September 2020

HOROLOGICAL TIMES™

Clockwork Technology Meets Planetary Exploration

Physics of the Hairspring and Escapement, Part 1



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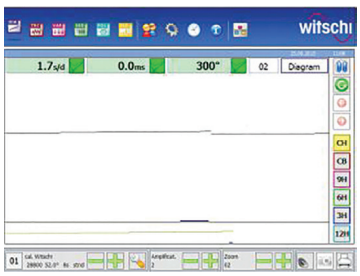


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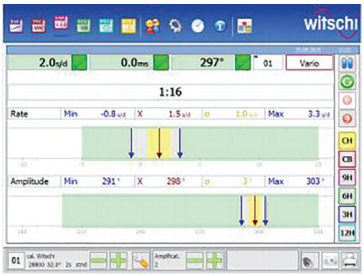
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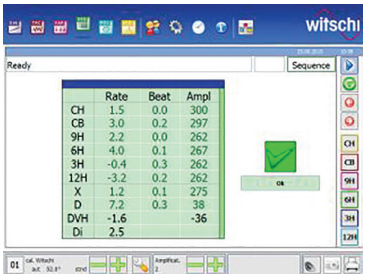
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Photo courtesy of NASA/JPL

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AWCI's vision is to have an educated and passionate horological community practicing the highest standards and with the resources to provide quality goods and services.

OUR MISSION:
Setting service standards and educating the horological community.

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a message from the president

AARON H. RECKSIEK, CW21



Aaron H. Recksiek
arecksiek@awci.com

AWCI is certainly not immune to the economic downturn that most people, businesses, and schools across the country and around the world are experiencing. When the pandemic started, the objective of the Board of Directors was to keep our entire valuable staff healthy while maintaining full pay plus benefits for as long as possible. The institute was closed due to local lockdown orders and classes were canceled. The hope of the board and staff, based on widely accepted scientific projections, was that the fallout would be short-lived, and things would return to normal during the summer months or possibly the fall.

We wanted our staff to remain reasonably productive, so we invested in online education like we never had before. The webinars have been largely beneficial and generally viewed as successful. We have also been developing and hosting some distance-learning courses with more direct virtual supervision from one of our instructors. New people have found the institute because of these new benefits, and I hope many of you have taken advantage of them as well. We plan to continue presenting webinars on a regularly scheduled basis, while improving our production skills. We invite you to keep up to date with the educational calendar to see what is coming. Thus far, most of these training webinars have been completely free to our members.

The *Horological Times* magazine has long been considered one of the best benefits of AWCI, according to our membership. We will continue to produce the same great content and are also reaching out to new, exciting, and talented authors to make the content even better.

Unfortunately, the virus has not subsided like we and many experts had hoped. The case numbers have continued to spike and fluctuate around the country and around the world, and the only predictable thing is that it remains unpredictable. Consequently, for the foreseeable future the Board of Directors has decided to be part of the solution instead of being part of the problem. It was a difficult decision to make.

Most in-person courses we teach at headquarters require people to travel by air and/or stay in hotels. This inevitably leads to a greater risk of exposure to the virus, possibly spreading the virus to people who did not elect to participate in our education, while also placing our staff and organization at risk. The board feels strongly about doing our part to help get the pandemic under control, while limiting the possibility of putting students, instructors, and essential workers at greater risk of exposure.

Let me assure you, we are not eliminating in-person education forever.

We have officially canceled the 2020 convention and will schedule the 2021 convention when the projections of the virus subsiding have become more predictable or there is a vaccine widely available. Most in-person courses in Harrison, Ohio, have been canceled except for a few that are scheduled in October (originally additions to the convention). Because conditions may improve by October, those courses will remain on the schedule until 30 days prior to their start date, when the board will evaluate the current state of the pandemic and make the decision to proceed with them or not. If you were signed up for the convention or any class that has been canceled, you should be receiving a refund from AWCI.

The mobile classroom will temporarily be placed in long-term storage. Its tight quarters and low air circulation do not lend themselves to the current public health crisis. It will remain an important part of the future of the organization to fulfill our educational mission. As soon as it looks safe to do so, we will schedule another nationwide tour of traveling education.

Let me assure you, we are not eliminating in-person education forever. We are looking at this situation as a re-prioritization of activities, and we are focusing on those we can do that aren't affected by the global pandemic. The Board of Directors are elected to be stewards of the institute on behalf of the membership. We have taken an oath to fulfill the mission

of the institute, "Setting Service Standards and Educating the Horological Community." We take this oath very seriously. We must also consider our finances, so that our institute remains available to future generations of horologists, while also considering our staff, families, and friends as well as our liability and social responsibility.

Due to these circumstances, the Board of Directors has made the incredibly difficult decision to lay off Tom Schomaker. Tom has been a vital part of AWCI over the years, and we don't take this decision lightly. We have evaluated our finances repeatedly and have been unable to put together a scenario where we can compensate Tom as he deserves without putting the future financial stability of the organization at risk. We feel Tom is an exceptional watchmaking instructor, and we hope he will consider teaching classes for the institute from time to time. We certainly wish him all the best in the next chapter of his career.

Some people have suggested that we use money from our perpetuation fund to keep all operations of the institute as undisturbed as possible. That endowment money does not belong to any of us directly; it is not our money to spend. The policy that was developed long ago was written to allow us to use a portion of the income towards our operating budget. The perpetuation fund is governed by a separate board of trustees for that specific reason. There has been a longstanding policy to avoid depletion of the principal of the fund, even when times are tough. That money ensures that the organization will continue to exist well into the future—far beyond our current staff and board.

The institute is facing a challenge unlike anything it has ever faced.

The institute is facing a challenge unlike anything it has ever faced, and never in my history of involvement with the institute have the decisions been so difficult.

If you have any comments, questions, or just want to voice your opinion, you can reach me by email at aaron@awci.com or by phone at 513-462-0588. Feel free to reach out to the entire Board of Directors via email at awciboard@awci.com. Please take care of yourself and your family and stay safe.

Very best regards,

Aaron Recksiek, President

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AWCI Board Meetings
Open to All Members!

All members are invited to participate in the monthly conference calls of the Board of Directors. The meeting will be streamed live using the GoToWebinar format, which will allow all interested AWCI members to participate.

To participate in the next meeting you will need to register at least 24 hours in advance. You will need to have your AWCI member number available.

After you register, we will verify your membership. The morning of the call you will receive an email with instructions to join the call.

You will be able to listen to the entire meeting. At certain times during the meeting your feedback may be requested, and you will be able to briefly share your thoughts by using the "raise your hand" button in the platform. The experience will be very limited for individuals who call in on the phone without logging in on their computer.



AWCI educational calendar

Check out AWCI's complete line of courses for watchmakers and clockmakers!

AWCI will not be holding classes in Harrison, Ohio, or on its mobile classroom until projections of the virus subsiding have become more predictable or there is a vaccine widely available. In the meantime, we invite you to browse our **course catalog**, **www.awci.com/course-catalog**, which offers 46 classes for watchmakers, including classes for beginners, technicians, and, of course, experienced watchmakers who want to sharpen their skills.

In the catalog, you'll find classes on

- Introduction to Watchmaking
- Quartz
- Vintage Watch Repair
- Tool Making
- Precision Timing

We also have 46 classes for clockmakers, including classes on

- American Time-and-Strike Movement
- Advanced Clock Repair
- Introduction to the Lathe

See our catalog for more!

We can use your help

We are always looking to expand our course catalog and educational resources as well as increase our team of instructors. During this downtime, we want to develop new courses and find new instructors who will collaborate with us. Reach out to us at education @awci.com if there is a class you would like to collaborate on as an instructor.

We look forward to receiving your class requests when the pandemic is under control, and we hope to have a new list of classes to offer.



Because of COVID-19, we are not certain if these classes will be held. However, since conditions may improve by October, these courses will remain on the schedule until 30 days prior to their start date. The board will then evaluate the current state of the pandemic and make the decision to proceed with them or not. If you were signed up for the convention or any class that has been canceled, you should be receiving a refund from AWCI.

October 5-7

Herschede Tubular Bell Clocks SOLD OUT
Instructor: Michael Gainey, CC21
AWCI Headquarters, Harrison, Ohio

$595

Michael will share his knowledge gained from 40 years of experience through his extensive PowerPoint presentation with over 200 photos focusing on examples of issues before and after a rebuild that are unique to most common Herschede Tubular Bell movements.

October 11-13

Practical Gear Cutting for the Horologist SOLD OUT
Instructor: David Lindow
AWCI Headquarters, Harrison, Ohio

$595

Come to AWCI after our convention for this practical, hands-on class where gearing and gear cutting will be practiced. Not only will the student learn the basic setups involved in cutting horological gears, but multiple approaches to tooling will be explored as well as theory from a practical standpoint.

October 5-7

WATCH 420S:
Vintage Chronograph Short Course SOLD OUT
Instructor: Bernhard Stoeber, CW21
AWCI Headquarters, Harrison, Ohio

$595

Back by popular demand. In this course, you will go through, theoretically and practically, different vintage chronograph calibers with emphasis on trouble-shooting, repair, and adjustments to each mechanism. Lemania, Landeron, and Valjoux calibers will be covered.



https://www.awci.com/webinars

Free/discounted webinars for AWCI members!

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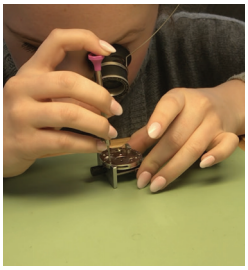
Stay involved, sharpen your skills, ask questions, and so much more!

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Send your suggestions to awci@awci.com!

For additional details about specific courses in comprehensive syllabi form, including complete tool lists, visit: **www.awci.com/classes** or contact the education director, Jason Champion, CW21, at 866-FOR-AWCI (367-2924), ext. 303. For additional calendar events visit: **www.awci.com/calendar**.

AWCI events calendar 2020






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Explore the Resources You Need to Succeed



AWCI

Clockwork Technology Meets Planetary Exploration

By Evan Hilgemann and Jonathan Sauder

Humans have long been fascinated by mechanical automata. In Greek mythology, Hephaestus, the god of blacksmiths and master craftsman of Olympus, created a large humanoid automaton named Talos to guard Crete. The Greeks themselves produced the Antikythera mechanism, the earliest known example of a mechanical computer.[1] In the 15th century, Leonardo da Vinci became famous for his various automatic devices.

But it wasn't until World War II that mechanical computing devices reached a zenith with the advent of mechanical fire-control computers[2] before the transistor was invented in the 1950s. Accordingly, modern spacecraft feature a dizzying array of computers, controllers, sensors, and other electrical components. But even the hardiest of these components cannot survive in one of the most extreme environments in the solar system: the surface of Venus.

Long referred to as Earth's sister planet due to its similar size and location in the solar system, Venus is a much more perilous world. The surface is an extraordinary 860°F, hot enough to melt lead, while the atmospheric pressure is 92 times that of Earth, high enough to crush a nuclear submarine. In the history of space exploration, only a handful of Soviet spacecraft have ever landed safely on the surface of Venus. Each spacecraft featured a large pressure vessel that kept sensitive electronics insulated from the Venetian atmosphere for a couple of hours, just long enough to send data back to Earth. Current mission proposals would only survive for up to 24 hours, despite using state-of-the-art technology. To enable long-term exploration of this exotic world, a return to age-old technologies may be in order.

