WATCH & CLOCK Bulletin

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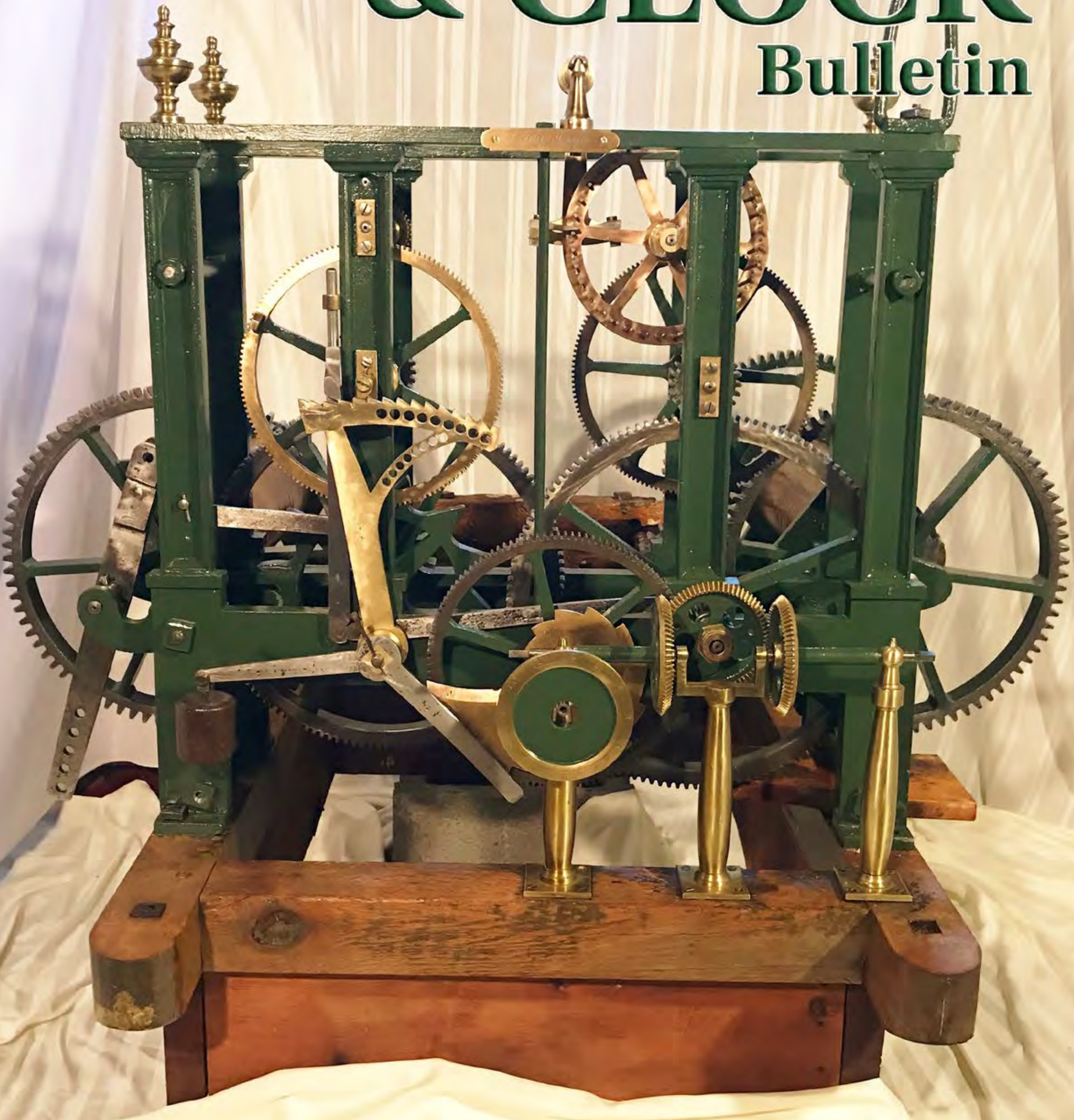

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The NAWCC, Inc. is the world's largest museum, research library, educational institution, and international community of horological professionals and enthusiasts dedicated to clocks, watches, time, and timekeeping.

We are committed to being the world leader, educator, and advocate for horology and for everyone who is interested in timepieces and horological issues.

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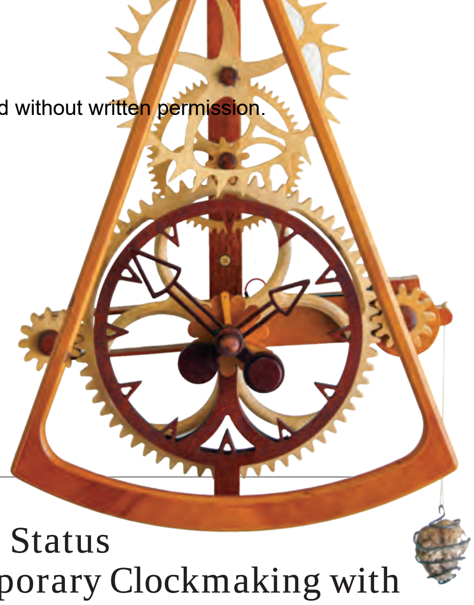
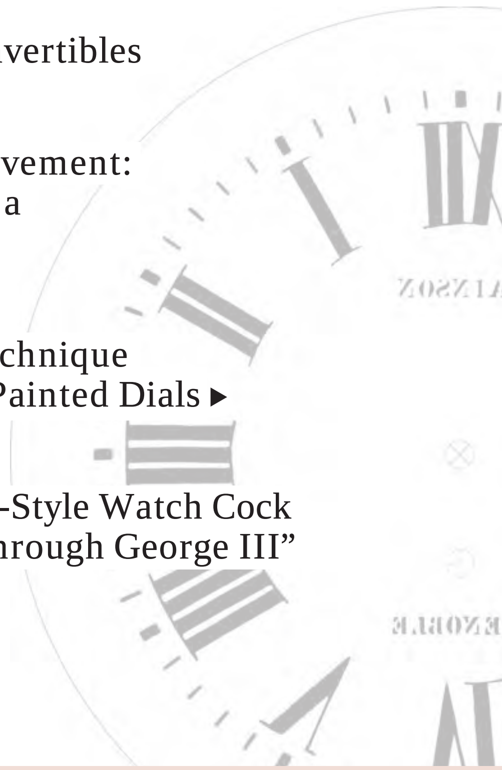


Columns

Articles



Letter from the Editor

Mark Twain stated, "The time to begin writing an article is when you have finished it to your satisfaction. By that time you begin to clearly and logically perceive what it is you really want to say." While this extreme process of rewriting is not always practical, authors do spend a lot of time researching, writing, and tweaking their work. The *Bulletin* relies on these writers to painstakingly prepare endnotes, decipher 18th-century script, and photograph a watch's hallmark without glare or shadows, among other challenges. Their efforts create the engaging content you find in each issue. On page 426, we acknowledge the writers of 2021 who provided educational and inspirational articles on a variety of horological topics. Thank you!

If you haven't seen an article on your favorite clock or watch topic, please write one! Details on submitting your work are available at www.nawcc.org/publications/submission-guidelines.

With this year's content published and done, I look forward to working with the next group of *Bulletin* authors. The close of 2021 brings gratitude for a wonderful group of NAWCC staff to work with each day and members who are passionate about all things horological. The year 2022 promises intriguing new articles for the *Bulletin* and great local, regional, and national events for members and new friends.

Laura Taylor
Managing Editor
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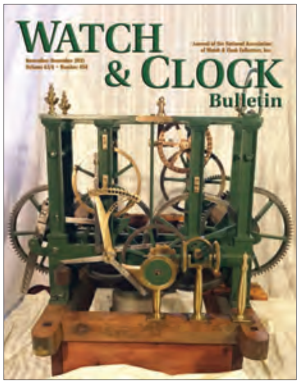
About the Front Cover



The front cover features the 2021 People's Choice Award winner in the Crafts Competition at the National Convention: an 1848 tower clock restored by Russ Oechsle. The clock was made by 19th-century bell and instrument maker Andrew Meneely, who also made a few tower clocks. One of them had been in Russ's sights for more than 40 years before he purchased and restored it. See page 423 for the complete list of 2021 Crafts Competition winners.

About the Back Cover

On page 366, Richard Cedar examines the possibilities for growth in contemporary clockmaking by comparing that craft with the modern studio pottery movement. He highlights the work of eight innovative clockmakers and explores how a clock can be an artistic expression as well as a timekeeper. The back cover shows clocks by Rick Hale (top right and bottom right), Florian Schlumpf (far left), and Clayton Boyer (middle row).

This season is a time to be thankful for the many blessings that we all have. I am very thankful for our great Board of Directors. Before Directors could be elected or appointed, the Nominating & Elections Committee searched for qualified NAWCC members to be considered for the Board. We thank Ruth Overton and George Goolsby for their leadership in identifying and encouraging exceptional individuals to serve as Board members. We must also thank our membership who participated in large numbers to vote for Directors. This is a "working Board." Each Director is willing to work extra hours to continue improving the NAWCC's procedures. Each Director is also willing to support the NAWCC through financial donations to help during these challenging times. The Board's dedication has resulted in successful initiatives for the Museum, Research Library, and Association as a whole.

