum is approaching either extreme. The supplementary arcs are equal.

**Beat adjuster**

Device to adjust the beat. With a screw you can adjust the relationship between the pallets and the pendulum by tilting the crutch.

**Bevelled glasses**

A bevel would be described, as a sanded edge are used for glass, gemstones or surfaces. These have a different effect to the refraction of the beam path and thus produce interesting views of objects lying behind on them.

To upgrade your Mechanica M1 we offer as an accessory a set of bevelled glasses.

**Bezel**

Dial ring

**Blueing**

Heat treatment of carbon steel. If polished or ground steel is heated to ca. 300°C an oxide builds up on the surface which appears blue.

For the visual enhancement of your Mechanica M1, elaborately hand-domed, polished and blued hand sets are available as accessories.

**Brass**

Alloy of copper and zinc. The gears of your M1 are made of brass. As protection against corrosion they are gold plated.

**Calibre**

Type of movement.

**Cannon pinion**

Part of the motion work. Attached to the minute wheel arbor. Drives the intermediate wheel.

**Centre wheel**

Part of the gear train. Transmits power from the barrel wheel to the minute wheel.

**Click catch**

Unit consists of ratchet wheel, ratchet and ratchet spring. Locks the barrel to the gear train. In the opposite direction it allows the clock to be wound.

**CNC**

Computer Numeric Controlled. Manufacturing of parts with computer

**Compensation pendulum**

A specially designed pendulum that does not change its length when temperature changes.

C

**Compensation tube** Part of the pendulum. Sits on top of the regulation nuts and compensates for the linear expansion of the pendulum rod.

**Concentric** Two parts or circles have the same centre.

**Concentricity error** Manufacturing in our workshop we are able to reduce the concentricity error to 0.02 millimetres.

**Counter weight** The minute hand is a unbalanced lever that absorbs power for half an hour, and supplies power for half an hour. To compensate this we installed a counter weight on the cannon pinion opposite to the hand.

**Crutch** Lever that connects the pallet arbor with the pendulum.

**Cycloid** Generating circle. A geometrical line, that appears when rolling a circle on a geometrical contour. Has served well for gears in clocks and is still used today.

D

**Dome** To dish. Method to enhance attraction of hands for example. For the M1 hand-domed and blued hands are available as an accessory.

**Drop** Free motion of the escapement wheel, after the escapement wheel tooth slipped off the impulse face of the pallet fork. Drop is necessary to avoid pallets bumping into escapement wheel teeth.

E

**Eccentric bush** Bushing with an off-centre hole. Mounted into the pallet arbor bridge. By turning the bush, the engagement distance of pallets and escapement wheel changes and the drop can be equalized.

**Engagement** Engagement is the gearing of wheel and pinion. The transmission of force is better the more teeth are in the engagement.

**Escapement**

Unit consisting of escapement wheel and pallet arbor. The escapement transmits the power to the pendulum that is necessary to maintain its amplitude. It also ensures that the gear train runs down gradually with the escapement wheel turning once a minute.

**Escapement wheel**

Part of the escapement. Wheel that engages the pallets. In the Mechanica M1 it turns once every 72 seconds and is mounted with a bushing on the escapement wheel arbor to which the second hand is attached.

**Fine regulation**

F

Exact adjustment of period of the pendulum by adding small weights on the fine regulation table. Adding weights speeds up the clock. Removing weights slows it down.

A twelve-piece set of precision adjustment weights is available as an accessory for your Mechanica M1.

**Fourth Wheel**

Part of the gear train between the minute wheel and the escapement wheel.

**Friction**

When designing a movement, avoiding friction is a main goal. Therefore all gear train bearings are equipped with ball bearings. Sometimes friction is necessary, for example, at a friction spring acts as a slipping clutch in the motion work, to make setting hands possible.

**Gear train**

G

Gear train transmits force to the escapement. It is calculated in a way that some arbors make a fixed number of revolutions relating to time measurement. These arbors carry the hands. Wheels are sometimes numbered from the slowest. Numbers vary with the running time of the clock. The month-running Mechanica has four. The escapement wheel is no regarded as a gear.