The Automaton Rover for Extreme Environments

The Automaton Rover for Extreme Environments[3] (AREE), Figure 1, is a concept to enable long-term exploration of the surface of Venus. AREE replaces vulnerable electronics with more robust mechanical systems. For example, on Venus power can be

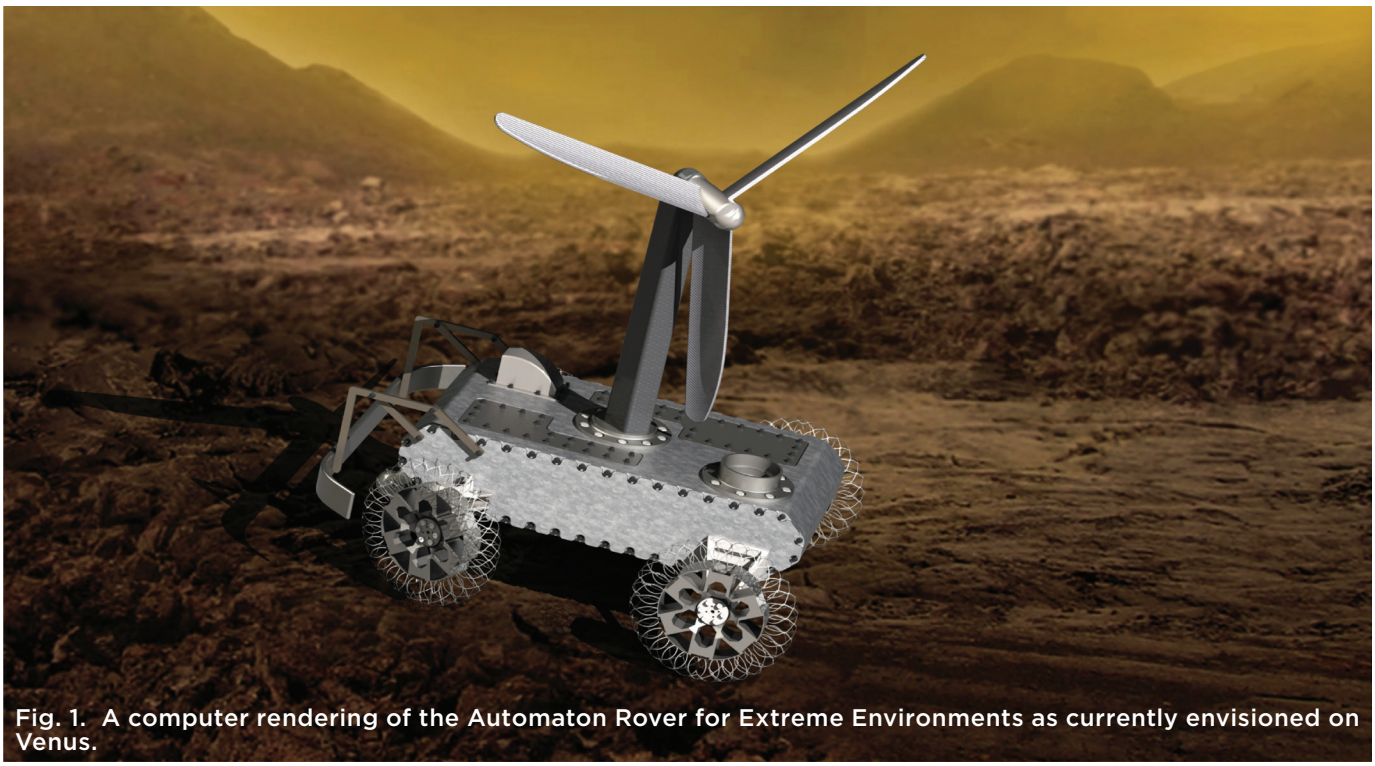


Fig. 1. A computer rendering of the Automaton Rover for Extreme Environments as currently envisioned on Venus.

generated from the dense wind using a turbine, energy stored in springs, and motion transmitted to wheels using gearboxes. Basic mechanical computing and sensing, similar to the mechanical fire-control computers of the 1940s, would be used to direct the rover. High-temperature electronics, although not eliminated, are used sparingly due to their low computing capabilities. In short, AREE enables the exploration of Venus by utilizing clever mechanism design where it makes sense, and high-temperature electronics where the technology is mature enough.

To take AREE from concept to reality, basic functionality must first be proven on a small scale. For AREE that means demonstrating complex mechanisms operating at Venus conditions. There are precious few examples of this in history. Some Soviet landers carried sample collection devices, but the design details for those missions have been lost to history. More recently, HoneyBee Robotics has successfully built electric motors and gearboxes for a Venus drill.[4] However, no one has ever attempted to build a device as complex as a fully integrated rover, and starting with a mechanical clock provides an ideal proving ground.

The Venus Clock

A clock requires use of basic mechanisms such as springs, gears, and bearings, and is therefore a useful precursor to more complex devices. Furthermore, some sort of clock or timing device would be required on an actual Venus rover to synchronize actions of the rover and regulate power. At this early stage, though, the goal is simple: demonstrate that a clock can run at 860°F, build confidence in the AREE concept, and gain experience in building high-temperature mechanisms.

Materials

Everything must be built out of something, so material selections was an early priority for the Venus clock. Fortunately, many options exist. Special alloys of steel are used in jet engines and power generation turbines that can withstand temperatures in excess of the surface of Venus. Other metals, like tungsten, have a melting temperature of over 6,000°F, and there are heat-resistant ceramics that survive temperatures even higher than that. Unfortunately, none of those are affordable with a limited research budget. More common metals like aluminum are too soft and would nearly melt on Venus, but titanium and stainless-steel alloys are a compelling middle ground: they have high melting temperatures but are also readily available. For this reason, all structural components on the Venus clock are made from 300-series stainless steel.

Springs

A spring powers the Venus clock much as one would power AREE. Springs store energy through elastic deformation, which means the spring material can return to its original shape and is not permanently bent. Many metals act as springs at room temperature. However, at higher temperatures temporary elastic deformation becomes permanent, energy is dissipated, and the metal is no longer a very good spring! Put another way, metals have a tendency to take a "set" at high temperatures. One of the big surprises in this project was just how easily that happens. Common high-temperature metals like stainless steel and titanium showed permanent deformation even when bent to only 10% of the yield strength (the point at which the metal is permanently deformed) and heated to Venus temperatures. More specialized alloys were investigated, and a nickel-chromium-iron alloy called Inconel 718 showed adequate performance at temperature. Inconel was selected as the spring material but necessitated the procurement of an expensive custom spring.

The final power spring had an outside diameter of 3.25", an arbor diameter of 0.5", provided an average torque of 2.5 in-lbs, and had 27 turns. These numbers were selected to match the performance of other steel springs in testing and to maximize the life of the clock in the oven, since there is no way to wind it while in a test chamber. The spring is fixed on the outer end and attached to a rotating shaft on the inner end.

Bearings/Bushings

Like most mechanisms, clocks feature several rotating shafts. In the Venus clock, all shafts are oriented vertically. The weight of each shaft is simply supported on a point at the end of the shaft. This method was influenced by jeweled bearings which mitigate friction through reduction of contact area. The shafts are stabilized with bushings made from Graphalloy, a self-lubricating graphite-metal alloy designed for use in furnaces.

Clock Assembly

Mechanical clocks today are typically made of small, precise components. The Venus clock is not a typical clock. The device must operate over a wide span of temperatures and be fabricated from custom components with a tight budget in mind. These concerns are addressed by using larger components with relatively loose tolerances. That way, small differences in thermal expansion are less likely to cause the mechanism to bind. By loosening tolerances, cheaper fabrication methods can be used as well. Most Venus clock components were cut from sheet metal with a waterjet. Only the escapement and pallet were CNC machined. The clock is relatively large, with dimensions of 7" x 7" x 4", due to the manufacturing methods used.

The basic layout of the clock is shown in Figure 2. The Inconel power spring sits on top and drives a gear train. The escapement is a simple pin-pallet design, known to be robust to manufacturing errors if not particularly precise. Historically, pin-pallets are relatively inexpensive and were a staple in low-end watches until quartz technology filled the niche. Finally, the balance wheel meters the escapement by using another Inconel spring. This balance spring is a simple strip of metal that engages a pin on the outside of the wheel.

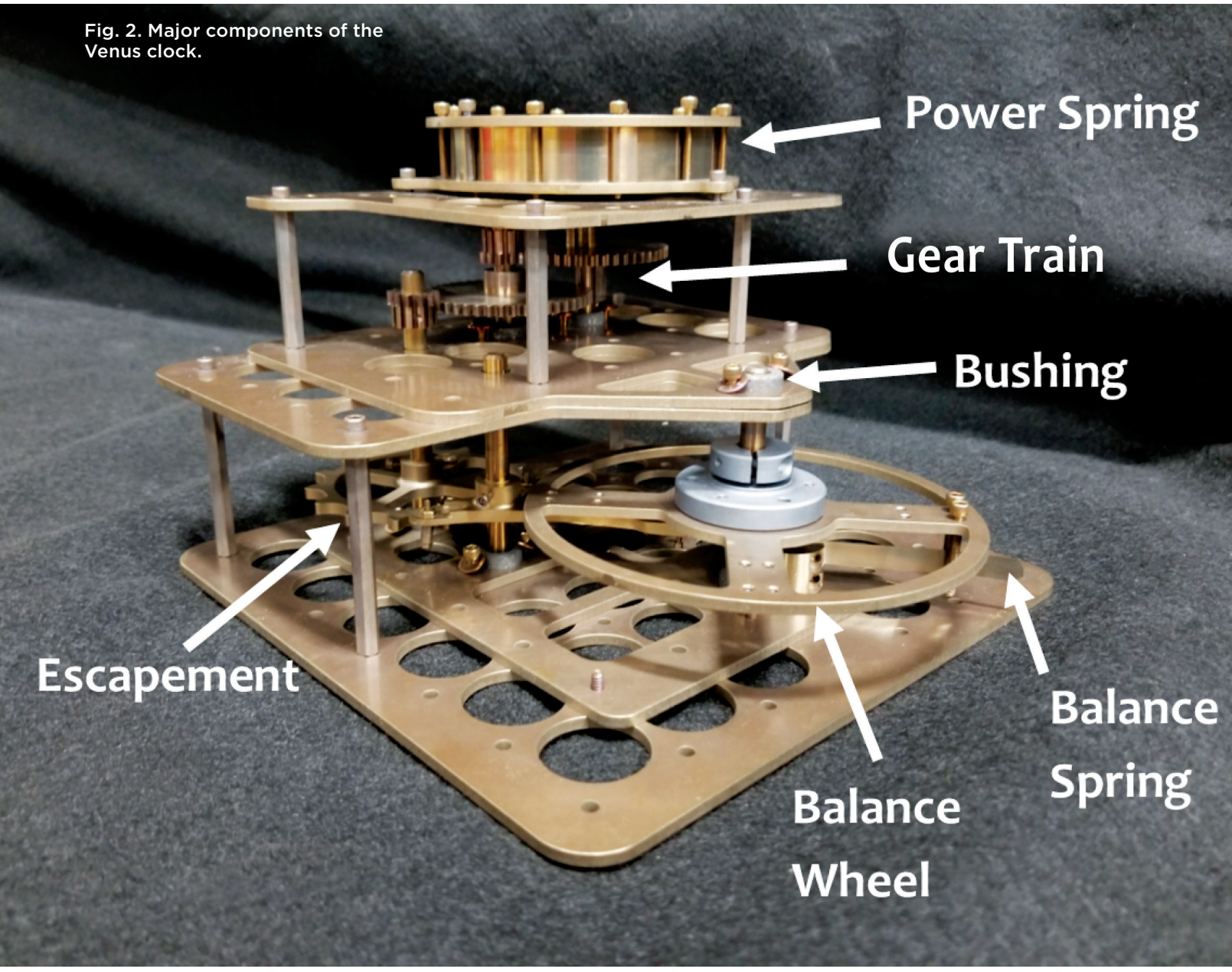
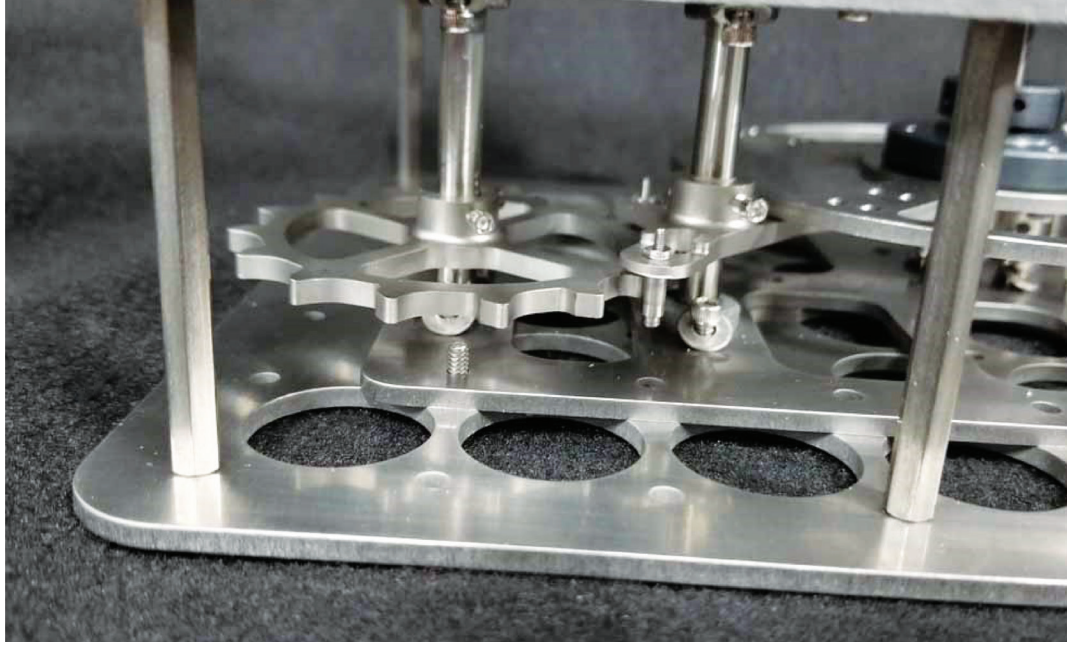


Fig. 2. Major components of the Venus clock.

Fig. 3. The escapement, specifically the escape wheel and pallet, before testing. Note the parts before testing do not have the patina seen in the post-tested clock in Figure 2.