Our success is also due to the great *team*work by the NAWCC's staff at headquarters, including both full-time and part-time employees. It starts at the top with the HQ Leadership Team of Sarah Gallagher, HR Manager, Development & Marketing Associate; James Campbell, Research Library Supervisor & Acting Museum Curator; Laura Taylor, Managing Editor; and Marlo Davis, Member Services Manager. We are pleased to announce a new team member: Ken De Lucca is our new Director of Education. He will hold his first class, "Introduction to Antique Clocks," in our reopened School of Horology on December 4-5, 2021 (details are on page 425). Each of the staff members is excited to work with our great membership.

We would not be as successful without the extra time and energy that Jay Dutton, NAWCC Treasurer, has invested to ensure a smooth conversion from an outdated accounting program to QuickBooks Pro Online as of April 1, 2021. After the Board passed its first realistic and balanced budget, Director Dutton has monitored our expenditures to keep them in line and continues to look for ways to increase our revenue.

It is estimated that one in four museums may close within the next four to five years as a result of COVID-19. We own our building and have no outstanding debt. We have much to be thankful for. We do need your continued financial support to ensure that we will be successful in the future. We are very appreciative of and blessed by every donor we have at the NAWCC, no matter what the donation amount.

We are also very thankful for the support provided by Ryan Miller from Brent L. Miller Jewelers & Goldsmiths, Lancaster, PA, along with Eliel Garcia, General Manager at Brent L. Miller. They have donated three billboards in the Lancaster area that will run for three months, promoting our wonderful Museum. We are already noticing an increase in attendance at the Museum and Research Library.

In addition, we are thankful for our annual NAWCC Ward Francillon Time Symposium held on October 7–9. I along with more than 100 other members of the NAWCC and the public were excited to participate in the "Horology 1776" symposium in Philadelphia in early October. Postponed from 2020, this groundbreaking conference took place at the American Philosophical Society, founded by Benjamin Franklin, and the new Museum of the American Revolution, both in the city's downtown historic district.

The symposium's theme of timekeeping during the American Revolution had never before been addressed, and a roster of eminent speakers shared their expertise during the two and a half days of lectures. The first-ever woman James Arthur Lecturer Dr. Sara Schechner, who heads Harvard University's Collection of Scientific Instruments, spoke on "Sundials and Clocks behind Enemy Lines." Other speakers included renowned scholars and authors: Mary Jane Dapkus, Damon DiMauro, Dr. Walter "Sunny" Dzik, Don Fennimore, Bruce Forman, Elizabeth Fox, Don Hagist, Frank Hohmann, Charles Hummel, David Lindow, Rich Newman, Steve Petrucelli, Patrick Spero, Scott Stephenson, Christopher Storb, and Gary Sullivan. During the Symposium, special tours were offered for participants to see Independence Park, David Rittenhouse clocks and orrery, and the Philadelphia Museum of Art. There was also a full-day excursion to our Museum in Columbia and the fantastic collection of early Pennsylvania tall clocks at Historic Rock Ford in Lancaster.

I especially thank our Symposium Committee Chair, Bob Frishman, who created and organized this event and who also presented a preview of his forthcoming book on Colonial Philadelphia clockmaker Edward Duffield. For members who could not attend, professional video recordings of each presentation will soon be available on nawcc.org and also via www.horology1776.com.

The year 2021 has certainly had its ups (Convention in Hampton, VA, and other in-person meetings) and downs (COVID-19, wildfires, weather events). The continuing positive note from year to year is the NAWCC membership. I'm grateful for each of you and look forward to seeing you in 2022!

James C. Price
NAWCC Chairman of the Board
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> [I]f we wish to be introduced to the workman who has the greatest share in the construction of our best clocks, we must often submit to be conducted up some narrow passage of our metropolis, and to mount into a dirty attic, where we find illiterate ingenuity closely employed in earning a mere pittance, compared with the price which is put on the finished machine by the vendor of more easy circumstances, though the latter has had little more trouble in the construction than to order his name to be inserted before it is placed for public notice in his bow-window.

Written just over 200 years ago, this excerpt from Rees's *Cyclopaedia* did not paint a rosy picture of the clock and watch trade in London. It is a far cry from the common, romantic notion that the name on the dial belonged to an individual who had toiled for hours to produce the now-cherished antique watch or clock. These small cells of production—the dirty attics—were also the training ground for apprentices to learn and develop skills according to their aptitudes.

In this multipartite model of production, workers were highly specialized and were, therefore, efficient practitioners. This meant cheap components for the vendor but with the distinct challenge of managing a complex supply chain. Illness, temptations of the tavern, and so on were obvious pitfalls; an aggressive competitor could easily sabotage a rival's business.

The law offered some protection to the vendors, in that a workman who absconded without finishing work could be imprisoned for one month. The famous chronometer maker Thomas Earnshaw (1749–1829) alleged that his rival, John Arnold (1736–99), had caused one of his workers to be incarcerated to deliberately hurt his business. The key to success was keeping your workers in close proximity and, if possible, under one roof. This was evidenced clearly in an account demonstrating that a skilled craftsperson could still outperform the machines of the time. In the 1885 book *Clock and Watchmaking*, David Glasgow reported from John Wycherley's Lancashire factory in Warrington Road, Prescot that a single screw was cut to shape, tapped, rounded, parted off, and burnished in around 15 seconds.

I am neither celebrating nor condemning the historical practices of the watch and clock trades, but want to highlight the significant difference to current horological practice. Networks of horological specialization are getting increasingly thin, and there is a distinct need for training in numerous areas, in terms of both geography and skills. Independent clock and watch repairers need to master more and more skills in order to survive, and makers of clocks and watches need to master many disciplines.

There is industry investment across the United States that supports a number of good schools that annually turn out qualified horologists to work in the modern watch service centers. However, there has been a recent lapse in classroom education for other areas of watch and clock repair. This is something that I and the Board of Directors are very keen to address as we work toward resurrecting NAWCC educational programs.

I am delighted to report that at the 2021 National Convention there was a tremendously positive meeting between a number of interested parties, including the NAWCC, American Watchmakers–Clockmakers Institute (AWCI), and Horological Society of New York (HSNY), all of which wish to see greater provision of quality horological education across the United States. What is most encouraging is the willingness of all to work in alignment to provide a broader educational offering. Each organization has its own individual strengths, and by closer collaboration we can ensure that a variety of accessible courses is available.

As a teacher during the pandemic, I had to make a radical change of approach to my practice, and implementing new approaches yielded some great results. Effectively teaching a practical subject online is not easy, though balancing virtual instruction with supervised classroom activities has proven highly effective. Over the coming years, I will be sharing my experience with our educators and working with friends at AWCI and HSNY to ensure that we optimize our educational programs to suit the requirements of existing and new NAWCC members and to play our part in turning around the decline of horological expertise.

In late July, you received an invitation to complete a short online survey relating to NAWCC classes. If you have responded, we thank you. With your feedback we are better equipped to develop a stronger educational program. As a reminder, one of our greatest assets is the NAWCC Forums (mb.nawcc.org), where there is a daily exchange of ideas and sharing of tips on overcoming clock and watch repair problems. If you do not use this resource already, please do consider using it to voice your needs or to offer mentorship.

Rory McEvoy
Incoming Executive Director

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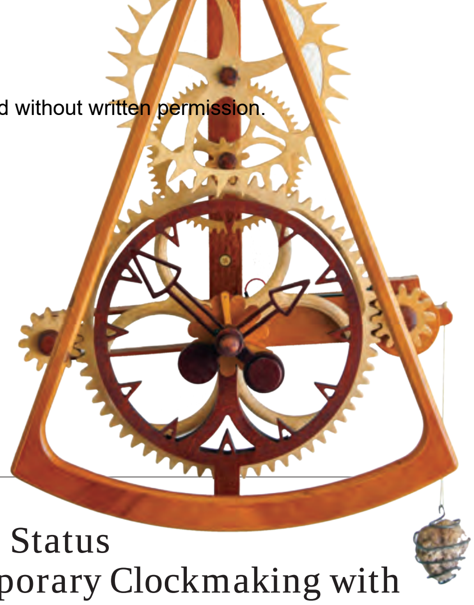

Columns

Articles

Some Thoughts on the Status and Future of Contemporary Clockmaking with Digressions into Modern Studio Pottery

By Richard Cedar (OH)

Strolling through an art or craft fair, you are likely to find a plethora of potters offering a variety of handmade ceramic creations. Ask one of the potters where they learned their craft, and they will probably mention taking classes at their high school or a local community center. Some may have studied ceramics as part of a fine arts program at a university. Contemporary studio ceramics are displayed alongside other art forms in art galleries and museums, avidly collected and sold by high-end auction houses. Collectors of contemporary handmade ceramics thrive alongside collectors of traditional/historic pottery. In comparison, there are only a handful of clockmakers creating contemporary clocks (not replicas or in the style of traditional timepieces), and it is rare to find their work at art fairs, galleries, museums, or sold by auction houses.

This article compares the evolution of modern studio ceramics and contemporary clockmaking, exploring some of the reasons for the modern ceramic movement's blossoming compared to the small number of contemporary clockmakers. From brief vignettes of eight active contemporary clockmakers, I explore what motivated them to take up the craft, the inspiration behind their clocks, and the processes they used to create them. From these insights, some thoughts are offered on the potential to increase interest in the creation of contemporary clocks.

Go back 200 to 300 years, and the crafts of pottery and clockmaking shared many similarities. To enter either trade, one would have worked for or apprenticed with a master craftsman and, after one's training, either joined an existing workshop or established one's own business. The products from these workshops ranged from functional products made to satisfy the local market to high-quality, ornate designs created for the aristocracy.