**Graham escapement**

Dead beat escapement. Invented 1720 by clockmaker George Graham of London. Thanks to the special shape of the pallets the escapement wheel is stationary while the pendulum makes the supplementary arc. The Graham escapement was an enormous step in precision clockma-king and has served well for centuries.

H

**Height of fall** Distance, the weight can run down.

**High grade steel** compound with other metals like nickel or chrome, gives steel special properties like anti corrosion.

**Hour wheel** Part of the motion work. Turns once in 12 hours and is driven by the intermediate wheel pinion. The pipe of the hour wheel carries the hour hand.

I

**Impulse** Process where the driving force is transmitted to the pendulum.

**Impulse face** Inclined plane on the pallets. The tip of the escapement wheel tooth slides along the impulse face and transmits a driving impulse to the pendulum.

**Intermediate wheel** Part of the motion work. Sits on the intermediate wheel stud and is driven by the cannon pinion.

**Invar** Special Iron-Nickel alloy with 36.8% nickel. Tempered Invar has a thermal expansion ten times less than steel. The alloy was invented by Charles Edouard Guillaume at the end of the 19th century. Sigmund Riefler was the first to use it 1896 as material for pendulum rods in precision clocks.

**Isochronism** The constancy of the period of the pendulum with changes in amplitude. Only achievable with small changes at low amplitude.

L

**Locking face**

Curved plane on the pallet which arrests the movement of the escapement wheel.

**Lock nut**

Knurled nut mounted under the regulation nut and prevents the regulation nut from turning.

M

**Maintaining power mechanism**

Movement unit, consists of maintaining wheel, maintaining power spring, maintaining click. Transmits power while winding the clock.

**Minute wheel**

Part of the gear train. Riveted to the centre wheel pinion but free to rotate on the minute arbor. Linked to the train by a friction spring. Drives the fourth wheel pinion.

**Motion work**

Unit with two engagements. Transmits the motion of the minute hand with the ratio 1/12 on the shaft of the hour hand. Motion work has cannon pinion intermediate wheel, intermediate wheel pinion and hour wheel.

O

**Oil sink**

Hemispherical hole at the outer opening of a bearing. The oil sink hold a small amount of oil as reserve.

P

**Pallet**

Part of the pallet arm on the pallet arbor, made of hardened steel or jewel. The pallets are ring segments inserted in the pallet arm. The centre of the ring segments is identical with the rotation centre of the pallet arbor. The polished inclined planes are called impulse faces.

Pallets made of agate are available as accessories for your Mechanica M1.

## P

**Pallet arbor bridge** Bearing of the pallet arbor on the back plate.

**Pendulum** Still today's best mechanical oscillation device. The period is determined by the length of the pendulum and the force of gravity.

**Pendulum bob** Heavy cylindrical weight at the lower end of the pendulum rod. You can choose from stainless steel or bronze.

**Pendulum lens** Lenticular pendulum weight that shows particularly good movement qualities due to its aerodynamically optimised shape.

A solid pendulum lens can be ordered as an optional extra for the pendulum. The fact that there is less air resistance means that the amplitude of oscillation, and consequently the rate, remain steadier. The lenses are numbered in sequence and can be fitted with the engraving either at the front or at the back. The lens is available in bronze or nickel finish.

**Period** Strictly speaking, the time taken for a pendulum to swing from one extreme to the other and return. Clockmakers traditionally only consider the time taken to swing from one extreme to the other. Following this tradition, your Mechanica has a 5/6th second pendulum.

**Pillar** Also movement pillar. Keeps distance between the plates.

**Pinion** Gear with less than 20 teeth. Manufactured in most cases of hardened steel. The Mechanica M1 has 5 hardened pinions. Intermediate wheel pinion, centre wheel pinion, fourth wheel pinion, escapement wheel pinion, minute wheel pinion.

**Pitch** The distance between two tips of teeth, i.e. the circumference of the pitch circle divided by the number of teeth.

**Pivot**

Thin end of a shaft. Part of the shaft which turns in the bearing holes of the plates. The pivots in your M1 are made of hardened steel.

**Plates**

Hold the bearings and are the base for all other movement parts. The Mechanica M1 has anodised aluminium plates.