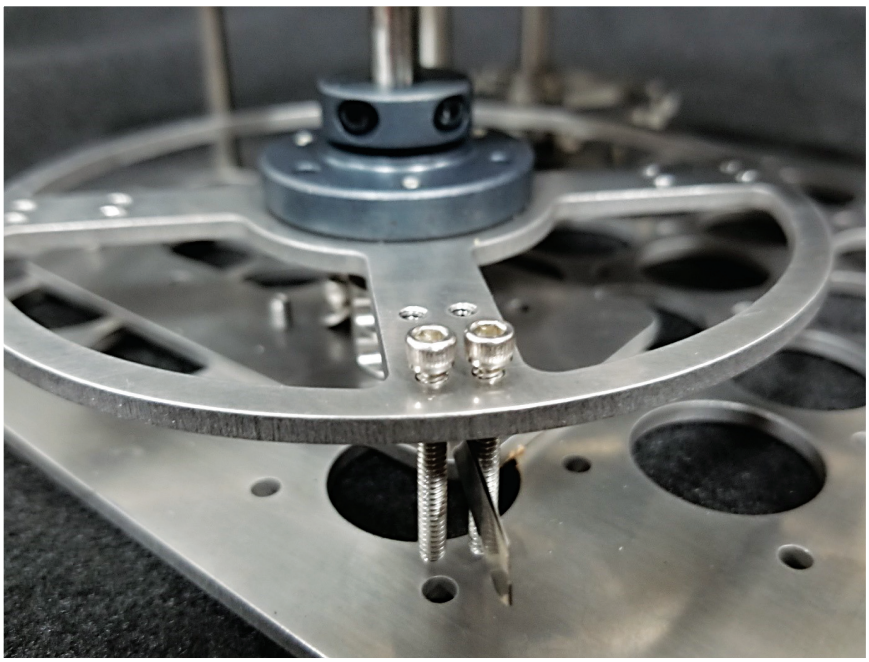
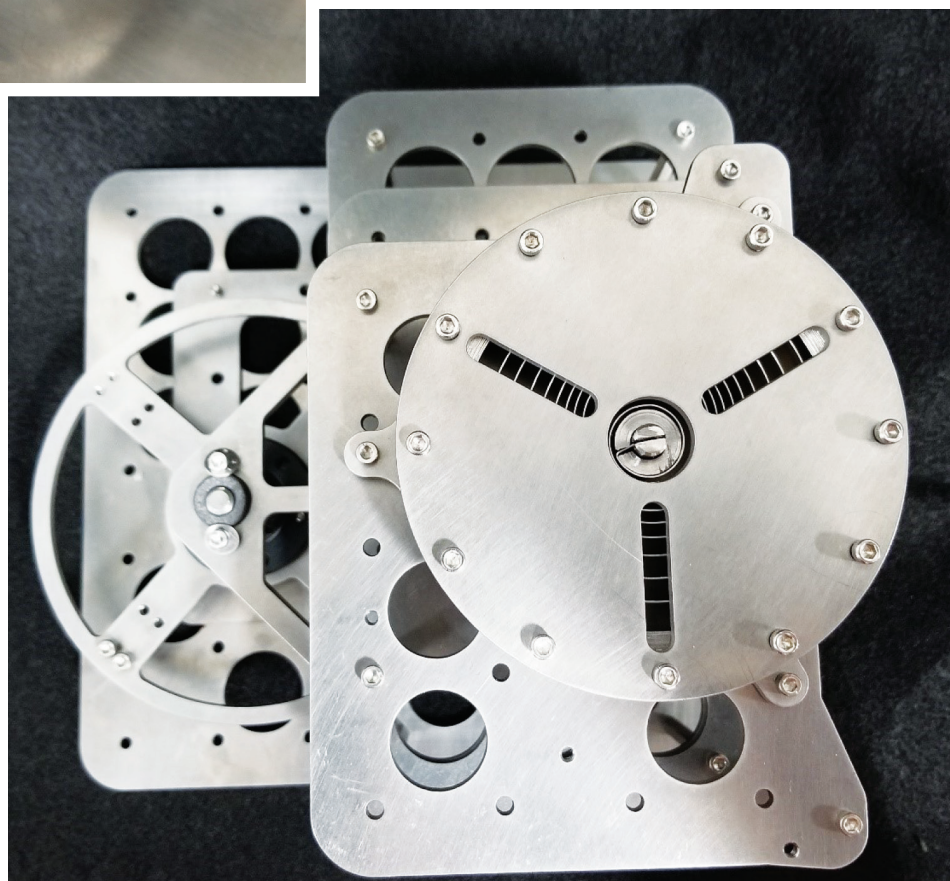


Fig. 4. The balance wheel.

Fig. 5. The mainspring barrel assembly with the coiled mainspring visible in the three slots.



Testing and Results

In the spirit of the design-build-test-repeat methodology, multiple iterations of the clock were constructed before coming to a final design. Early versions were made from laser-cut acrylic plastic and 3-D-printed components to verify the design. After graduating to metal, testing occurred in a small oven that reached Venus temperature but not pressure. Initial results were promising but revealed some issues. Most notably, there was significantly more friction in the gear train after exposure to high temperatures than before, but the clock returned to its original performance after it was disassembled and put back together. Although the specific cause of this issue hasn't yet been verified, a possible explanation is that the high temperature evaporated off any oils or other lubricating contaminates that could have reduced friction. There also could have been some other chemical or molecular change on the surface of the stainless steel. The problem was addressed by decreasing the gear ratio between the spring and escapement, thereby delivering more power to overcome friction but reducing the spring life.

After all the iterations and troubleshooting, the Venus clock did indeed operate at 860°F, fulfilling the initial design goal. Just as importantly, it provided a base of experience with which to go after a more ambitious project: an actual rover capable of roving in a Venusian environment.

The Rover

Applying lessons learned from the Venus clock, designs were made for a simple benchtop scale rover that could move forward, sense an obstacle with a bumper, and reverse direction, all at the surface temperature of Venus. AREE will not have cameras or sensors typical of mobile robots; these electronics would not survive the extreme environment. Instead, AREE senses obstacles by simply bumping into them with a mechanical sensor, causing the rover to reverse and find a new path forward. The benchtop rover mimics this process.

The clock and rover share the same power spring and are both made of 300-series stainless steel, but the similarities largely end there. The power springs on the rover are mounted horizontally, releasing power into a planetary gearbox and then into the wheels. The planetary gearbox incorporates a reversing mechanism that triggers when the bumper is contacted. Also, instead of using bushings, the rover incorporates full ceramic ball bearings.

The planetary gearbox is configured such that when the rover moves forward, power is transmitted from the Sun gear (the input) to the ring (the output) through stationary planets gears. This is a typical configuration for a planetary gearbox and causes the output to spin in the opposite of the input. When the bumper is depressed, all three components are effectively locked together and forced to rotate as one. The output now

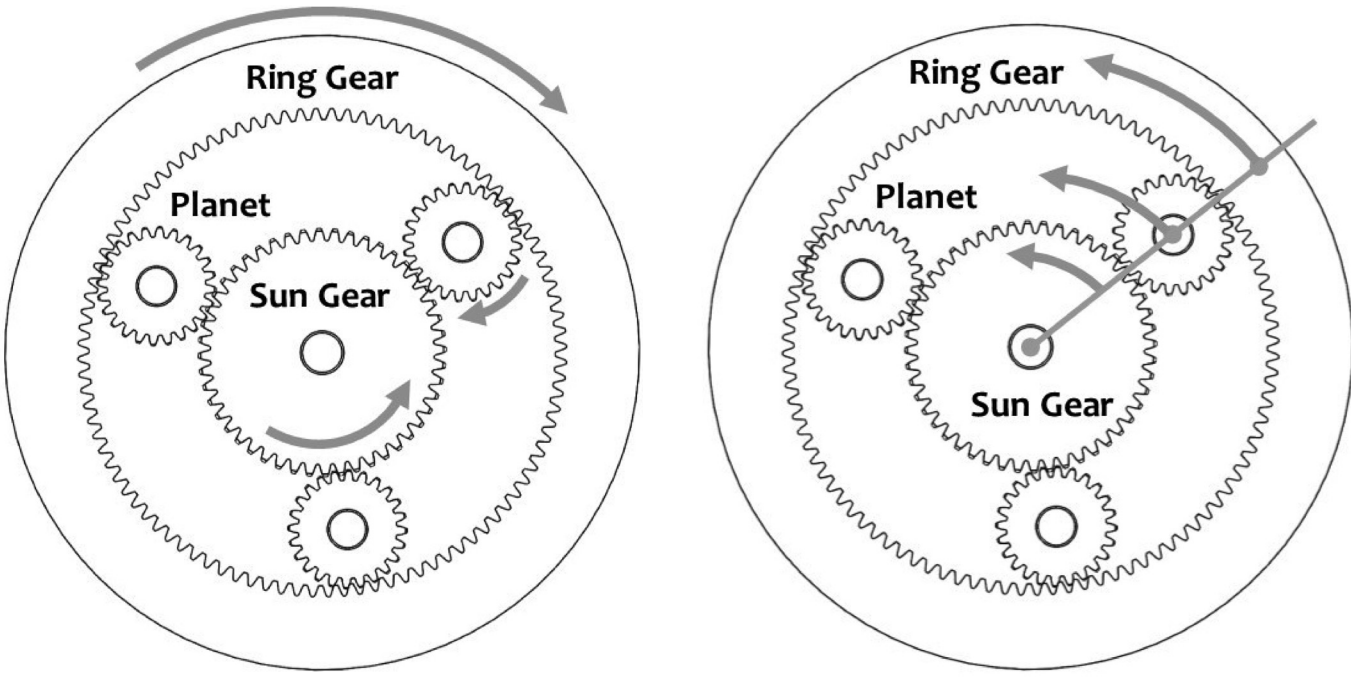


Fig. 6. (Left) The planetary gear configuration when the rover moves in the forward direction. The planets are fixed in space, and the ring moves in the opposite direction of the Sun. (Right) When the rover reverses, all three components are effectively fixed together and rotate in unison around the central axis.

spins in the same direction as the input, and the drive direction of the rover is reversed. See the diagrams in Figure 6. After one revolution of the gearbox, the system resets itself and the rover moves forward again. The completed gearbox assembly is shown in Figure 7.

The rover, Figure 8, is about 2' long and only 4" wide. The form factor was dictated by the Venus test chamber, which is 8' long and 12" in diameter, allowing the rover to roll along its considerable length.

During the test, the rover was held in place with a pin jamming the spokes on the rear wheel. When the test temperature was obtained, the pin was pulled using a wire protruding out of the chamber. The rover then successfully moved down the chamber,

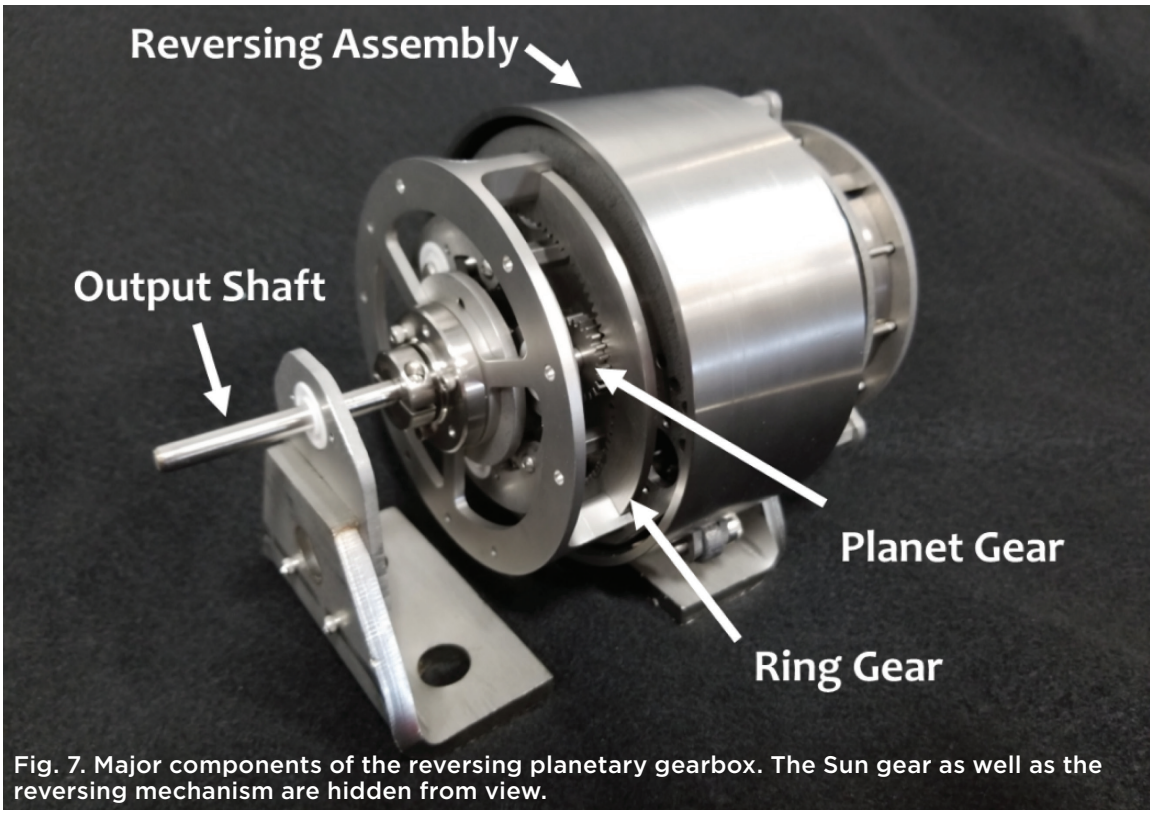


Fig. 7. Major components of the reversing planetary gearbox. The Sun gear as well as the reversing mechanism are hidden from view.