With the advent of the Industrial Revolution, the small craft workshops either evolved into large industrial factories or, unable to compete with mass-produced products, gradually died out. With a few exceptions, by the mid-1900s, small pottery and clockmaking workshops had virtually disappeared.

At this point, the crafts of pottery and clockmaking took dramatically different paths. The modern studio pottery movement grew out of the workshops of a few charismatic potters. Perhaps the most notable of them was Bernard Leach, who became interested in pottery while living in Japan, where there is a long history of small potteries supplying handmade ceramics for the Japanese tea ceremony and other cultural practices. Leach apprenticed with a traditional Japanese potter and, on his return to his native England, set up a pottery workshop and wrote a formative book on studio pottery that covered both the practical aspects of pot-making as well as the philosophy behind his handmade pottery. Leach took on apprentices from around the Western world who returned to their home countries, including the United States, and opened their own studios. Other potters, including Rudy Autio

Figure 1A. Functional teapot by Warren Mackenzie. Mackenzie apprenticed with Bernard Leach in England before setting up a studio in Stillwater, MN. He taught pottery classes at the University of Minnesota. I can confirm that this teapot brews a fine cup of tea. AUTHOR'S PHOTO.

and Peter Voulkos,[1] challenged the craft-oriented pottery traditions and Asian influence espoused by Leach and his followers, creating work that blurred the lines between functional pottery, sculpture, and ceramic art. This resulted in long debates[2] on the relative merits of "form" versus "function" in modern studio ceramics. Figure 1 shows three teapots from my collection, displaying the spectrum of function and form.

Contemporary pottery/ceramics production has blossomed, and there is now an abundance of studio ceramicists selling their work in parallel to mass-produced pottery. The craft of clockmaking has not experienced a similar rejuvenation.

One can hypothesize the reasons for the divergent paths these two crafts have taken. Anyone who has witnessed a potter working on a potter's wheel cannot help being enthralled by the process. With a few careful pushes and pulls, the potter transforms a lump of clay into an elegant vase, bowl, or even a teapot spout. A skilled potter makes the process appear effortless, and the onlooker wonders if they could learn the art of pot making. This is often the stimulus that results in a person signing up for pottery classes. They soon find that throwing a pot is not as easy as it looks, but with the aid of a good instructor, practice, and patience, almost anyone can learn to make a pot they can be proud of. As they advance, they discover that there is considerably more to creating a pot than mastering the use of a potter's wheel. Developing glazes used to decorate pots and firing them in a kiln to flux (melt) the glaze requires a considerable understanding of chemistry. This technical complexity results in a natural winnowing of interest in pottery. Still, a significant number of people develop a passion for potting and decide to pursue pot making either as a part- or full-time vocation.

Compare this to a person's reaction to first seeing a skeleton clock. They are often fascinated by the complexity of the mechanism and the motion of the escapement, wheels, and so on. Still, even if they are mechanically minded, the idea that they could create a similar clock is intimidating and overwhelming. Overcoming a natural fear of the intricacy of a clock's mechanism is just one of the barriers to be surmounted before taking the first step down the road to becoming a clockmaker.

One could also postulate that there is no longer a need or market for contemporary clocks, as one can purchase amazingly accurate, mass-produced timepieces for around $20 from the local megastore. However, the same is valid for ceramic tableware. For example, the same megastore sells very affordable, perfectly functional coffee mugs, but there is still a market for more expensive handmade coffee mugs. The difference is that mass-produced mugs are formed using an industrial process that minimizes the cost but restricts the form of the final product. In contrast, a good potter will have given considerable thought to the mug's design and its use, without the limitations of an industrial process. The handmade mug will be visually attractive, nestle comfortably in one's hand, and have a rim shaped to be a pleasure to drink from. It is more than just a coffee container; it has "soul."

1B

Figure 1B. Whimsical sculptural teapot by Kostas Ulevicius. Comprising the essential elements (body, spout, lid, and handle), this teapot was designed primarily as a decorative sculpture but could be used to brew tea. AUTHOR'S PHOTO.

1C

Figure 1C. Teapot as social commentary by David Bolton. Influenced by his inner-city surroundings and urban decay, this teapot's elements allude to the competition between natural and manufactured objects in our cities. I have never attempted to use this teapot to make tea. AUTHOR'S PHOTO.

Figure 2. Recent work created by Rick Hale—Clockwright. COURTESY OF RICK HALE.

Below is a series of short vignettes of eight contemporary clockmakers. Each has come to the craft of clockmaking from a different background, overcome the challenges of becoming a clockmaker, and taken clockmaking to a new level by creating clocks with "soul."

Rick Hale — Clockwright Fine Mechanical Timepieces

Based in Kalamazoo, MI, Rick Hale describes his work as an attempt to explore and challenge the way people feel the passage of time in the post-industrial era. Having graduated from Michigan State University with a degree in English and become disenchanted with the prospect of teaching, Rick turned to woodworking as a hobby first and then as a career. Rick had learned the basics of mechanics from his father, who had been a mechanic, and he used these skills to make his first clock. That clock "was very, very bad," he said, but it inspired him to learn more about clocks, clockmaking, and horological history. Early on, he was inspired by modern clockmakers, including James Borden, Clayton Boyer, and Will Matthysen, who, when contacted, offered assistance and encouragement when he was stuck, sending him articles, books, tools, and material. Ultimately, Rick has combined his clockmaking and woodworking passions.

He uses different wood varieties, carefully chosen for their color and grain pattern, to highlight each clock element (Figure 2). The result showcases the brilliance hidden in his favorite clockmakers' mechanisms—Harrison, Breguet, Burgess, Arnfield, and Tompion. Learn more about Rick's work on his website (www.clockwright.com) and in a recent *Quill & Pad* article.[3]

Florian Schlumpf — Schlumpf Innovations

Florian Schlumpf's career began after he graduated from the School of Arts and Crafts in Lucerne, Switzerland, as a sculptor. He traveled the world for two years on a motorcycle he made, and then he pursued education in the field of mechanics. He attended Zentralschweizer Technikum in Lucerne, earning a diploma in mechanical engineering. His experience attempting to climb a mountain pass on an old bicycle led him to set up a business producing an innovative series of bicycle hubs that he designed. The sale of his bicycle hub business opened the door for Florian to explore new fields of interest, including clocks and precision mechanisms. His first "Time Machine," the TM1, was introduced at Baselworld in 2014 as a purely artistic experience with no time indicators.[4] More recent work includes "Time Machines" that incorporate time indicators, "Philosophical Machines," and "Art Machines" that use innovative mechanisms to explore the art of space, time, and motion. Florian's work falls on one edge of the horologic form versus function spectrum.

Examples of Florian's works are shown in Figure 3, and additional details and the inspiration behind their creation are given at his website (www.schlumpf.ch) and in a 2017 *Quill & Pad* article.[5]

Clayton Boyer — Clayton Boyer Clocks

When he was young, Clayton Boyer loved the how-to monthly magazines like *Popular Science*, *Mechanics Illustrated*, and *Popular Mechanics*. His youthful dream of building a wooden clock described in a *Popular Mechanics* article was thwarted by a lack of tools, money, and materials. When he retired from his chiropractic practice 50 years later, the dream of building a wooden clock still smoldered in the recesses of his brain. He researched the few available clock designs on the Internet, decided upon one that looked intriguing, and ordered it. The clock plan arrived, and a few days later, he emerged from his shop with a completed mechanism. He stood in front of the clock, anticipating the pride of showing off his project but could muster none. It was big and blocky, and he said to himself, "Blind monkeys could design a better-looking clock than this." He has been designing and building clocks ever since, possibly becoming the most prodigious and prolific active clockmaker.

Working from his home in Hawaii, Clayton has created hundreds of clocks, orrerys, and other contraptions and gizmos. Unlike other clockmakers who have developed a distinctive style, each of Clayton's clocks has its own personality. He has explored a wide range of escapement mechanisms, including a single-wheel clock "Radiance" that employs a modified chaffcutter escapement that he described in the February 2009 issue of the *Watch & Clock Bulletin*.[6]

Clayton offers plans, complete with a materials list and detailed

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3B

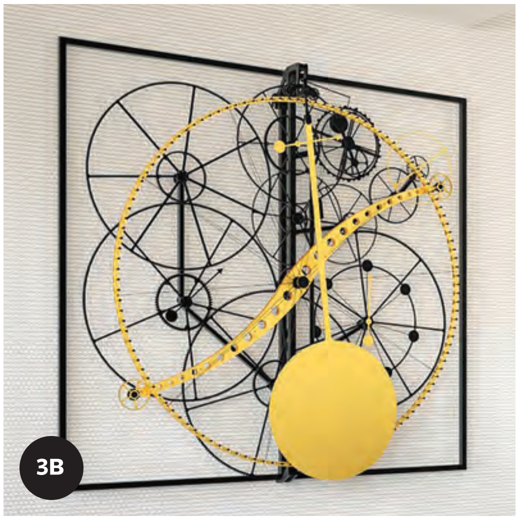


Figure 3. Time Machines created by Florian Schlumpf—Schlumpf Innovations: (A) TM3-J5, (B) TM4-C3, and (C) TM5-C2. COURTESY OF FLORIAN SCHLUMPF.