**Precision pendulum clock**

Sophisticated timekeeper with extremely high accuracy. Clocks with compensated pendulums were used until the late 60´s as reference time for science and official standard time.

**Rate**

Daily rate is the time difference between the clock being tested and the standard time (radio controlled clock).

R

**Reading**

The time that the clock displays.

**Regulation**

Refer to fine or rough regulation.

**Regulation nut**

Knurled nut at the lower end of the pendulum. With the regulation nut the pendulum bob can be raised or lowered. Shifting the bob upwards makes the clock faster.

**Regulation pin**

Stainless steel pin which has to be inserted into the lateral hole at the tip of the pendulum. With this pin you can hold the pendulum when turning the regulation nut and avoid damage of the suspension spring.

**R**

**Regulation weights** — Small metal pieces that make the clock run faster when put on the regulation table. With the regulation weights you can adjust your clock to an accuracy of a few seconds a month.

**Regulator dial** — Classic precision clocks have this special way of displaying time with separate dials for hours minutes and seconds. This avoids the need for motion work but requires the gear train to be modified so that one arbor (for the hour hand) turns twice a day. The hour hand never ob-scures the seconds dial.

A regulator dial is available as an accessory for your Mechanica M1.

**Rough regulation** — Adjusting the accuracy of the M1 with the regulation nuts at the tip of the pendulum. You can adjust the clock up to ca. 1 sec. a day.

**Rubies** — Very hard mineral from the corundum family. Artificial rubies are used as bearing stones in high-quality clocks.

The longevity of the M1 can be enhanced with a set of rubies for the escapement lever bearings. The standard brass bushings will be replaced with non-wearing ruby bearings.

**S**

**Spring** — The beat adjuster has a coil spring.

**Supplementary arc** — Oscillation phase of the pendulum.
Outbound supplementary arc: pendulum travels from the end of the drop to the turning point.
Inbound supplementary arc: pendulum travels from turning point to locking.

**Suspension spring** — Spring steel strip between brass jaws. The suspension spring holds the pendulum.

**Temper**

Carefully controlled heat treatment of the Invar rods to relieve stresses in the material. Only tempered Invar rods have predictable thermal expansion.

**Torque**

Turning force.

**Transmission ratio**

Determined by the number of teeth in a pair of engaging gears. Expressed as the number of turns the driven gear makes when the driving gear turns once.

**Tungsten**

Very heavy metal, density 19.3g/cm3.

**Winding period**

Time a fully wound clock will run without rewinding. The winding period depends from the height of fall, the measurements of the barrel and the gear ratio. Your M1 has a 30 day winding period.

# Accuracy table as a copy template

This accuracy table is designed to help you check the accuracy of your Mechanica M1. The recordings will also be extremely helpful to you when performing regulation. When doing so, it is recommended that you note the number and size of the counterweights on the fine regulation table.

A standard radio-controlled clock is perfectly adequate for use as a reference when checking accuracy. With a little practice, you can notice differences of less than 0.5 seconds between the two clocks. Ideally, the two clocks should always be compared at the same time of day.

It is not absolutely necessary to record the temperature, air pressure and amplitude, but doing so can help you to draw conclusions about the cause of any accuracy fluctuations.

**Formula for calculating the »accuracy«**

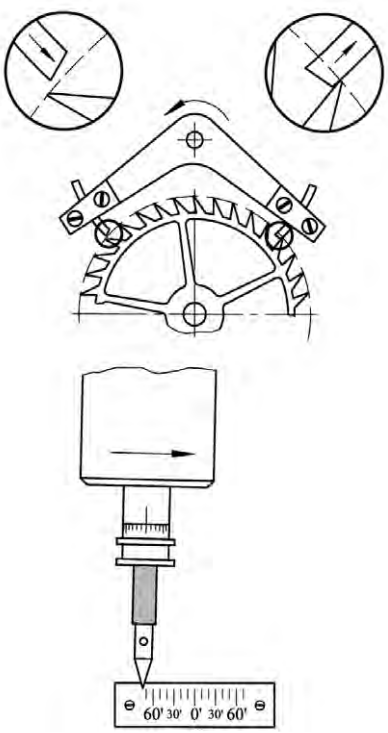
$$\frac{\text{Accuracy}}{\text{24 h}} = \frac{\text{Difference between the status}}{\text{Time difference}} \times 24$$