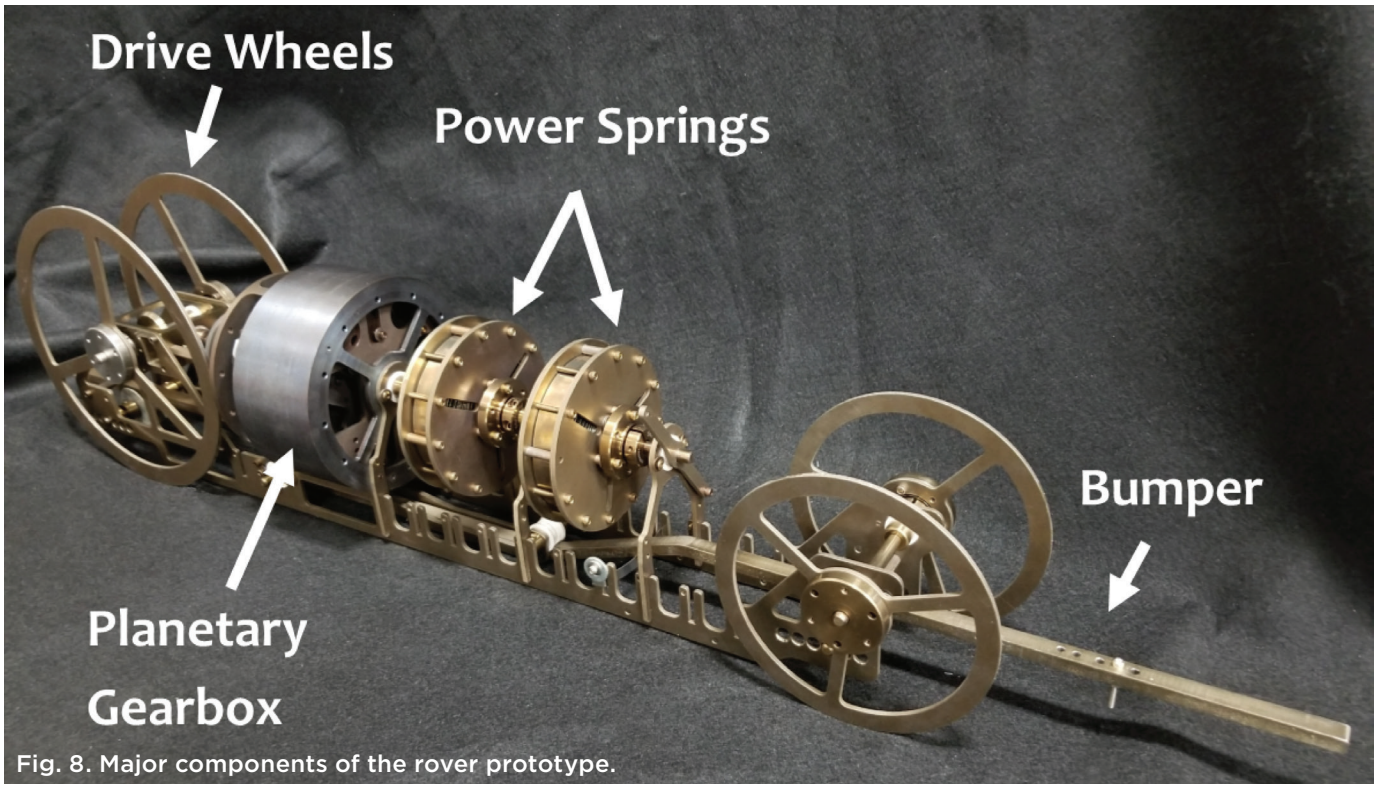


Fig. 8. Major components of the rover prototype.

contacted the end wall, and reversed direction. Figure 9 shows an image of the rover in the Venus chamber during a test that was performed only at Venus temperature. Note that the rover is in motion as evidenced by motion blur in the gearbox.



Fig. 9. The benchtop test rover inside the Venus test chamber during a test. The rover was in motion when this picture was taken as evidenced by the motion blur on the rear of the gearbox. A video of this test is available on YouTube.[5]

Conclusions

Traditional spacecraft often take decades to go from the drawing board to landing on another world and AREE is no exception. This development of a high-temperature clock and rover has been immensely successful and sets the stage for more ambitious projects which, with a lot of hard work and some luck, may lead to the surface of Venus. At its core, AREE is a paradigm shifting idea. The concept forces individuals to reconsider what a spacecraft must look like and opens the door to more innovative uses of mechanical systems across the solar system. In this light, it is exciting to consider Leonardo da Vinci's designs for helicopters, tanks, and even a small autonomous cart, and how his ideas continue to influence innovation today.

Acknowledgements

We would like to thank the AREE interns Tonya Beatty, Sean Dunphy, and Andre Shahinian who worked tirelessly in the lab to bring these ideas to reality, as well as Nicholas Manousos and Kiran Shekar of the HSNY for providing input on the mechanical design. Countless others at NASA/JPL contributed ideas and motivation to this project, for which we are grateful. This work was funded by the NASA Innovative and Advanced Concepts (NIAC) program, which funds early-stage transformative concepts for space exploration. All photos courtesy of NASA/JPL.

Notes and Further Reading

1. There is plenty of accessible information on the Internet about the Antikythera mechanism. For more of an academic treatment see: Tony Freeth, et al. "Decoding the Ancient Greek Astronomical Calculator Known as the Antikythera Mechanism," *Nature* 444, Nov. 2006, pp. 587-591.
2. For a full discussion on various mechanisms that can be used as computing devices, see "Computing Mechanisms and Linkages" by Anthony Svoboda. An entertaining US Navy training film is also available on YouTube under "Mechanical Computer—Basic Mechanisms in Fire Control Computers": https://www.youtube.com/watch?v=s1i-dnAH9Y4&t=2180s.
3. For a more complete discussion on AREE, see the Phase 1 NIAC Report which is freely available online: Sauder, J. Hilgemann, E., et al. "Automaton Rover for Extreme Environments."
4. Kris Zacny's paper, "Development of a Venus Drill," covers both the history of the Soviet drilling efforts and HoneyBee's recent efforts. A more easily accessed history can be found on Don Mitchell's excellently researched website: http://mentallandscape.com/V_Venera11.htm.
5. See https://youtu.be/CQRIj-IRiQQ for a video of the high-temperature test.

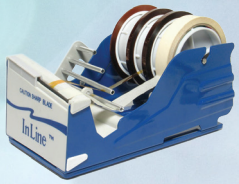
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Jonathan Sauder is a mechatronics engineer at NASA's Jet Propulsion Laboratory and was the primary-Investigator on the Automaton Rover for Extreme Environments project.

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The Smithsonian Magazine *ranked Columbia, PA, among the top 20 best small towns to visit in the United States, in part, because of its strength in history.*

The National Watch & Clock Museum provides a wealth of information about the art and science of timekeeping. When you can't visit the museum, check out the webinars and podcasts about horology for everyone who loves watches, clocks, and all things to do with keeping time. Listen on Spotify, iTunes, and Sound Cloud.

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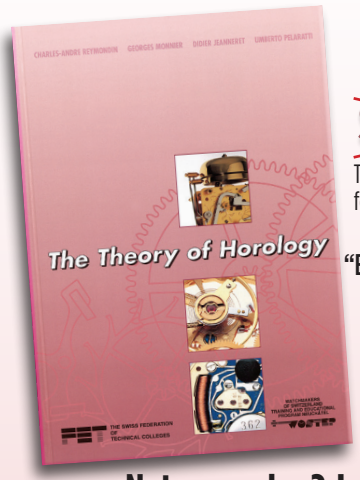
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Physics of the Hairspring and Escapement
Part 1

Previously published in *Horological Times*, June 2007



By Dr. Matthew Clark

Watchmaking has come a long way in the 400+ years since Robert Hooke invented the hairspring and Christiaan Huygens installed it in a watch. Escapement technology has also blossomed into a niche that sets certain calibers apart as watchmakers seek mechanical means to achieve true isochronism. The lever escapement in particular is still widely used after being so finely tuned since Thomas Mudge invented it in the late 1700s. Given its long history, core principles of the applied technology still hold true today. Knowing these principles can assist the practicing watchmaker in diagnosis of less-than-ideal timing issues and help to fine-tune a watch's regulating organ to its utmost potential.

This two-part series by Dr. Matthew Clark deftly explains the hairspring and lever escapement's theoretical function and failings in modern watches. Review this old, but still relevant, technology to again familiarize yourself with how mechanical technology is used in these tiny machines to achieve great precision.

~Andrew DeKeyser, CW21

The use of the spiral hairspring with a balance wheel as a method of timekeeping has proven to provide robust and accurate time since its inception by Dr. Hooke in 1610. Various methods of giving impulse to the balance wheel were developed—the verge, cylinder, lever, and chronometer escapements—but all rely on the harmonic motion of a balance wheel and spiral hairspring for keeping time.

The hairspring provides a smooth restoring force that is proportional to the angular movement of the balance wheel; the more the wheel turns from its center position, the higher the force the spring pushes the wheel back to its initial position. This principle allows the balance wheel to oscillate back and forth with nearly constant frequency. The speed of the oscillation is determined by the mass of the balance wheel and the stiffness of the spring by well-known formulas.

The timekeeping deficiencies of the flat spiral hairspring were soon apparent. The flat hairspring does not vibrate with the same period at low and high amplitudes of the balance wheel when the spring is fully wound and nearly run out. This error, isochronism, vexed watchmakers until the development of the overcoil hairspring.

The mathematics of the hairspring were intensely studied at the turn of the century by horologists such as Grossman, Phillips, Lossier, Airy, and others. They applied calculus to the hairspring to compute its properties. Unfortunately, even today there are no simple equations that describe the motion of the hairspring and balance wheel. Unfortunately, the motions are too complex for such analysis. Fortunately, we have a tool unavailable to the horologists of the 19th century—the computer.

Using simulation techniques well known to engineers, nearly all aspects of hairsprings can be simulated, taking into account the shape, stiffness, weight, as well as pivot friction, air resistance, and internal friction in the spring. The model also allows the effect of gravity to be factored in to allow computation of positional timing.

The simulation is based on the formulas provided by Hooke and Newton to calculate the movement of both the balance wheel and the hairspring. The computations, known in engineering as the method of finite differences, involves computing the position and forces on the spring and balance wheel in time slices every microsecond. The impulse of the pallet

fork on the balance wheel is simulated to accurately represent the increase in energy as the balance wheel rotates. This time-consuming simulation was run to simulate 10 seconds of running time, and then the results were analyzed.

Simulation has the advantage that it is not complicated by faults in the watch movement or escapement and can provide insights that are difficult to evaluate in an actual movement. The computations and comparison with measurements show that calculated isochronism[1] and positional timing agree with general observations made by horologists in the past. However, there were several discrepancies between the calculated optimal hairspring configuration and the configurations in common use today. One of the most intriguing is the optimal pinning angle of the hairspring. The pinning angle is defined by three points: the point at which the hairspring leaves the collet, the center of the balance staff, and the point where the curb pins hold the hairspring. While calculations by Lossier, Woodward, myself, and others suggested that a 90° pinning angle was optimal, nearly all Swiss lever movement watches are manufactured with a 0° pinning angle. The reason for this, which is the effect of the energy required to unlock the escapement, can be demonstrated through calculations. In addition, the effect of other escapement features, such as the spacing of the curb pins, the common configuration of the outer coil on flat hairsprings, and the effect of locking energy are explored.

Methods

To study the details of hairspring motion and vibration, a computer program was written that solves the Newtonian equations of motion for a hairspring connected to a collet. This program takes into account air friction, internal spring friction, pivot friction, the position of curb pins, the spacing between the curb pins, and, of course, the shape of the hairspring. The positions of the spring are computed every microsecond, taking about four hours per computation of each point.

Wherever possible, the theory is compared to rates measured on actual watches. This is more challenging than it first appears because as the watch runs down, the ticks become very faint, and measuring rate and balance wheel amplitude becomes very difficult.

Escapement Review

Although the lever escapement is well known, and there are many texts on the subject, we will review the escapement from the balance wheel's point of view.