3C

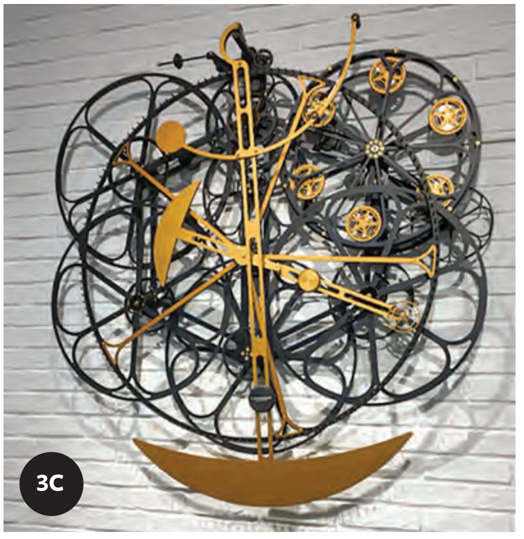


Figure 4. Three examples of Clayton Boyer's wooden clocks: (A) Simplicity, (B) Radiance, and (C) Swingtime. COURTESY OF CLAYTON BOYER.

instructions for almost all his designs (www.lisaboyer.com). His clock plans range from "Simplicity," designed as an entry into clockmaking, to a series of clocks in his "masochist's corner." He will only sell plans of these challenging clocks once the customer has successfully constructed one of his simpler designs (Figure 4). Initially, the clocks were designed to be cut from wood using a scroll saw; however, he now offers plans in digital format (.dfx files), allowing the components to be cut using a computer-controlled router, laser cutter, or even 3D printed.

Clayton's goal has always been to spread the joy to other woodworkers that he has found in creating these wonderful mechanisms, and he has a large and loyal following of "clocksters" who have built many of his designs. A search for "Clayton Boyer clocks" on YouTube reveals videos of the clocksters' work; some rigorously follow the original design, others have made significant customizations. In addition to clock plans, Clayton has also published a book entitled *A Practical Guide to Wooden Wheeled Clock Design* in which he shares his "secrets" of clock design. Although this book focuses on the design and construction of wooden clocks, it is an excellent introduction to making clocks from any material.

Phil Abernethy — Chronometric Machine Works

A third-generation clockmaker, Phil Abernethy began his career at age 14 working under his father, David Abernethy. Initially undertaking clock restoration in their company Abernethy & Son based in Toronto, Canada, Phil later specialized in tower clock restoration and public clock commissions.

Exposure to many great works, combined with a lifelong interest in art, provided the grounds to explore the potential of clockwork as art. Over many years of experimentation, he has developed a sculptural approach to his craft while paying homage to its centuries-long history. His early work was more of an abstraction of horological norms, more horologically inspired kinetic art, than true clockmaking. Lately, his work has taken on a more classical approach, building on his ideas from the past couple of decades (Figure 5). He has two favorite escapements: the Grasshopper ranks first on his list by virtue of its geometry and animation, and a close second is the Gravity escapement. For his recent clocks, he has developed some unique adaptations of these escapements that enhance the clocks' sculptural and aesthetic qualities.

Phil uses an array of materials that has included acrylic, copper, brass, aluminum, peacock feathers, and LED lighting. Additional information on the intent behind his clocks and further technical details can be found at his website (www.philabernethy.com) and *The Naked Watchmaker* blog.[7]

Figure 5. Clock creations by Phil Abernethy—Chronometric Machine Works: (A) Space Time No. 1, (B, C) Dual Grasshopper. COURTESY OF PHIL ABERNETHY.

Jeff Schierenbeck — Wooden-Gear-Clocks

From the basement of his house in Eau Claire, WI, Jeff Schierenbeck and his wife, Marcie, started their business, Wooden-Gear-Clocks, selling kits of his clock design in 2002. A couple of years earlier, Jeff had "designed and built his first wooden gear clock as a gift for his clock-loving father-in-law, cutting all the parts by hand with a scroll saw. Additional clocks for other family members soon followed. When others expressed interest in the clocks, Jeff employed laser cutting to produce clocks in kit form. A website [www.wooden-gear-clocks.com] followed, along with the production of another clock design. . . . The business continued to grow. In 2007, a building was purchased and renovated, a CNC laser was purchased,"[8] and operations were moved out of their house and into the new shop in Altoona, WI.

Wooden-Gear-Clocks now offers a range of six clock designs, with plans for more in the works. Figure 6 shows three examples. Jeff's clocks cater to a range of customer's desires and capabilities. The designs can be purchased as complete kits with a detailed instruction manual, offering

Figure 6. Jeff Schierenbeck—kits from Wooden-Gear-Clocks: (A) Ascent, (B) Legacy, and (C) Tranquility. COURTESY OF JEFF SCHIERENBECK.

someone with basic mechanical skills and standard household tools the satisfaction of creating an attractive, working clock to adorn their wall. Alternatively, just the plans and critical hardware can be purchased, allowing the purchaser to cut the components using a scroll saw and drill press. Other combinations of plans, pre-cut parts, and materials are also available.

James Borden — Timeshapes

Visitors to the National Watch & Clock Museum in Columbia, PA, are drawn to the organic form, graceful curves, and large exposed wooden wheels of James Borden's clock (Figure 7A).

James refers to his clocks as Timeshapes, also the name of his business (www.timeshapes.com), which he recently relocated to Red Wing, MN. He creates 10 to 15 clocks each year using combinations of walnut, maple, and cherry. His clocks vary in size from table clocks to monumental clocks. His largest clock so far is a 30' tall clock that was commissioned for Boston Scientific Corporation in Minneapolis- (Figure 7B). On his website, James describes Timeshapes as presenting "a different vision of the passage of time: less frenetic and urgent than the normal ticking of a clock; slower paced; peaceful; playful; something easier to live with."

As part of studying for a Bachelor of Arts degree in humanities, James had read about American clockmaking history, including the early New England clockmakers' wooden mechanisms. While studying in Munich, he and a friend saw the famous Glockenspiel tower clock, which inspired them to build a clock for a class project. James spent the year after graduating creating pieces in his parents' basement, including a Victorian clock in the style of a jeweler's regulator. He made a movement for the clock but got so frustrated trying to fit it in the cabinet and line it up with the dial's holes that he just decided to make the clock work freestanding or hanging out in the open and go literally "outside of the box" with the design. This became the aesthetic forerunner of his future works. He later attended Wartburg Theological Seminary in Dubuque, IA, but eventually realized he would rather pursue his interest in clockmaking. James opened his clock shop in 1985 to repair and restore antique timepieces. Gradually, his clocks transitioned away from traditional design to emphasize the clock mechanism's kinetic, sculptural nature.[9]

Dave Atkinson — Woodentimes

Originally from Yorkshire, England, Dave Atkinson left school at 17 and did small jobs before deciding to travel around the world. He got as far as Switzerland, where he met a German girl who became his wife. They settled near Frankfurt, Germany, and Dave trained as a carpenter to support his new family. Working in construction in the summer, he needed income in the winter and started to build things, eventually making wooden clocks. He learned clockmaking by trial and error. Initially selling

Figure 7. James Borden's "Timeshapes": (A) wall clock at the National Watch & Clock Museum, Columbia PA, COURTESY OF THE NATIONAL WATCH & CLOCK MUSEUM, (B) clock displayed at Boston Scientific, Minneapolis, MN, COURTESY OF JAMES BORDEN, and (C) a suspended clock, COURTESY OF JAMES BORDEN.

completed working clocks, Dave soon transitioned to selling his clocks in kit form.[10]

Woodentimes (www.woodentimes.com) now offers a choice of 11 clock designs (three of which are shown in Figure 8). One design, Undecimus, can be constructed from laser-cut cardboard and paper that is delivered in a flat, letter-size envelope; it can be built on a kitchen table. Dave offers full clock kits as well as paper plans and computer .dfx files for those who want to make their own parts. His customers use materials ranging from plexiglass to wood to create a unique appearance for their clocks.

Eric Freitas — The Clockwork of Eric Freitas

When Eric Freitas went to the College for Creative Studies, Detroit, MI, in the late 1990s, his focus was on design, painting, and sculpture. His career as a professional illustrator left him unfulfilled, though, and he turned away from art altogether for a while until the world of clockmaking grabbed ahold of him.

Eric has always been impressed by the precision work and finishing details applied by clockmakers but found imperfection and asymmetry to be aesthetically more interesting. To give the viewer a sense of time, he presents a narrative of change and transformation in his clocks. Wear and tear, rebirth, and growth all contribute to a sense of time passing. In much of his work, there is a story of a clock that once-was, now overtaken by nature and becoming something new.

Eric made several quartz clocks but was also intrigued by W. R. Smith's *How to Make a Skeleton Wall Clock*,[11] so he decided to create fully mechanical clocks. He knew how to use a metalworking lathe and a manual milling machine, having been trained by his father, an automotive engineer, so Eric had the means to bring his ideas to reality. He made his first mechanical clock by following the steps from Smith's book but it was nowhere close to the example clock's appearance. It functioned as a mechanical clock but it looked completely nontraditional. At the end of 2019, Eric completed his first high-complication clock—a perpetual-calendar clock called "Perpetual No. 1" (Figure 9). More information about Eric's work can be found on his website (www.ericfreitas.com) and in an April 2020 *Quill & Pad* article.[12]

Lessons Learned

All but one of the clockmakers presented here were self-taught with no formal background or training in horology. In describing their path to becoming a clockmaker, each expressed a lifetime fascination with things mechanical and realized the possibilities of combining mechanical function with aesthetic beauty through their clocks.