# Accuracy table

| Date | Time | Temperature | Air pressure | Amplitude | Status = difference in comparison to the official time in seconds | Difference between statuses from one recording to the next |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

| Time difference between the recordings in hours | Accuracy / 24 h in seconds | Comments |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

## FIGURE 3A

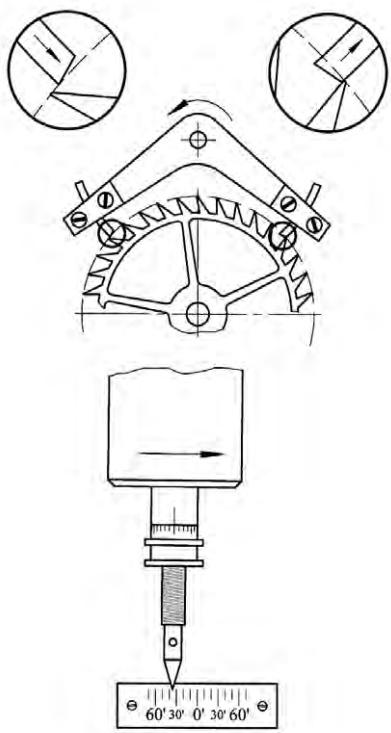



*Escape wheel:*
*Resting against the locking face of the entrance pallet and does not turn, i.e. is »locked«.*

*Pallet lever:*
*Following the movement of the pendulum.*

*Pendulum:*
*Is located at the left-hand inversion point at the start of the inward swing before release of the escape wheel.*

## FIGURE 3B



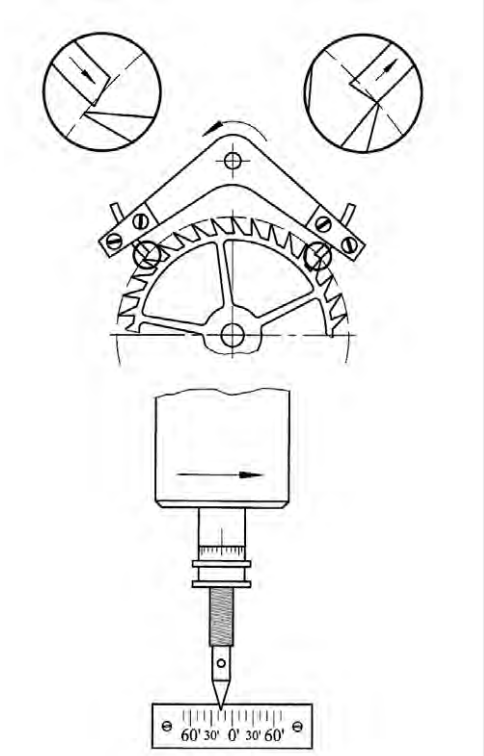

*Escape wheel:*
*Is locked.*

*Pallet lever:*
*Following the movement of the pendulum.*

*Pendulum:*
*Is at the end of the inward swing before release of the escape wheel.*