The first event is the unlocking of the escapement, shown in Figure 1. At about 26° before center, the impulse jewel strikes the fork slot of the pallet fork. Until this time, the balance runs free of interaction with the escapement. The unlocking requires that some energy is transferred to the pallet fork to overcome the draw of the escapement and also move the escape wheel backwards in slight recoil.

The next event is the impulse. This occurs when the tooth of the escape wheel pushes the pallet fork so that the fork slot impacts the impulse jewel and provides energy to the balance wheel. As Figure 2 shows, this is normally when the impulse jewel is aligned with the balance staff center and the pivot of the pallet fork. However, the impulse can be given before or after center, depending on the configuration of the escapement. While a hammer-like impact is desirable, the fork may push the pin and remain in contact until it is free from the fork, or as Carl Anderson once described, the pin may actually strike the fork hard enough to accelerate the fork so that it is struck by the opposite side of the fork.[2] The balance wheel is accelerating until it reaches the dead center position where it has maximum angular velocity. The fork must move even faster than the impulse jewel at this point, so cleanliness and quality of oil on the pallet stones is of utmost importance.

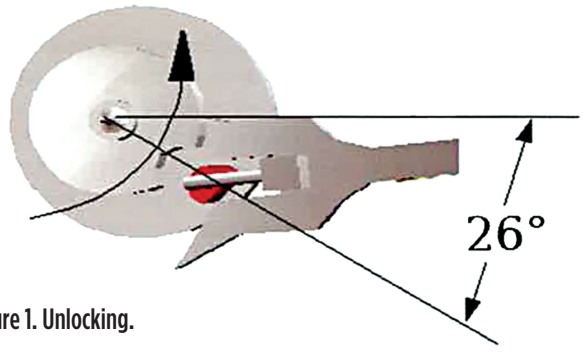


Figure 1. Unlocking.



Figure 2. Impulse.

The third event does not actually affect the balance but involves the escape wheel and pallet fork. During the rest of the travel of the pallet fork, it is not in contact with the balance wheel. At about 26° after center, the impulse jewel leaves the slot of the pallet fork, as shown in Figure 3. At this time, the escape wheel strikes the pallet jewel to make the characteristic locking sound. The total angle between locking and unlocking, normally 52°, is the "lift angle." The actual lift angle may vary, however, based on the make of the watch and the adjustment of the escapement.

The oscillograph in Figure 4 illustrates this sequence by the sounds. The impulse sound, near the central marker defines the 0° position from Figure 2. The unlocking is at 26° before this point, and the locking sound is 26° after this point. The angle of the balance wheel changes linearly with time in this region, making the graphical analysis accurate to 1% or better. Most timing machines will compute the balance amplitude from the average time interval between the unlocking and locking sounds[3]; however, the nature of the sound waveforms for various watches can make it difficult to accurately measure this gap.

Effect of the Pinning Angle

The pinning angle of a hairspring is the angle between the point at which the hairspring leaves the collet, the center of the balance staff, and the point at which the curb pins contact the hairspring. It has long been known that the pinning angle has a strong effect on the ability to keep time as the mainspring power runs out and the balance wheel amplitude decreases. In the model hairspring shown in Figure 5, the inner coil is at the Y axis, and the curb pins are generally aligned with this point to prove a 0° pinning angle in modern watches. However, previous analysis over the last century, including the original work of Lossier, and later Woodward and Clark, have always shown that the optimal isochronism is provided with a pinning angle of approximately 90° for a hairspring independent of an escapement.[4,5] These results are shown in Figure 6.

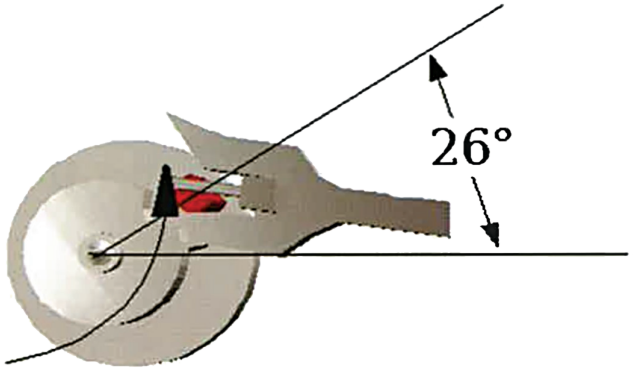


Figure 3. Locking.

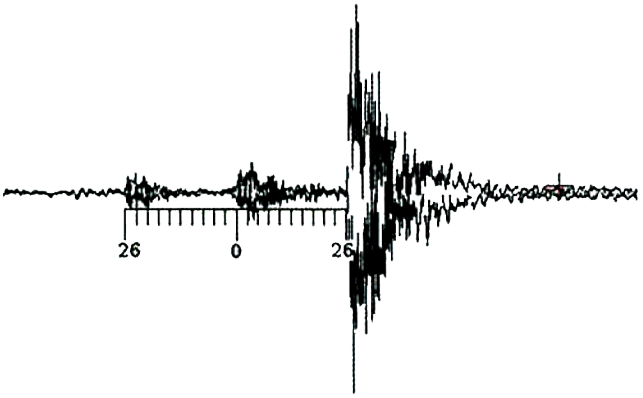


Figure 4. Oscillograph of a lever escapement.

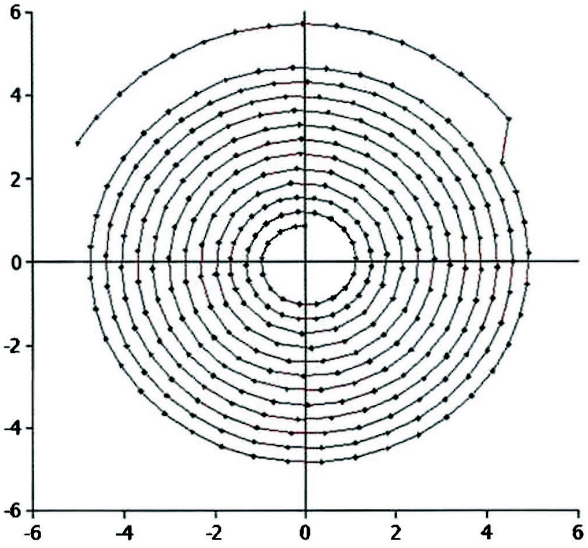


Figure 5. Modeled hairspring.

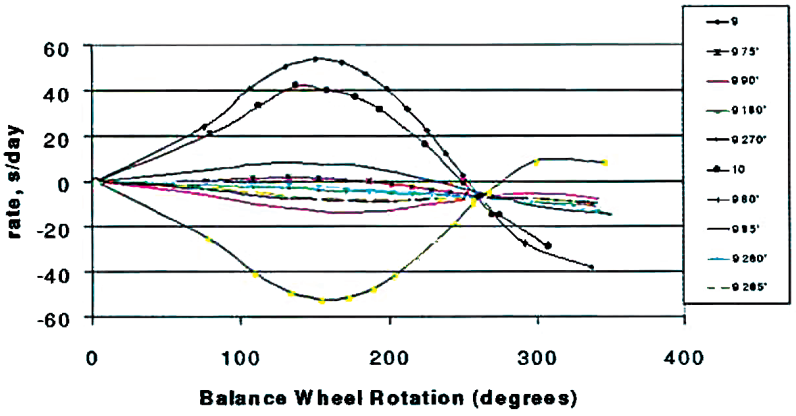


Figure 6. Rate and amplitude vs. run time for various pinning angles without effect of escapement.

Obviously, a 0° pinning angle has been found to give better performance in practice and therefore it has been adopted into general use for the Swiss lever escapement. However, the discrepancy between the theoretical and observed behavior has rarely been investigated.

The simple explanation, elaborated further in this article, is that the effect of the escapement changes the properties of the theoretical hairspring to change the optimum pinning angle. The most important effect of the escapement is that a small amount of energy is taken from the balance wheel for unlocking. This tiny amount of energy makes enough difference to completely change the calculated results and bring them into agreement with the observed behavior. Figure 7 shows the computed rates, including the effect of unlocking. The 0° pinning point is close to optimal for continuously good rates over the run of the mainspring.

This behavior has been verified on a modern ETA movement by various adjustments of the escapement. The following charts of observed balance wheel amplitude vs. rate were made in this laboratory. The rates are adjusted in the graphs to begin at 0 s/d even though the actual timing was dramatically fast or slow due to the adjustments. In Figure 8, the regulator and curb pins were removed to provide a pinning angle of -90°.

In Figure 9, the regulator was adjusted to provide a pinning angle of about +60°, again giving a curve agreeing with the theoretical behavior shown in Figure 7.

In Figure 10, the regulator was adjusted to provide the correct timing and beat which is -5°, again giving a curve agreeing with the theoretical behavior shown in Figure 7.

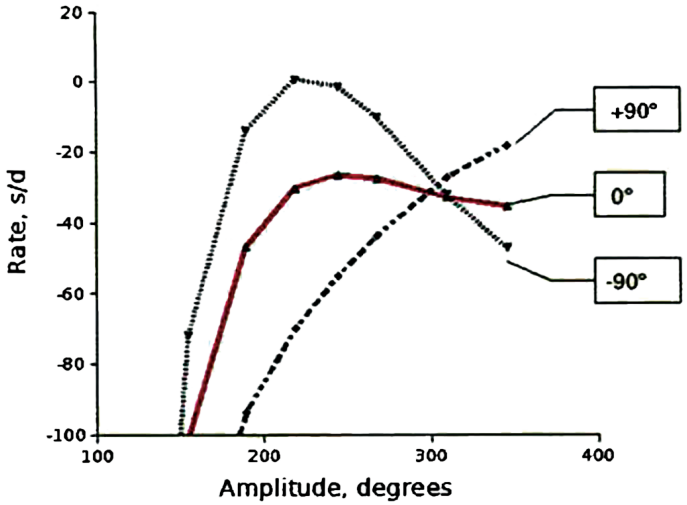


Figure 7. Computed rate vs. amplitude for various pinning angles, with escapement unlocking energy.

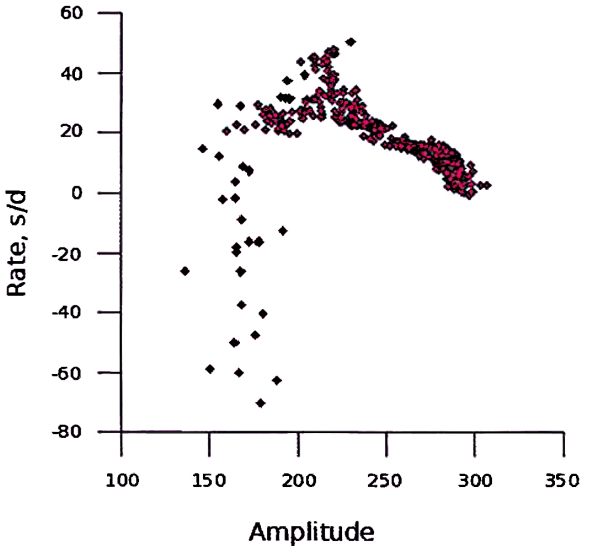


Figure 8. Observed rate vs. amplitude, negative pinning angle.

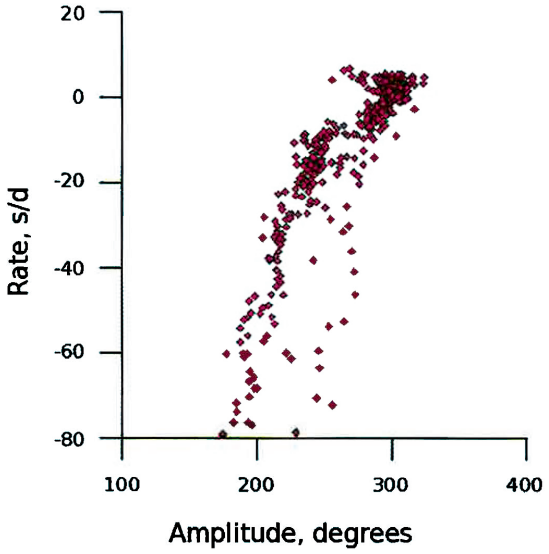


Figure 9. Observed rate vs. amplitude, positive pinning angle.

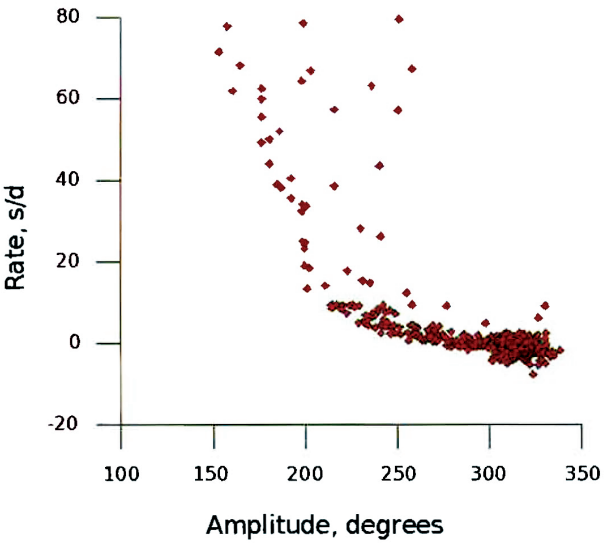


Figure 10. Observed rate vs. amplitude, normal adjustment.