Their clocks' artistic styles range from flowing, organic forms and gothic surrealism to industrial, geometric shapes. Most of the clockmakers highlighted here use wood as the primary material, although this grouping may be due to my own bias toward wooden clocks. The

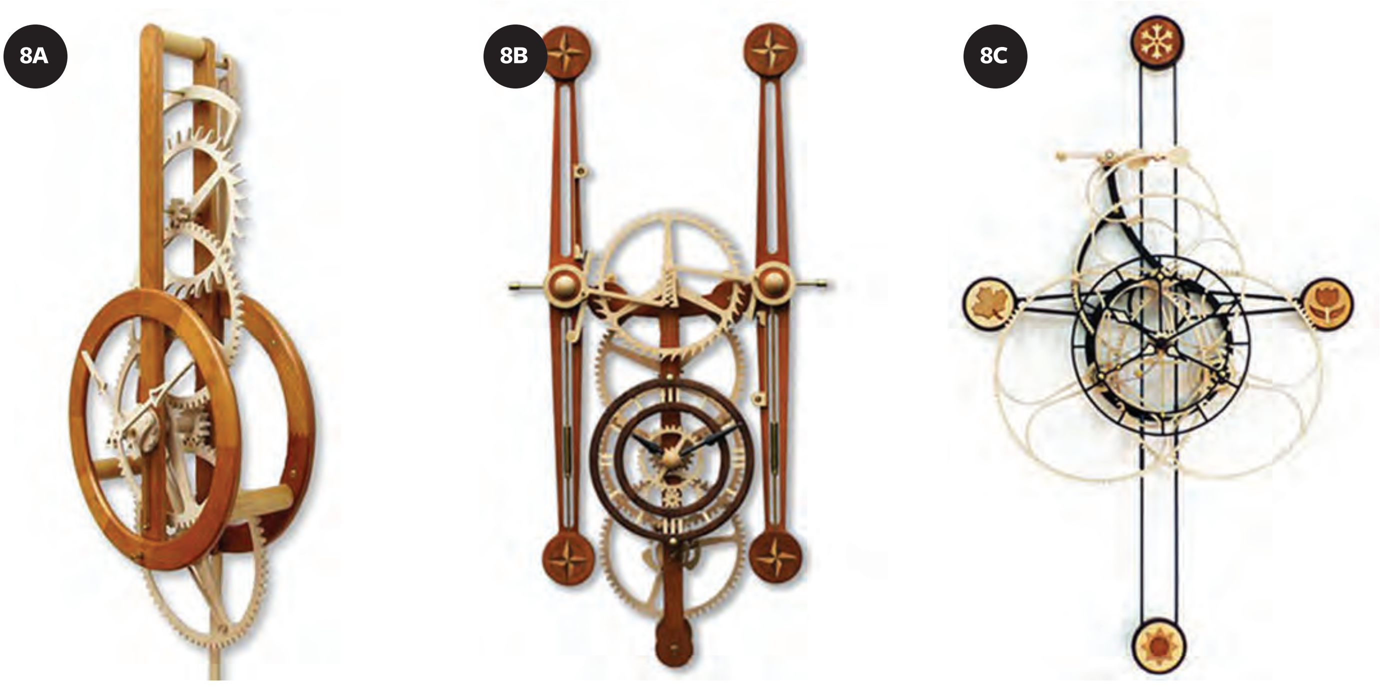


Figure 8. Clock designs by Dave Atkinson—Woodentimes: (A) Primus, (B) Sextus, and (C) Duodecimus. COURTESY OF DAVE ATKINSON.

choice of motive power includes weight- and spring-driven, with some incorporating electric winding mechanisms. The grasshopper escapements' visual dynamics and possible innovative variations make it a popular, although not exclusive, choice.

With the prevalence of a variety of accurate timepieces in our lives, clockmaking design is no longer bound by the traditional requirements of accuracy, reliability, and infrequent winding. Contemporary clockmakers are free to create clocks that express more than just time. A clock can be a work of art that accentuates the mechanism's motion, giving the purchaser an aesthetic value that they would not get from a mass-produced timepiece. Modern clocks span the spectrum of form versus function.

It is notable that most of these clockmakers are using computer-aided design (CAD) tools to create their clocks. In some cases, they are taking advantage of high-quality virtual renderings of the clock in motion to assess its aesthetic qualities before commencing fabrication. With a digital representation of the clock, many of the clockmakers have chosen to embrace the use of computer-numerical-controlled (CNC) machines to form some of the components. The machines they use range from laser cutters and CNC mills to multi-axis machine tools.

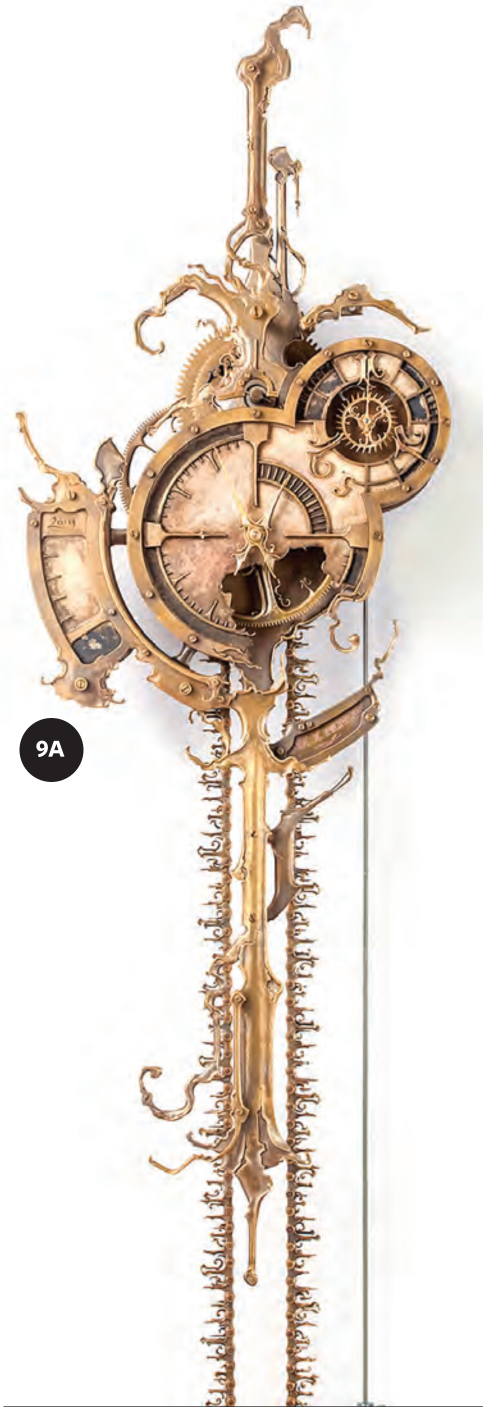
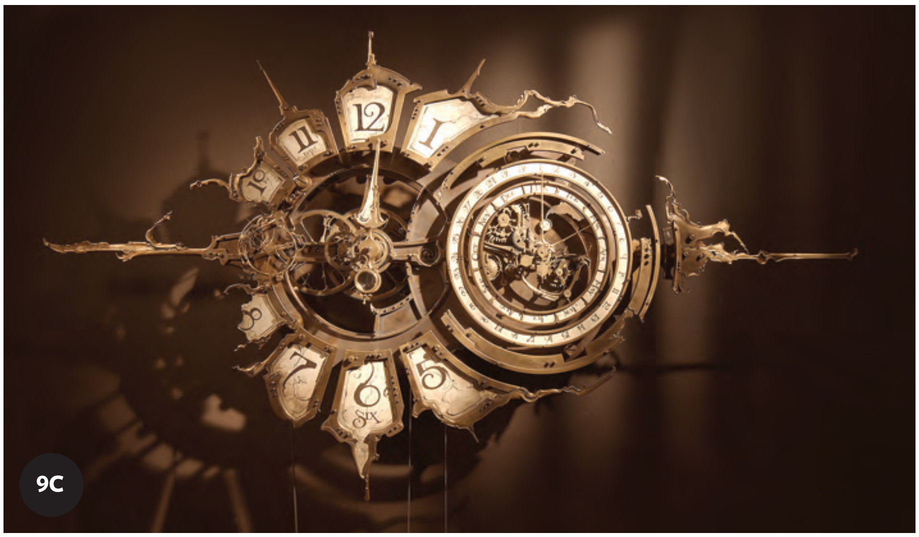


Figure 9. Clock designs by Eric Freitas: (A) Quinquagenarius, (B) closeup of Quinquagenarius, and (C) Perpetual No. 1.
COURTESY OF ERIC FREITAS.



For me, one of the most interesting aspects is that three of the featured clockmakers have decided to sell their clock designs as plans or kits rather than as completed clocks. There are several advantages to this; for example, the clockmaker does not have to worry about shipping a delicate object or servicing the clocks that are sold. They also gain the satisfaction of seeing a single clock design giving pleasure to multiple customers, many of whom are first-time clockmakers.

These clockmakers (and several others who sell plans and kits of more traditional clock designs) have recognized that people still want to build clocks. The ability to satisfy this market with affordably priced plans and kits has been enabled by the introduction of personal computers and computer-controlled laser cutters in the last 20 years or so. Before this, it would have been challenging to produce high-quality clock plans or to accurately cut wooden clock parts at an affordable price.

In total, these three clockmakers have sold significantly more than 12,000 clocks in plan or kit form.[13] Even after accounting for sales made to repeat customers, many thousands of people have been introduced to clockmaking by purchasing plans and kits from these clockmakers.