*Is at the start of the locking angle.*

## FIGURE 3C

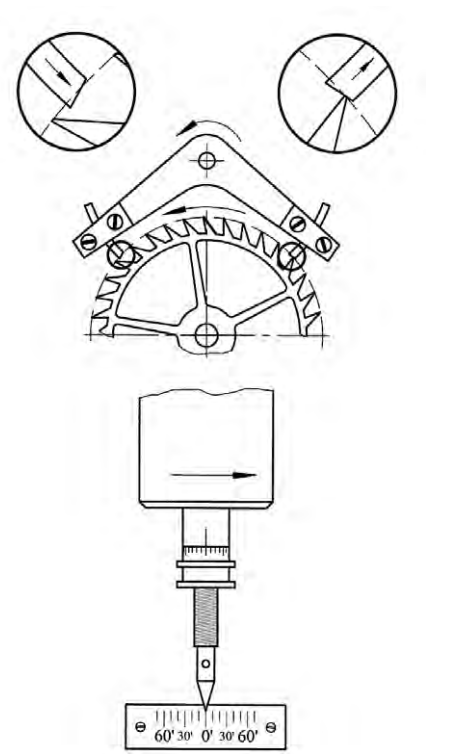



*Escape wheel:*
*Is still locked.*

*Pallet lever:*
*Following the movement of the pendulum.*

*Pendulum:*
*Is at the end of the locking angle.*

## FIGURE 3D

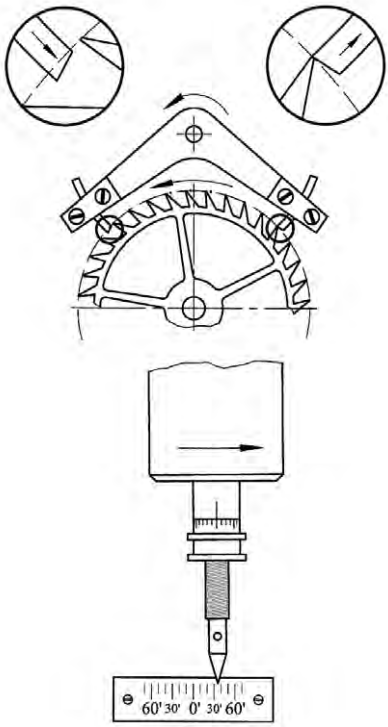



*Escape wheel:*
*Sliding over the pallet face of the entrance pallet, lifting the pallet lever, providing an impulse.*

*Pallet lever:*
*Transferring the impulse to the pendulum.*

*Pendulum:*
*Starting to receive the impulse (at the start of the lift angle).*

## FIGURE 3E

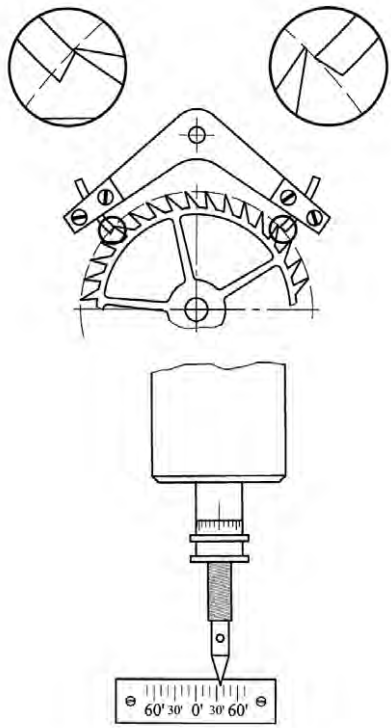



*Escape wheel:*
*Is at the end of the pallet face, finishing the drive impulse, about to start falling.*

*Pallet lever:*
*Finishing transferring the impulse.*

*Pendulum:*
*Finishing receiving the impulse.*

## FIGURE 3F

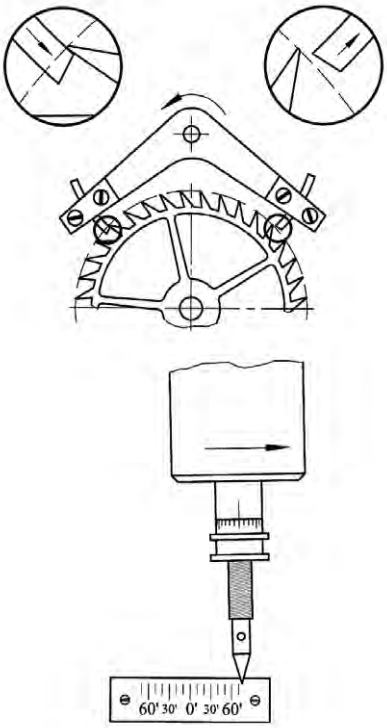



*Escape wheel:*
*Has finished falling.*
*Has just fallen from the pallet face and is now resting against the locking face of the exit pallet.*

*Pallet lever:*
*Following the movement of the pendulum.*

*Pendulum:*
*Has just finished receiving the impulse.*

**FIGURE 3G**




*Escape wheel:*
*Is locked.*

*Pallet lever:*
*Following the movement of the pendulum.*

*Pendulum:*
*Is finishing the outward swing.*


Bookmark & visual background for checking the escapement

(Page 59)