The observed curves indicate that with careful adjustment the rate can be made very constant over a large range of amplitudes. Figure 11 shows that the adjustment reflected in Figure 10 affords an isochronism of 2 s/d or less.

This study is for a flat hairspring. My studies suggest that the main function of the overcoil is not to lessen side pressure on the balance staff, but to allow adjustment of the pinning angle. If the overcoil is moved, the pinning angle is changed, and the watch must be brought back into beat. It is this adjustment that provides a means to bring the watch to isochronal timekeeping.

Thus, with the inclusion of the escapement, the important factors for simulating hairspring behavior have been identified and shown to provide a reliable basis for evaluating adjustments of watches. The remainder of this article will delve more deeply into these and other adjustments.

Effect of the Outer Coil Shape

Most modern flat hairsprings feature an extended arc for the last 90° or so of the spring, as illustrated in Figure 5. The principle reason for this is to allow clearance for the curb pins. The coil must be extended so that the body of the hairspring does not contact the curb pins when the hairspring is fully unwound in operation. In addition, this portion of the spring must be circular, not spiral, so that the motion of the regulator pins does not move the hairspring.

In addition to the mechanical convenience, this extension also in itself reduces the error due to isochronism as compared to a spiral hairspring. In Figure 12, the computed performance of the normal flat hairspring with an extended outer coil is compared to a pure spiral hairspring. This simple feature reduces the isochronal error by about 30% over a pure spiral hairspring.

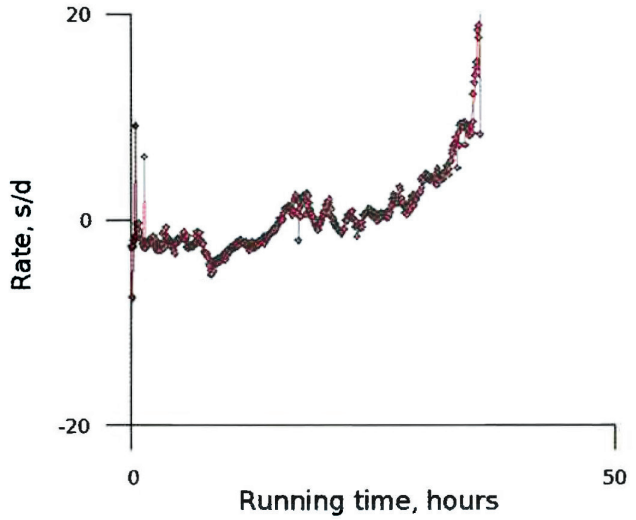


Figure 11. Observed rate vs. running time.

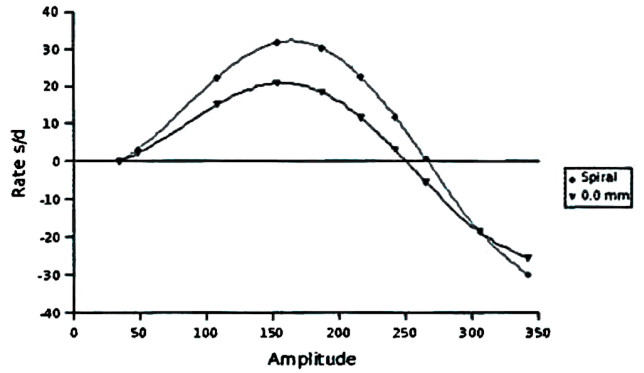


Figure 12. Comparison of isochronism of spiral and standard hairsprings.

The position and movement of the center of gravity of the hairspring has long been examined for insight into timing, especially positional timing.[6] As Figure 14 shows by the yellow path traced by the center of gravity, the center moves farther from the center due to the extended outer coil, as compared to the spiral hairspring shown in Figure 13. In these figures, the hairspring is colored by strain, red being the lowest and blue the highest strain. The motion of the center of gravity is magnified by 10 to make it more apparent.

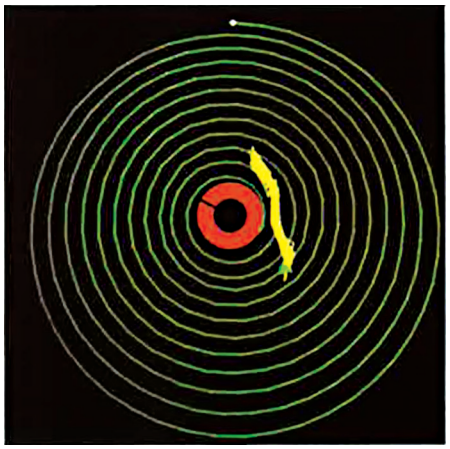


Figure 13. Motion of center of gravity for spiral hairspring, in yellow.

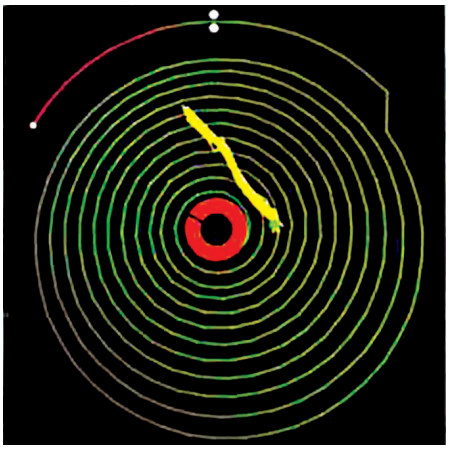


Figure 14. Motion of center of gravity for standard hairspring, in yellow.

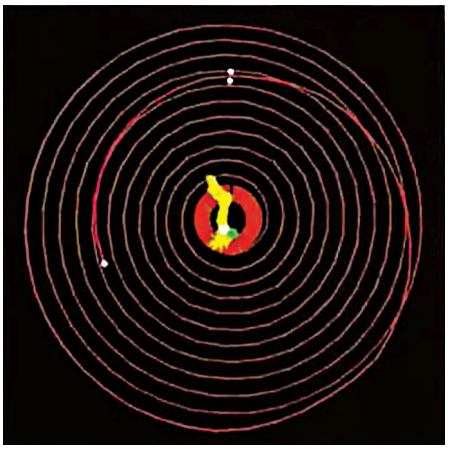


Figure 15. Motion of center of gravity for an overcoiled hairspring, in yellow.

Analysis of the strain on overcoiled hairsprings confirms that the overcoil reduces strain or makes it more evenly distributed and substantially decreases the movement of the center of gravity, as shown in Figure 15.

Part 2 will continue next month.

Acknowledgements

Wit Jarochowski for advice and watch movements.

Robert Porter for supplying materials about the Institute of Oscillographic Horology.

Jim Lubic and the AWCI for encouragement and technical support.

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6. For example, see De Carle, Donald. *Practical Watch Adjusting*. Colchester UK: NAG Press, pp. 105, 1987.



Citizen to Establish Accutron as Standalone Brand

By Andrew DeKeyser, CW21

The Bulova brand was obtained by Citizen in 2008. Citizen has decided to spin off the iconic Accutron into its own brand. The Accutron was introduced in 1960 as the world's first electronic watch and boasted accuracy of 360 Hz, which was a huge improvement over the most accurate mechanical watches beating at 5 Hz. The Accutron remained the most accurate wristwatch until the quartz movement came along almost 10 years later. Citizen plans to leverage this American heritage of accuracy and innovation in this new Accutron brand.

The new Accutron brand will pivot from utilizing the tuning fork technology of the original Accutron and the later high-hertz quartz iteration to a wholly unique system they introduced at Baselworld 2019 that utilizes an electrostatic motor and two electrostatic generators. This is how Jack Forster of *Hodinkee* describes the operation of electrostatic motors,

> An electrostatic motor . . . uses the direct attraction and repulsion of positive and negative electrical charge. In its simplest version, an electrostatic motor's rotor sits between two electrodes, one of which carries a positive electrical charge, and one, a negative. As the edge of the rotor passes an electrode, it acquires a charge identical to the electrode, which pushes that part of the rotor away (like charges repel) causing the rotor to turn.

The electrostatic generators work with a more conventional rotor to charge a capacitor that powers the low-consumption electrostatic motor that is regulated by a quartz oscillator and is used to propel the second hand. The minute and hour hands are advanced with a conventional stepper motor.

No launch date has been published.

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First Swiss Watchmaking E-Commerce Site to Launch Soon

By Andrew DeKeyser, CW21

Switzerland's first watchmaking e-commerce website, Watchys.ch, will launch soon, according to EINPresswire.com. The site will offer for sale and worldwide shipping new and used watches, watch tools, watch spare parts and mechanisms, as well as downloadable reference materials.

In the past, these transactions would only take place through personal networking and flea markets in Switzerland. But Watchys will make these services available internationally online. The site will list some 2,000 items in French and English to make it easy to find the correct components for watch repair with the use of a structured online catalog that will be easy to browse and search.

Watchys will also offer companies, independent watchmakers, and individuals the opportunity to sell their own goods on their platform.

WATCHYS
WATCHMAKER'S SHOP

Source

https://world.einnews.com/pr_news/523057138/watchys-announce-imminent-launch-the-first-swiss-watchmaking-global-e-commerce-site

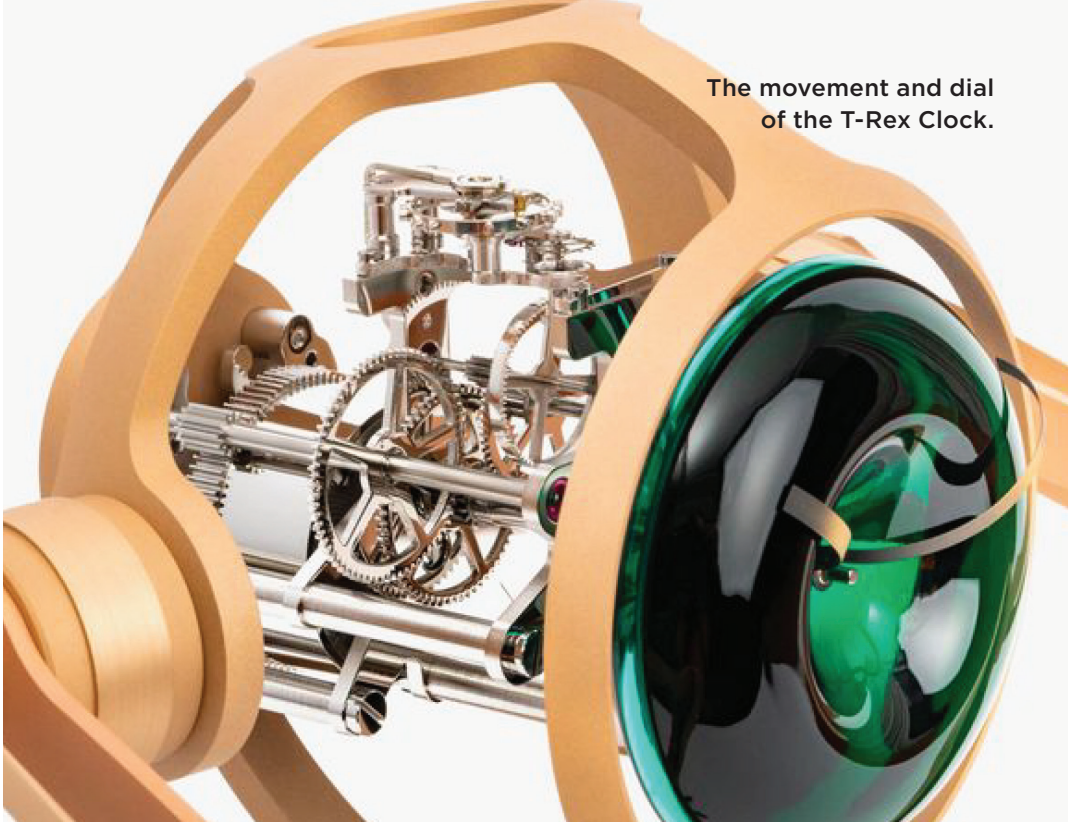
Andrew DeKeyser is the owner of HCP Watchmaking in Sisters, Oregon. He graduated from the Lititz Watch Technicum with WOSTEP certification.

In Summary

The T-Rex Desk Clock

By Donna Hardy

L'Epee 1839 and MB&F (Maximilian Büsser & Friends) collaborated to create T-Rex, an unusual desk clock. At about 10 1/2" tall, the clock is made of stainless steel, palladium-plated brass and bronze, and blown glass. The head of the T-Rex houses the clock and is crafted from artisanal hand-blown glass.