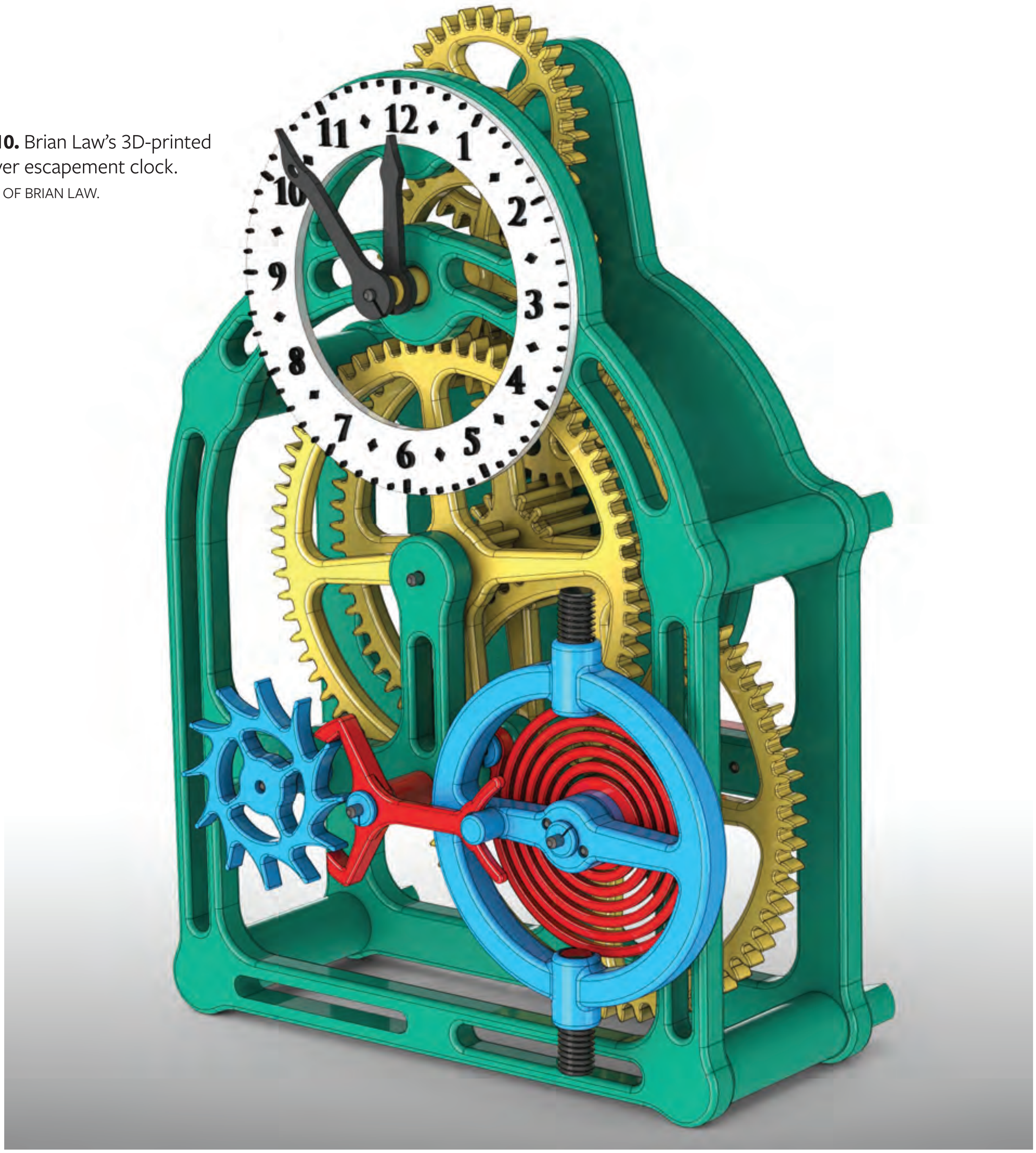


Figure 10. Brian Law's 3D-printed Swiss lever escapement clock.
COURTESY OF BRIAN LAW.

It is unclear what happens to all these neophyte clockmakers once they have constructed one or more clocks from kits or plans. Is their interest in clockmaking satisfied after making a clock or two, or would they like to learn more, perhaps design and build their own clocks, but they do not know how to proceed?

The remainder of this article explores possibilities for building on the interest that these novice plan and kit clockmakers have shown by constructing their first clock. How can they be encouraged to take a deeper interest in clockmaking or other aspects of horology?

Future Horologists

Embracing technology to create contemporary clocks could be the answer to attracting the much-needed next generation of horologists. Starting with one of the available digital designs of a clock (available from either the clockmakers featured above or several others offering similar products), the novice clockmaker can use relatively inexpensive CAD software to modify the design or use it as the starting point for their own creations. Of course, the CAD design can be used to fabricate components using traditional techniques, but it opens the opportunity to take advantage of computer-controlled machines such as a laser cutter or CNC router to create a clock's components. Computer-controlled machines are becoming less expensive each year, but the starting price for the entry-level equipment and associated software is approximately $1,500, so it is a significant investment. There has been, however, a phenomenal growth in makerspaces (also called fab labs or hackerspaces) across the United States in public libraries, schools, colleges, nonprofits, or for-profit organizations. Makerspaces usually offer access to a variety of computer-controlled cutting machines and often have instructors who can provide guidance in their operation.

Another exciting development is the growth of 3D printing and its potential use to fabricate clock parts. The accomplished wooden clockmaker (and vendor of clock plans), Brian Law, among others, has pioneered the use of 3D printing to create clocks. Figure 10 shows Brian's 3D printed Swiss lever escapement clock. The digital file and instructions on constructing this and other clocks are available from his website (www.woodenclocks.co.uk). As with computer-controlled cutters, purchasing a 3D printer requires a significant investment but these printers are often available at makerspaces.

Three-dimensional printing and similar manufacturing technologies to fabricate both plastic and metal components are still in their infancy. But they could allow clockmakers to manufacture parts that would be extremely difficult if not impossible to create using conventional manufacturing techniques. Taking advantage of the capabilities of 3D printing opens the possibility to create some very innovative contemporary clocks.

There is a big step from constructing someone else's design to designing one's first clock, whether it is designed on paper or using CAD software; constructed from wood, plastic, or metal; or fabricated using a lathe, scroll saw, CNC machine, or 3D printer. The vendors of clock kits and plans typically offer excellent support for their customers, but it is unrealistic to expect them to give novice clockmakers help and advice on their designs. So, where does a novice clockmaker turn to for help? Continuing with the theme of taking advantage of technology, the NAWCC's online Forums (mb.nawcc.org > Horological Education > Clock Repair, Restoration, & Design > Clock Construction) offer an ideal resource for those needing advice on tools and techniques for creating contemporary clocks.

Conclusion

In the middle of the 20th century, the blossoming of modern studio ceramics evolved from the confluence of charismatic people, ideas, and events.[14] The impetus for writing this article was to highlight the innovative work produced by a small nucleus of contemporary clockmakers and explore the idea that a clock can be both an artistic expression and an accurate timekeeper. Recent advances in affordable computer-aided design and machining technology, their availability at makerspaces, and the ability to share knowledge through the NAWCC Forums could be the factors that stimulate a resurgence in clockmaking. In the future—hopefully!—it may be common to see contemporary clocks alongside studio ceramics for sale at art fairs and displayed in galleries and museums.

Acknowledgments

The author thanks Phil Abernethy, Dave Atkinson, James Borden, Clayton Boyer, Eric Freitas, Rick Hale, Brian Law, Jeff Schierenbeck, and Florian Schlumpf for responding to numerous emails, sharing their stories, and giving permission to use photographs of their work. Their thoughts and feedback significantly improved the final version of this article. The opinions expressed are the author's alone, and he is responsible for any errors or omissions.

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14. See Cooper, *A History of World Pottery*, and also Newby and Benjamin, *A Beautiful Spirit.*

About the Author

Richard Cedar studied mechanical engineering before becoming a jet-engine designer. Being single, he thought that taking pottery classes would be an excellent opportunity to meet eligible young ladies. Richard ended up falling in love with making pots rather than a potter. He taught evening pottery classes at a local recreation center until his career became all-consuming, and he gave up pottery. While searching online for something to amuse himself on a cold winter's night in 2004, Richard came across Jeff Schierenbeck's Wooden-Gear-Clocks kits. He bought one and quickly constructed it, not realizing that this would be the start of a quest to design clocks that balance the hypnotic beauty of a kinetic sculpture with an accurate timekeeper. See www.CedarClocks.com for additional information on Richard's clocks.

Moments: Time in the Arts

If your travels take you to Germany this winter, be sure to see the exhibit "Moments: Time in the Arts" at the Museum in Wittelsbach Castle, Friedberg, running from November 20, 2021, to February 20, 2022. The exhibit will feature works of art from the 16th century to the present, drawing attention to special moments and aesthetics in the artistic treatment of the phenomenon of "time." Contemporary clockmaker Florian Schlumpf will create a "time machine" specifically for this exhibit. Exhibit details are available at https://museum-friedberg.de/sonderausstellung.

Astronomical Skeleton Clock

Completed after 12 Years of Construction, Part 1

By Mark Frank (IL)

Overview

Born of a happy convergence of artist and artisan, exuberant creativity, and exquisite craftsmanship, this machine is a work of art in which mechanics, visual fantasy, and fun converge.