*Please cut at the dotted line*

*Kink here*

# TECHNICAL DATA OF THE MECHANICA M1
(Base clock kit)

## The movement

- Plates* of 4mm thick anodised* aluminium
- Gear train* completely bedded in 10 ball bearings*
- Hardened steel pinions*
- Very fine crossed out wheels, milled, polished and gold plated
- Graham escapement* with hardened, adjustable steel pallets
- Dial of anodised* aluminium
- Hands of steel, handmade and blued*

## The clock

- 30 days power reserve
- Achievable accuracy: +/- three to four seconds over the course of a month
- Driving weight made from tungsten*; 3000 g with pulley
- Case made from solid, untreated precious woods in cherry, walnut and black lacquered
- Case sealed against dust
- Hidden shelf integrated into the base of the case for accessories
- Pendulum cock and movement holding arrows screwed directly onto the back panel of the case
- Engraved plaque available on request at no extra charge with the signature of the customer


## The pendulum

- Pendulum rod made from heat-treated Invar*
- Solid pendulum cylinder* made from bronze*
- Temperature compensation
- Fine regulation table
- 5/6 pendulum

# MECANICA M1
# **Accessories**

To give you the opportunity to upgrade your Mechanica M1 technically and visually, various accessories were already considered during the planning of the kit. With the following extras you can individualize your Mechanica M1 in the areas of longevity, accuracy and appearance.

**UPGRADE KIT**

**ESCAPEMENT LEVER WITH AGATE PALLETS AND ESCAPEMENT WHEEL**

One option is to install an escapement lever with agate pallets. This reduces the escapement friction of the Mechanica M1. The scope of delivery includes a gold-plated escapement wheel with an adjusted, complete escapement.

**UPGRADE KIT**

**RUBIES FOR THE ESCAPEMENT LEVER BEARINGS**

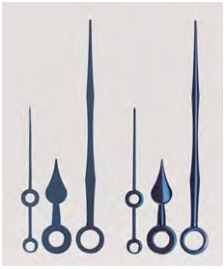
The longevity of the M1 can be enhanced with a set of rubies for the escapement lever bearings. The standard brass bushings will be replaced with non-wearing ruby bearings.

**UPGRADE KIT**

**PULLEY WITH BALL BEARINGS**

The ball-bearing rope pulley offers not only visual appeal but also two technical advantages: Its ball bearings do not wear and they keep frictional losses to a minimum, which improves the accuracy of the clock.

## UPGRADE KIT
### HAND-DOMED AND POLISHED HANDS
The hands " domed ", polished and blued in elaborate manual work, give the dial even more exclusivity.



## UPGRADE KIT
### BEVELLED MINERAL GLASSES
All three panes of glass have polished bevelled edges. It gives the case even more elegance.


## UPGRADE KIT
### BAROMETRIC INSTRUMENT
To compensate the negative influence of changing air pressure a barometric instrument with aneroids can be delivered. This upgrade is a must to increase the accuracy of your Mechanica.
This detail, which is also very visually attractive, is often ordered by Mechanica M1 lovers.

## UPGRADE KIT
### SATTLER VARNISH
Possibility to equip the case of the Mechanica M1 with a more exclusive surface.


**UPGRADE KIT**

**CERTIFICATED WEIGHTS FOR FINE REGULATION**

With the certificated set of twelve weights an even more exact fine regulation is possible.

**UPGRADE KIT**

**ADJUSTABLE PENDULUM SCALE**

The horizontally adjustable pendulum scale is characterized by its attractive appearance and allows the pendulum tip to be set precisely to the " point zero".«.

**UPGRADE KIT**

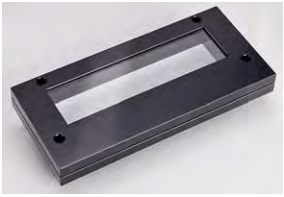
**PENDULUM LENSE**

A solid pendulum lense can be ordered as an optional extra for the pendulum. The fact that there is less air resistance means that the amplitude of oscillation, and consequently the rate, remain steadier. The lenses are numbered in sequence and can be fitted with the engraving either at the front or at the back. The lense is available in bronze or nickel finish.