The movement and dial of the T-Rex Clock.



The glass dial is suspended in a transparent sapphire sphere. The eight-day power reserve movement was made by L'Epee. The clock is wound at the back of the movement, and time is set at the center of the glass dial by using the same key. The legs, which were designed using 3-D scans of fossilized dinosaur skeletons, actually move. It is produced as a limited edition in blue, green, or red—100 pieces per color.

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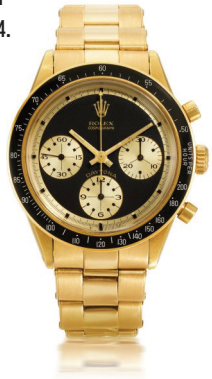
Rolex Daytona JPS Fetches $1.5 Million at Auction

By Andrew DeKeyser, CW21

As Sotheby's has shifted focus from in-person auctions to online auctions, sales have continued to bring in record profits. Sotheby's latest high-ticket item was a 1969 Rolex Daytona reference 6264 in 18 karat gold that sold for $1,545,723. The watch was named after the 1970s Lotus Formula 1 sponsor John Player Special with its black and yellow color scheme.

The watch fetched double its presale estimates, which demonstrates the ongoing perceived value of the most desirable Rolex models. Sotheby's claims to be the highest-grossing auction house in the world this year, having sold watches worth a total of $48 million so far.

The 1969 Rolex Daytona reference 6264.



Source

https://usa.watchpro.com/rolex-daytona-jps-sells-for-1-5m-at-online-auction-crowing-a-record-half-year-at-sothebys/

Andrew DeKeyser is the owner of HCP Watchmaking in Sisters, Oregon. He graduated from the Lititz Watch Technicum with WOSTEP certification.

JCK Virtual

By Donna Hardy

JCK held its annual convention/trade show totally online as a virtual event, August 10-14. The show is normally held in Las Vegas in early June. In recent years, AWCI has exhibited at the show and presented classes for watchmakers and watch technicians. This year, AWCI had a virtual booth at the event. JCK Las Vegas is scheduled for June 4-7, 2021.

Source

jckonline.com

Donna Hardy is the managing editor of the *Horological Times*.

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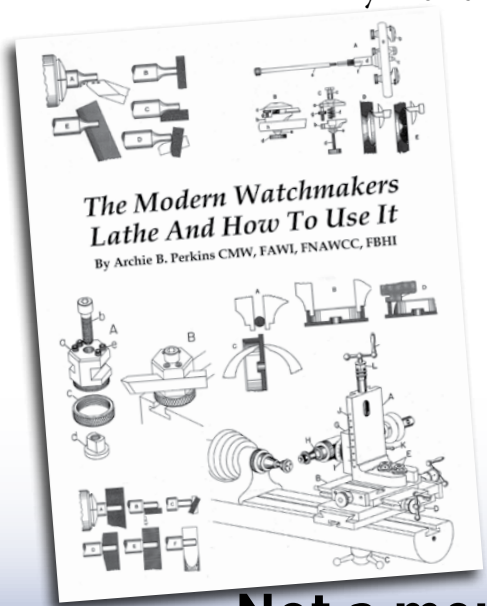
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From the Workshop

By Jack Kurdzionak, CW21, FAWCI

Sad News

The venerable old Swiss firm known as AF closed and liquidated at the end of July. AF Switzerland SA was founded by Albert Froidevaux in 1926 in La Chaux-de-Fonds. Froidevaux started his business as a supplier of watch spare parts and tools under the company name Kocher & Froidevaux, which subsequently became Albert Froidevaux & Fils SA. The company's rapid success led many of the world's most prestigious watch producers to choose Albert Froidevaux & Fils SA to distribute the replacement parts for their products—in many cases, on an exclusive basis. Over the years, the family business expanded to include more tools for watchmakers and jewelers. The company name was changed in recent years to AF Switzerland SA.

AF also had a subsidiary business, Centre Fournitures Manufactures d'Horlogerie SA, founded in 1964, that prepackaged watch parts in an internationally accepted standard form for many Swiss manufacturers. Many watch parts you purchased from various brands, including Omega and ETA, were packaged in those standardized capsules by AF. For about 50 years the company has been closely held by the Clark family, who maintained its industry-leading position for most of that time. Unfortunately, recent changes in the industry caught up with AF, and they were no longer able to remain in business. Stephanie Clark sent this to all of AF's clients in late July:

> It is with a heavy heart that we must announce that we have reluctantly decided to proceed with the closing of our company. The reasons are manifold, not least being the regrettable decision of our major Swiss suppliers of watch parts to terminate our contracts of parts distribution in recent years and to handle watch servicing mainly through their own network to the detriment of the independent trade. The watch parts business was a major part of our turnover, and despite efforts to increase the tool side of our business, the situation had become more and more difficult. The creation and development of the Internet has also contributed to a major change in marketing, allowing more and more competitors to enter the scene and to bypass the traditional distribution network. Furthermore, our efforts to find a successor and a partner to rely on resulted in a setback. As you can imagine, deciding to cease trading was not easy, but events finally obliged us to take this painful step.

Change is inevitable and often painful. Saying that does not make change easier for those involved in a business that declines and closes. The loss of AF will be felt worldwide because it further limits our ability to obtain spare parts and supplies. None of us is responsible for these changes, but we all need to adapt to them if we are to continue in this profession.

Brain Teaser Question from June HT

One quality watch manufacturer used some very clever engineering for many of its wristwatch movements sold after World War II. Although they added cap jewels to the train wheels to increase the jewel count and fit convex balance jewels to those wheels, they were able to use the same train wheels for every jewel count from 17 through 22 for all watches built up from the same base model. Those wheels all had straight pivots. There was no need to specify straight or conical pivots when ordering train wheels for this brand. This manufacturer also used the same balance staff in both a man's watch and a woman's watch. Although these watches were entirely different, the manufacturer was able to fit the same balance staff to both. Another hint is this company at

one time had some of the world's best horological engineers on its staff. Which company made these movements?

Responses

Richard Cuny from New Jersey said Elgin was the company. He reasoned that Elgin, after WW II, did introduce the first unbreakable mainspring, the Durapower, which they guaranteed to never break. They also developed a free-sprung balance with flexible spiral arms and movable inertia block weights with a balance staff guaranteed to never break. Elgin also produced a synthetic watch oil, their M56b. However, Elgin always used cap jewels for any conical pivots and did not use the same staff on movements with entirely different designs. As for the lifetime guarantees for the mainsprings and balances, that ended around 1964 when the company ceased making watches. They did have a government contract during WW II to produce a marine chronometer, but they were never able to mass produce them. They also made an electric watch and an automatic watch in the 1950s. Both efforts failed. Elgin did some decent engineering and research, so I would give them a B-.

Larry Bernard from California wrote

> My familiarity with post-WW II wristwatches is rather limited from a repair standpoint. However, one American company was known for clever engineering since its inception (and before!) when they pioneered mass production of watch movements in 1852. Your hint that "this company had at one time some of the world's best horological engineers on its staff" leads me to believe you are referring to the (as it was known post-WW II) Waltham Watch Company, previously American Waltham, before that, American Watch Company, Boston Watch Company, Appleton, Tracy, & Co., and sometimes just by the name on the movement. They had several really creative and excellent engineers who left at one time to become the Nashua Watch Company, putting out a very few (highly prized today) very fine watches before folding and being reabsorbed into American Watch Company, where they continued as the "Nashua Division" in that company, producing several models of unusual design. Later, if I recall correctly, some of them left for Elgin. So, I believe it must have been Waltham that produced the movements with straight cap-jeweled pivots. I did not know this, nor did I know they used the same balance staff for men's and women's watches. I do know that they came up with a friction-fit balance staff for pocket watches (maybe wristwatches too?) that made staff replacement very easy (as long as the replacement staffs were available), using only a staking tool, without danger of damaging the balance (these were known as the "blue hub" balances, as referenced by the late Henry Fried in his excellent book).

Larry was correct about Waltham and very knowledgeable about its sometimes-tortured history. During the Edward Howard, Aaron Dennison, and Royal Robbins years of leadership, the finest engineers and mechanics worked there. The Nashua, New Hampshire, operation was originally an independent think tank sort of operation that was merged into the Waltham operation. Watch company historians regard those years back in the 1870s and 1880s as Waltham's finest hours. After that, they really just became a mass producer of watches. Some excellent, others good, and the rest mediocre or worse. I believe the company name became Waltham Watch somewhere in the WW I era after another reorganization when the Buck Dumaine regime took over.

I lived most of my life in the Boston area not too far from the Waltham factory. At the time I began in the business, about 1970, many of the trade watchmakers and some jewelry store owners had either worked at Waltham or trained in their company school. I got to know quite a few of those people. I do not know any who are still living, but their influence in the Boston watch-repair market was significant for over a generation. Waltham did not suddenly close, but rather died a slow, painful death after their bankruptcy around 1950. They slowly shut down operations and closed their final remaining production in the mid-1980s. At that time, they made a small number of mechanical clocks for aircraft cockpits.

Returning to the original question. Waltham always had conical pivots when they used cap jewels, and I know of no staff used in a small woman's watch

that also was used in a man's movement of an entirely different design. Waltham did use small pocket watch movements that they fit into wristwatch cases, but those were easily recognized for what they were—pocket watches in a smaller case. I would give Waltham's Nashua division an A+ and 20th-century Waltham a generous C-.

The company I had in mind was Hamilton, which, I believe, had the best horological engineers from the late 1930s through the 1950s. They designed, built, tested, and then mass produced about 10,000 marine chronometers during WW II. These were as good as or better than any other chronometer ever built. Chronometers had never been mass produced by anyone before or since. Hamilton also made deck-chronometer-grade watches for the navy. Their wristwatches and pocket watches of that era had truly interchangeable parts that did not require any adjustments to properly fit. They developed their own synthetic oil, Hamilton PML, and the unbreakable mainspring they called Dynavar. They also produced the first electric watch brought to market, the Grade 500. The finish on their material was superb when compared to the average Swiss or American product of that era. Finally, they did some clever work with material. The 21/0 ladies' movements based on the grade 750 movement and the quite different 22/0 movement, grade 911, used the same set of train wheels. All pivots were straight, regardless of the jewel count. The gents' 14/0 movements, grades 980 and 982, did the same with all straight pivots for the train wheels. Finally, the 22/0, grade 911, ladies' movement and the gents' 14/0 grade 980 movement shared the same balance staff, pivot 0.08. These movements are entirely different in design and size, yet they use the same staff. I will say that for the late 19th century, Waltham was the best and for the mid-20th century it was Hamilton. I would grade Hamilton with an A+.

The Hamilton 17 jewel, size 21/0 movement in Figure 1; the 22 jewel, size 21/0 movement in Figure 2; and the 17 jewel, size 22/0 movement in Figure 3 all use the same set of train wheels. None of those three movements share the same balance staff. The 17 jewel, size 22/0 movement in Figure 3 and the 17 jewel size 14/0 movement in Figure 4 share the same balance staff but not the same train wheels.

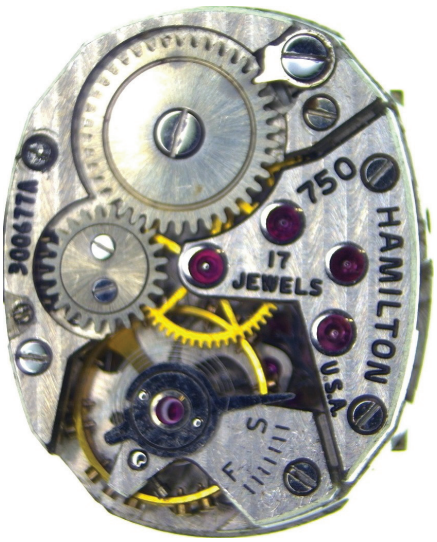


Fig. 1. The Hamilton 17 jewel, size 21/0 movement.



Fig. 2. The Hamilton 22 jewel, size 21/0 movement.



Fig. 3. The Hamilton 17 jewel, size 22/0 movement.



Fig. 4. The Hamilton 17 jewel size 14/0 movement.

Jack Kurdzionak, watchmaker and watch material specialist, owned a Boston-area watch sales and service shop for 40 years. He has a BS (Northeastern University, 1967) and has studied at ETA, WOSTEP, BHI, SGUS, and AWCI, and works for Eckcells Watch Materials.

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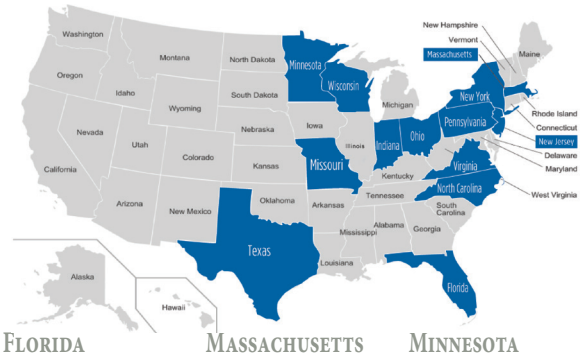
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How Are You Coping?