In August 2007, the *NAWCC Bulletin*[1] published the first article on a complex astronomical skeleton clock commissioned by the author and being built by Buchanan of Chelmsford, Australia.[2] At that time a detailed, full-size wood mock-up was completed, and that article covered the proposed clock's mechanical specifications and functions as depicted through the mock-up. A follow-up article was published in April 2011, marking roughly what we thought would be the halfway point in the construction; in reality it was only one-third.[3] At that time the four movement trains with much of the "between the plates" components were completed. These are the basic time, celestial, quarter and hour strike trains, the last two combined into one module. In a two-part *Watch & Clock Bulletin* article published in the January/February 2017 and March/April 2017 issues, I began to cover the fabrication of the complications as represented by the clock's dial work: petite and Grande sonnerie strike and repeat, sidereal time, equation of time, and a third-order perpetual calendar.[4]

In this fourth segment, I will continue to cover what has been accomplished since the 2017 *Bulletin* articles through early 2019. These encompass the tellurion, Sun/Moon rise and set, orrery, thermometer, planisphere and international time dial. The project is now complete.

The mechanical portion of the clock is complete but there are still the remaining tasks needed for final areas of refitting, improvements, debugging, and a complete polishing, which involves taking the entire mechanism apart down to the last screw for bluing and parts for polishing. As of this writing, we decided to encompass one final and major design change: a switch from the clock being weight driven to spring driven.

At this point one might ask, "Why is this taking so long?" I would direct the reader to the earlier three articles for a full explanation of the complexities and mechanical innovations of this clock. Very briefly, we are creating a machine that will have nearly 8,000 parts, including about 500 wheels, four remontoire, dual Harrison grasshopper escapements, compound and epicyclical governor fly fans, Janvier-style slant wheel variable differentials, quarter repeating Grande and petite sonnerie striking, and depending on how one counts, about 71 complications.[5] This will be the most complex skeleton clock made for its size: 34″w x 34″h x 22″d.

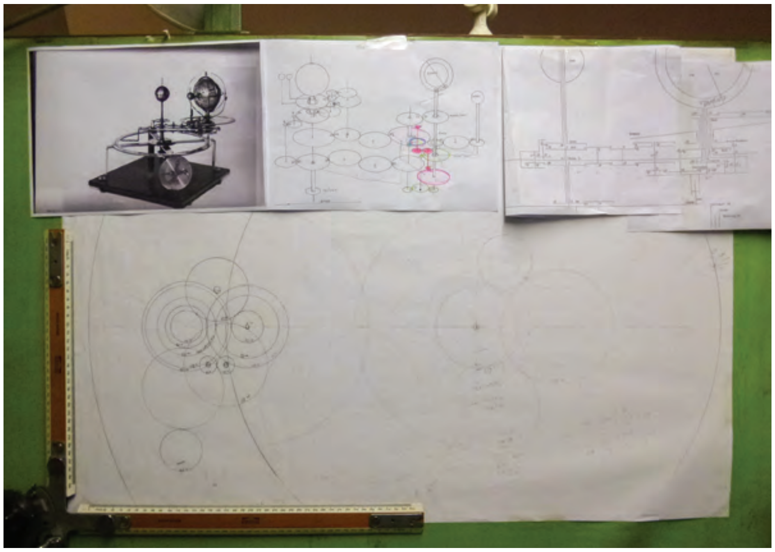


Figure 1. The starting point for the tellurion. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

The philosophy behind the design and its impact on the fabrication as well as future maintenance has been covered in the prior articles. To briefly recap: I wanted a mechanism that had complexity, a size that would comfortably fit within a home, and visual movement. It is this last specification that I believe has surpassed all others. There is always something moving to amuse the viewer. We have also broken new engineering ground by making the machine 99% oil free through the use of ceramic ball bearings and, where appropriate, dry jewel bearings. The machine is also built on a modular design: all of the celestial complications are removable without the need of tools. The three main trains are also individually removable.

I have borrowed liberally from the designs of the past masters of the horological arts: Tompion, Breguet, Janvier, Harrison, Hahn, Robin, Schwilgué, Wagner, Fasoldt, LeCoultre, and others. I can only hope that if there is a "clock heaven" they are looking down at this creation with a smile. A video demonstrating the clock can be viewed at https://youtu.be/ojdmaUYZNR8.

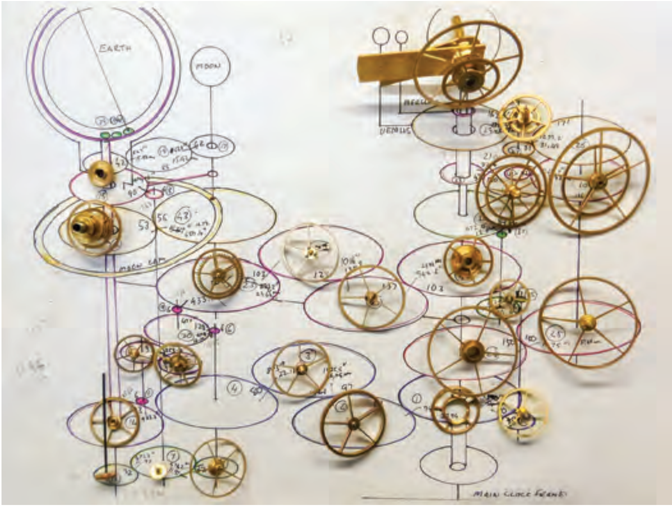


Figure 2. Buchanan's tooth-count drawing with many of the completed wheels. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

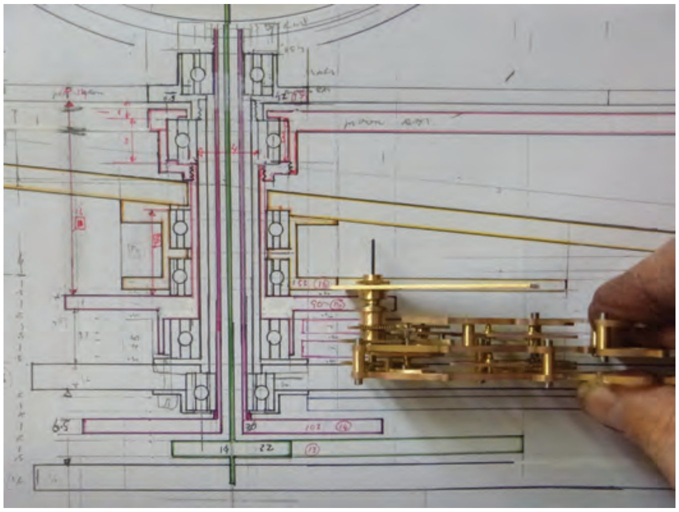


Figure 3. Cutaway drawing of the central drive for the Earth-Moon system. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

The Tellurion

Figure 1 shows the start for the tellurion complication. We began with a photograph of an example of a stand-alone tellurian by Mathäus Hahn, 1780, in the upper left-hand corner.[6] The upper right corner has a schematic of that mechanism. The upper center is a drawing of our version, which has the addition of the inner planets Mercury and Venus as well as the Earth-Moon system found in Hahn's piece. The lower, oversized paper is a scale drawing, oversized to 1:5. When a formal drawing is needed, Buchanan usually draws a large-scale size to more clearly see how the various components are arranged. Figure 2 shows the majority of the 39 wheels that will be needed for this complication.

Figure 3 shows a closer view of the side elevation depicting a cutaway view of the complex set of concentric drives for the Earth-Moon system as well as the Moon's slanted node ring depicting the 5.15-degree tilt in the Moon's orbit compared to the Earth's ecliptic. One can see the advantages of having the large-scale drawing to more clearly show the many components as compared to the actual part. In most cases tellurions and orreries are mounted horizontally, that is, the horizontal display is mounted to the vertical central drive. In our clock the tellurian is turned 90 degrees for a vertical display. The drawing as well as the part is oriented the "wrong" way in this figure to make it easier to understand. Traditionally, a set of concentric tubes are used to drive the planetary display much like the cannon pinions used in conventional clocks to drive the minute and hour hands. But more are needed for this application. Here we have four tubes along with a center arbor. Notice the set of five ball bearing rings.

Figure 4 shows the central drive upon which the entire tellurion is mounted and rotates. It contains seven ball

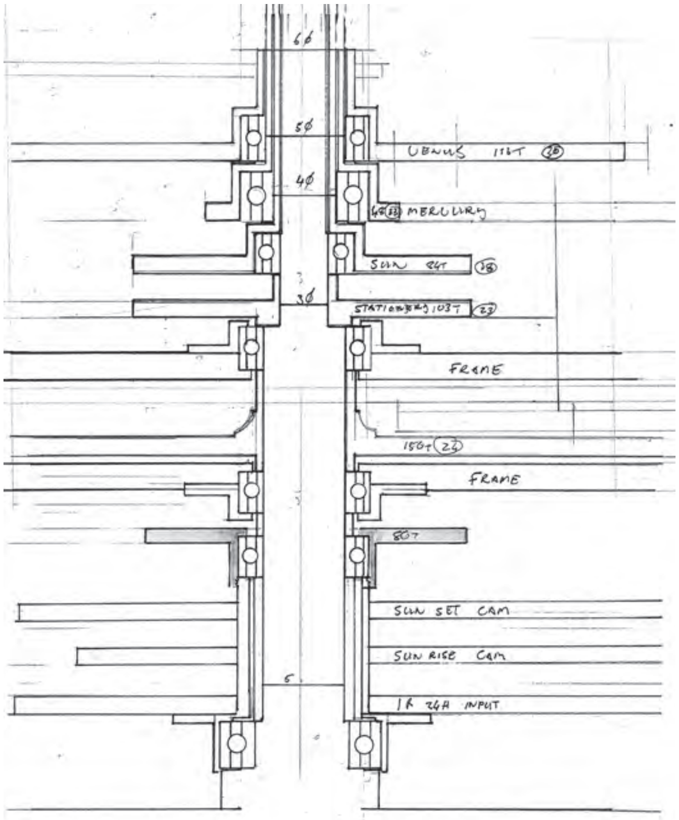


Figure 4. Cutaway drawing of the central drive for the Sun, Mercury, Venus, and the rotating tellurion frame. COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

bearings. Two pairs of bearings are for the rotating frame and support for the tellurian on the main stationary mounting post attached to the clock and three for the drives to the Sun, Mercury, and Venus. Many tellurions and orreries simply employ a Sun that does not rotate, but the Sun does have an approximate rotation of 24.47 days.