**UPGRADE KIT**

**POLISHED CASE-HOLDING SCREWS**

A further detail to add an elegant appearance to your M1, are the four case fitting screws with polished and blued center and two polished movement fixing screws.



**UPGRADE KIT**

**GLASS WINDOW IN THE TOP OF THE CASE**

The integrated mineral glass on the top allows the movement to take the spotlight.

## UPGRADE KIT
### SET OF FINE-POLISHED SCREWS

4 gold-plated washers and 24 fine polished/fine turned stainless steel screws enhance the look of the movement.


## UPGRADE KIT
### REGULATOR DIAL

The design is similar to the classic precision clocks from the last century and comes very close to the actual Model Classica Secunda 1985 by Erwin Sattler.
The kit includes the dial, an intermediate plate, three additional wheels with a new counter-weight for the minute hand, a new hour, minute and a new second hand (the domed hands in the picture are another upgrade).



## UPGRADE KIT
### CUTAWAY IN THE NORMAL OR REGULATOR DIAL

The upgrade kit “cutaway in the regulator dial” can only be ordered in combination with the upgrade kit “regulator dial”.
The cutaway in the seconds subdial and the milling in the front plate of the movement allow a view of the gold-plated gear wheels and the Graham escapement. The upgrade set contains the dial with a cutaway and the milled-out front plate with its cutaway.

# MORE CLOCKS AVAILABLE AS KIT

MECHANICA M3

MECHANICA M4

**Precision pendulum clock Mechanica M3**
As constant progress and further development program, it was only a matter of time until the Mechanica M1 would be offered also in a seconds pendulum variant. The Mechanica M3 is also equipped with all technical quality features of the Erwin Sattler Classica Secunda 1985.

**5/7 precision pendulum clock Mechanica M4**
is in no way inferior to its great role models in terms of quality features. Some of the characteristic features are a temperature-compensated invar pendulum, hardened steel gears and milled, gold-plated wheels.

**Table clock Mechanica M5**
Now you can assemble your own precision table clock without any clockmaking skills. The use of ball bearings for the gear train and the use of innovative materials make assembly quick and easy. Your self-assembled Mechanica M5 will always reliably display the correct time..


MECHANICA M5

Model Classica Secunda 1985

The great model for your Mechanica M1 is the Classica Secunda 1985 precision seconds pendulum clock from the Erwin Sattler clock manufactory in Munich.

With its Classica Secunda 1985 model, Sattler is continuing the tradition of precision pendulum clockmaking in Germany. Clocks like this were used as scientific instruments up to the middle of the last century, and were engineered to perfection down to the last detail due to the importance of absolute precision.

With this in mind, the case, which is 142 cm high, 36 cm wide and 17 cm deep, is fitted with bevelled* glass panes on three sides and features lasting protection thanks to multiple coats of varnish. The hands are meticulously domed*, polished and then blued* by hand. They show the time precisely on the silver-plated regulator dial*.

The Invar pendulum compensates for changes in temperature and air pressure by changing the length of its pendulum, ensuring that it always swings at precise one-second intervals.

All components of the movement with a 30 day power reserve are finished to a first-class standard and refined by lacquering or gilding. The high degree of perfection of this precision pendulum clock is not only intended to ensure accuracy, but also to delight the observer with its delicate mechanics.

The Classica Secunda 1985 model shown here and all other models in the Sattler collection are of course not available as kits. These clocks are sold exclusively in selected clock retailers..

If you share our joy and enthusiasm for the fascinating world of clocks, we would be happy to send you the latest Erwin Sattler catalogue, including a list of retailers, free of charge.

MÜLLER & SATTLER UHRENBAUSATZ GMBH
Lohenstraße 6 · D - 82166 Gräfelfing
Phone: +49 (0)89 89 55 806-20
info@uhrenbausatz.de www.uhrenbausatz.de

UHRENBAUSATZ

Müller & Sattler Uhrenbausatz GmbH

Lohenstraße 6 · D - 82166 Gräfelfing · Germany

Tel.: +49 (0)89 / 89 55 806-20
Fax: +49 (0)89 / 89 55 806-28

e-mail: info@uhrenbausatz.de
www.uhrenbausatz.de