By Donna Hardy

We asked two watchmakers/clockmakers in two different parts of the country how they have been coping with the effects of the coronavirus pandemic on their businesses. Bob Little, CC, CW, owns a shop in Logan, Ohio. It's a small town but most of his work comes from nearby Ohio cities as well as some in West Virginia. Andrew DeKeyser, CW21, owner of High Cascades Precision Watchmaking, in Sisters, Oregon, also works in a small town but serves all of Central Oregon.

Have you reopened for business?

Bob: Our local health department has adopted all Ohio Department of Health guidelines for businesses reopening and doesn't have any additional county specific guidelines. I followed the Ohio Department of Health guidelines for nonessential retail business reopening. Retail businesses were closed on March 23 and were allowed to reopen on May 12, using the state guidelines. Retail businesses could reopen May 5 if they used curbside service, one customer at a time, by appointment only, which I did.

Andrew: Yes. We were completely closed to the public for four weeks but now maintain regular store hours.

What are your locality's COVID-19 rules and how are you meeting them in your business?

Bob: Retail businesses in Ohio must ensure a minimum six feet of distance between individuals, and if they cannot, they must install a barrier. To accommodate customers in my shop, I installed a clear plastic barrier between customers and me at the counter so that I could explain things to them about their timepiece while being closer than six feet. Typically, I place the timepiece on the customer's side of the barrier, explain everything and answer any questions, and process their payment. For clock pickups, I use a demonstration movement on my side to show customers how their clock works and how to maintain it.

I have a container of hand sanitizer and individual wipes on the customer's side, which about 50% of the people use. I also have several posters on the wall that I downloaded from the Ohio Department of Health's coronavirus website regarding mask requirements, virus symptoms, self-health assessment, and requirements for retail.

I am required to perform a daily symptom assessment of myself, which I always do in the morning

using guidance from the Ohio Department of Health's checklist. I always wear a mask when customers are present and have disposable masks available for customers. I do ask my customers to also wear a mask, since this became a state requirement on July 23, 2020 at 6 p.m. Everyone has been very cooperative in wearing masks. After the customers leave, I use disinfectant to wipe down the areas they touched while in my shop.

I am required by the Ohio Department of Health to offer designated hours for vulnerable populations. To accomplish this, I schedule their appointment at their convenience and provide curbside service.

Andrew: We are in what our governor is calling Phase 2 of reopening. Phase 2 allows gatherings while using face coverings and maintaining a six-foot social distance. Additional restrictions apply, such as face coverings at all times in public indoor spaces as well as outdoors when six feet of social distancing cannot be achieved. And the total indoor occupancy is capped at 10 people. We have disposable surgical masks available for patrons at no cost, and we encourage hand sanitation and social distancing with signage. I enforce the face covering rule very sternly—no one enters the store without a face covering.

> "No one enters the store without a face covering."
>
> ~Andrew DeKeyser

Briefly describe a typical workday for you now.

Bob: I try to do all shop visits by appointment to prevent having more than one customer in my shop at a time. I do accommodate walk-ins, but I explain the requirements for entering my shop. Probably 75% of my customers prefer curbside service, which is more convenient for them. I have had several customers with COPD (Chronic Obstructive Pulmonary Disease) who really appreciate the curbside service because they don't have to remove their oxygen generator from their vehicle.

I have started doing service calls on grandfather clocks and have modified that process too. While there are no specific state guidelines for clock house calls, I use the guidelines on the OSHA website for in-home repair services: https://www.osha.gov/SLTC/covid-19/in-home-repair.html. I call the customer the day before the service call and tell the customer when I will be coming and that I need to confirm their health status and any people they have been in contact with, according to the Ohio Department of Health and OSHA guidelines. I tell them they must stay in the adjacent room until I'm done, and then we must stay 6 to 10 feet apart during billing, payment, and departure. I say that, for health reasons, I won't be able to greet them by shaking hands. Of course, the customer and I both wear masks. I use hand sanitizer before entering, put on examination-type gloves, and touch nothing in their house other than their clock. When I'm done, I wipe the areas of the outside of their clock case that I touched with a clean microfiber cloth and soap-based, antique cleaning solution. I tell them to not touch their clock for three or four days, "just to be sure." After I have removed all my equipment, I take off the disposable gloves and clean my hands again with hand sanitizer. I tell the customer that some of this may seem "extreme," but I'd rather be safe than sorry, and people are very appreciative of my care. I used to do multiple service calls during a day. Now, I only do one service call per trip, so that I won't be suspected of carrying any contamination from one house to another. I have no idea where my customers go or what they do, and I think this is a conservative but necessary precaution.

I usually try to schedule all shop appointments in the afternoon so that I can have several hours of uninterrupted work in the morning. My workday isn't much different than it was before, except for the increase in curbside service and added precautions.

Andrew: My workday is very similar to what it was before with the addition of disinfecting counters and doors four times a day, policing and handing out face coverings, and employing an ozone generator when I leave in the evening.

Has there been a silver lining for you?

Bob: The amount of work returning to my shop has been very good. Since reopening, I have actually had more work than usual come in, probably from the state's closure for about six weeks—it backed things up. One customer said that while they were isolated at home, they kept looking at their clock that wasn't running, and it started to "bug" them. They decided the first thing they would do when they could go out was get their clock fixed!

> "They decided the first thing they would do when they could go out was get their clock fixed!"
> ~Bob Little

Andrew: The time when we were closed gave me, and the clock repair department, an opportunity to still work because we were able to stay under the 10-person occupancy maximum and keep a six-foot social distance at all times. These four uninterrupted weeks gave us time to work into our massive backlog. We didn't have customers bringing us new work during that time, but we were able to deliver many repairs as soon as we were able to open to the public once again.



Horological Association of Virginia (HAV)

HAV's annual spring convention had been postponed until August due to the coronavirus. Because of difficulty in obtaining commitments from originally scheduled speakers and uncertainty about attendance, it has been delayed further. The 2020 fall seminar has been canceled for the same reasons. However, the 2021 annual convention has been scheduled for April 30-May 2 at the Stonewall Jackson Hotel in Staunton.

The next scheduled video board meeting will be September 15, 2020, at 6 p.m. Board meetings are open to all members. Contact chapter president, Joe Jabbour, at clockappraisal@wildblue.net.

TriCity Watch and Clockmakers Guild of the Horological Association of Virginia

On Friday March 6, 2020, just before the coronavirus shutdowns, the TriCity Watch and Clockmakers Guild of the Horological Association of Virginia (HAV) hosted a tour of the B.A. Sunderlin Bellfoundry in Ruther Glen, Virginia, that included friends and family of guild members. B.A. Sunderlin Bellfoundry is owned by husband and wife Benjamin and Kate Sunderlin and has been in operation for six years. It is the only traditional bell foundry in the United States casting bells using the swept loam method. This traditional method provides for more exquisite surface detail, improves concentricity, and allows the metal to cool more slowly, producing a better-quality casting. After a guided tour of the gallery and foundry, members observed an actual pour of a large bell and 12 smaller bells of varying sizes.

B.A. Sunderlin Bellfoundry is a full-service nonferrous foundry that casts virtually any alloy using sand-moulding techniques, as well as lost wax casting. For more information, contact Kate Sunderlin at kate@sunderlinfoundry.com or call 804-822-0800.

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Previously poured bells waiting for tuning and finishing.



Pouring the bell.



From left to right: Tuck Tompkins, Nancy Beck, Mark Pellmann, Deborah Pellmann, Jose Nepomuceno, Caleb Pellmann, Susan Nepomuceno, Carol Adams, Dave Voss, Sandy Jensen, Lars Gunlicks, Ted Polk, Jim Adams, Laura Germain, John Beck, Jason Germain, Chris Germain, Alex Germain.

Horological Society of New York (HSNY)

The following information was obtained from The Horologist's Loupe, *submitted by Carolina Navarro, Director of Public Relations, HSNY, Copyright©2020. Published by the Horological Society of New York, Inc.; all rights reserved.*

Thanks to the support of HSNY sponsors, benefactors, members, and the horological community, HSNY has awarded $155,000 in financial assistance to watchmaking students, schools, and professionals to date in 2020.

In April 2020, HSNY launched the Working Watchmakers Grant to assist industry professionals directly during the COVID-19 pandemic. HSNY issued checks for $1,000 to 100 watchmakers and clockmakers across 31 states, totaling $100,000.

Despite the cancellation of the HSNY 2020 Gala & Charity Auction, America's oldest watchmaking guild pushed forward and awarded the Henry B. Fried Scholarship to six watchmaking students. Established in 2017, the Henry B. Fried Scholarship aims to help watchmaking students succeed in every way by helping to cover the cost of watchmaking tools and living expenses while attending a full-time watchmaking school.

New in 2020, the Howard Robbins Award was established as a grant for watchmaking schools in the United States. Howard Robbins (1950-2020) was a professional in the world of timepieces for nearly 40 years and passed away in March 2020. This award is intended to foster Robbins's professional rigor, love of people, and belief in education within the watchmaking community. The 2020 recipients of the Howard Robbins Award are the Veterans Watchmaker Initiative in Delaware ($15,000), the only technical school devoted to disabled veterans in the US and Paris Junior College's Texas Institute of Jewelry Technology in Texas ($10,000), established in 1942 to provide industry job training.

HSNY has been on summer break for the months of July and August. No lectures were scheduled, but Virtual Horological Tutoring classes continued. Virtual tutoring presents the theoretical side of HSNY's classes; no tools or equipment necessary. In these 60- to 90-minute sessions, groups of up to four students follow along and ask questions as watchmaking instructors walk through each class while they disassemble and reassemble a movement on live video. The next lecture will take place on September 9 via live stream.

New Officers and a New Trustee

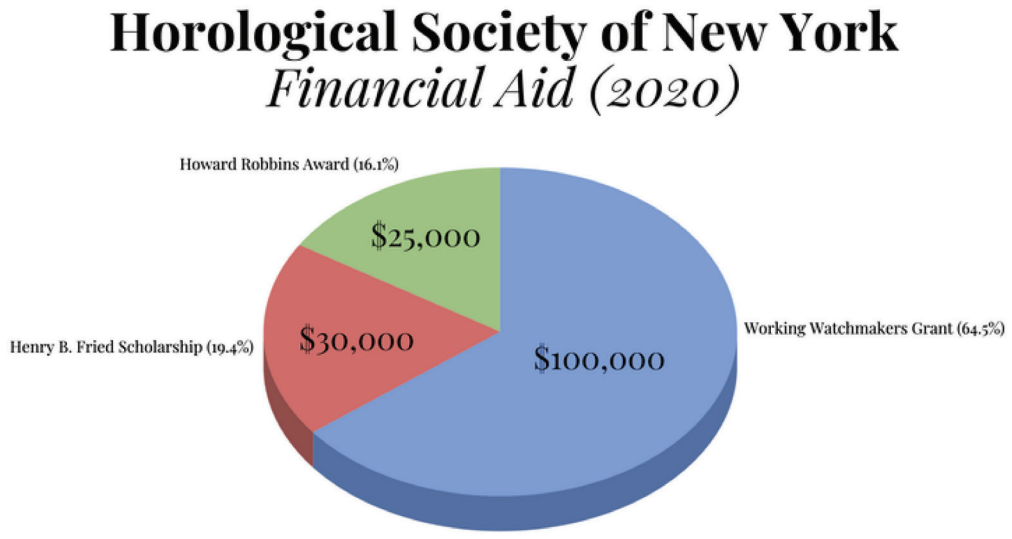
Nicholas Manousos (formerly HSNY president) succeeds Edwin Hydeman as executive director. Manousos also serves on the Academy of the Grand Prix d'Horlogerie de Genève and is the technical editor for *Hodinkee*. John Teifert, technical manager for LVMH Watches & Jewelry, assumes the role of president, and John Davis, director of service operations, Rolex Watch USA, assumes the role of vice president. Teifert and Davis succeed in their roles as vice president and trustee, respectively. Actor and horological designer Aldis Hodge is the newest trustee. He is known for his roles in movies, such as *The Invisible Man* and *Straight Outta Compton*. He is also an accomplished horologist who serves on the academy of the Grand Prix d'Horlogerie de Genève.

HSNY Officers

President: John Tiefert

Vice President: John Davis

Director of Public Relations: Carolina Navarro · carolina@hs-ny.org



AWCI Welcomes New Members

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Rafael Garcia	TX	Alexander Vossbrinck	CA
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Stjepan Grguric	Canada	Andrew Zwit	OH

In Memoriam

Gordon D. Bucknam	FL

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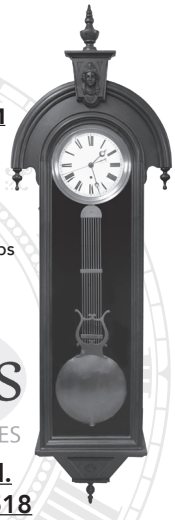
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