This is approximate because the Sun is a ball of slippery plasma and the poles actually rotate more slowly at 38 days than the areas near the equator. The view of this drawing is in the correct orientation, and it becomes immediately apparent why ball bearings are necessary in this application. Construction for such instruments in horology before ball bearings used concentric brass tubes, resulting in a fair amount of friction. This was possible with a typical design where the tubes were vertical, but where they are oriented horizontally, it compounds the friction problem, the reason why in the past, few such complex astronomical constructs were oriented horizontally.

Figures 5 through 10 show the design of the tellurion frames and the final product. All of these are cut out from the solid brass blank on a jeweler's fret saw by hand, a laborious process. All of the red dots in the illustrations represent pivot jewels. The completed frame is shown in Figures 11 and 12. One can see the double-frame construction in the first photo. A conventional frame has two plates; a double frame has three. Next is the completed assembly ready for the wheels and other components.

We now begin the next complication within the tellurion. There are two dials that will denote the sidereal and synodic months. Figure 13 explains the differences between the two. The sidereal month closely resembles sidereal time displayed on the clock's main time dial, but substitutes the Moon for the Earth in relation to the observation of a distant star.[7] The sidereal month is 27.322 days, while the synodic month is 29.531 days, the period we are familiar with for the Moon's motion.

The design in Figure 14 is compiled into a CNC mill equipped with a precision cutter to engrave the dial on this tiny scale (Figure 15). Figure 16 shows the small scale at which we are now working. The size of engraving here compares to that which one finds on a watch dial; Buchanan employs computer-aided machinery. Both dials are shown mounted within the area that will be below where the Earth globe will be positioned (Figure 17). The circled areas on the image show the tiny pointers that read the information from the dials. The two tiny gears at the center will drive the Earth.

Figure 18 shows one of a pair of Earth horizon markers. As the Earth rotates, this one indicates where on the Earth the Sun will rise and set. A second pair indicates the same information for the Moon's rise and set. Figure 19 shows the extremely small screws used to secure the horizon markers as well as other small sector dials located in this area. Figure 20 shows the Moon's node ring. This ring represents the Moon's 5.15-degree tilt in relation to the Earth's ecliptic. The upper and lowest points of the Moon's tilted orbit are its *nodes*. The node points are indicated by the triangular indicator on the sector dial mounted to the inside of the node ring. The ascending node, uppermost point, is located at 12 o'clock

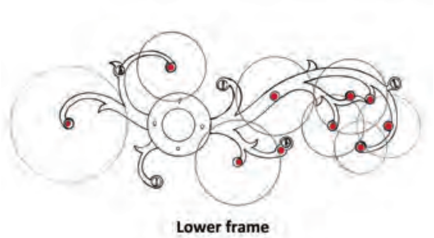


Figure 5. Design drawing for the lower tellurion frame. COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

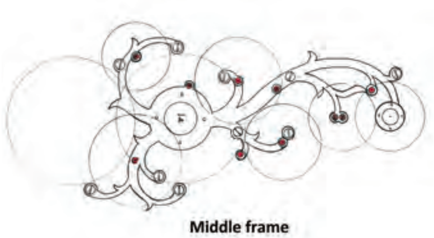


Figure 6. Design drawing for the middle tellurion frame. COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

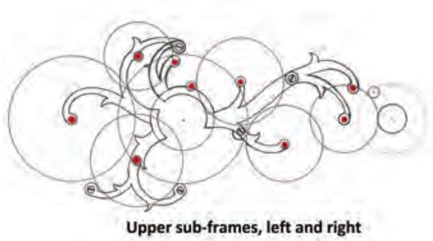


Figure 7. Design drawing for two upper tellurion sub-frames. COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

Figure 8. Initial test plate for fitting of the tellurion to the clock. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

Figure 9. Design drawing positioned for transfer to the plate. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

Figure 10. The completed full frame and sub-frame pairs. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

Figure 11. Side elevation showing the double-frame design. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

Figure 12. The completed filigree frames with jeweling. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

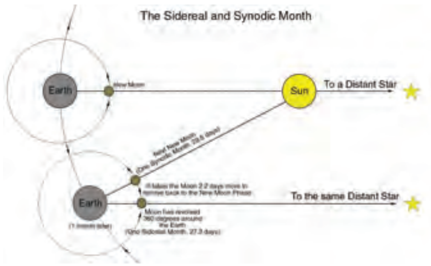


Figure 13. Sidereal and synodic months. COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

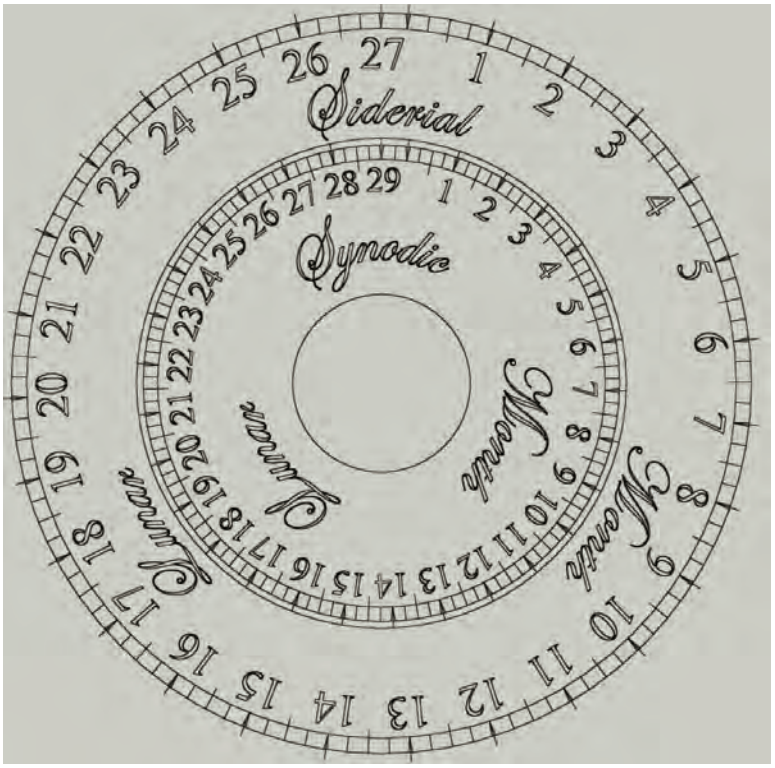


Figure 14. The artwork for the sidereal and synodic dials. The misspelling *siderial* was later corrected. COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

Figure 15. The completed dials. PHOTO BY BUCHANAN, The misspelling *siderial* was later corrected. COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

Figure 16. Diminutive size of dial and superlative engraving. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

Figure 17. The dials installed below where the Earth resides. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

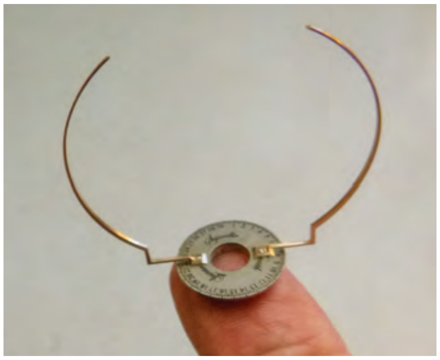


Figure 18. A pair of sunrise and set horizon markers. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

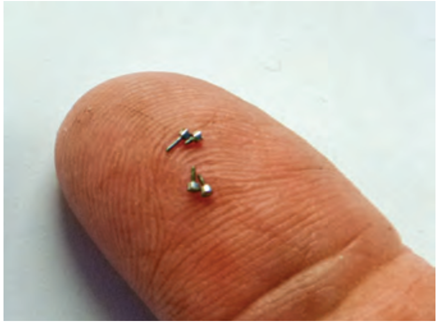


Figure 19. Tiny custom-made screws to secure the markers. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

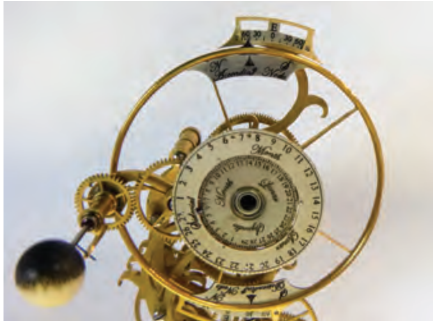


Figure 20. The node ring with eclipse season windows at 6 and 12 o'clock. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

Figure 21. Earth globe cut from mammoth ivory section. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

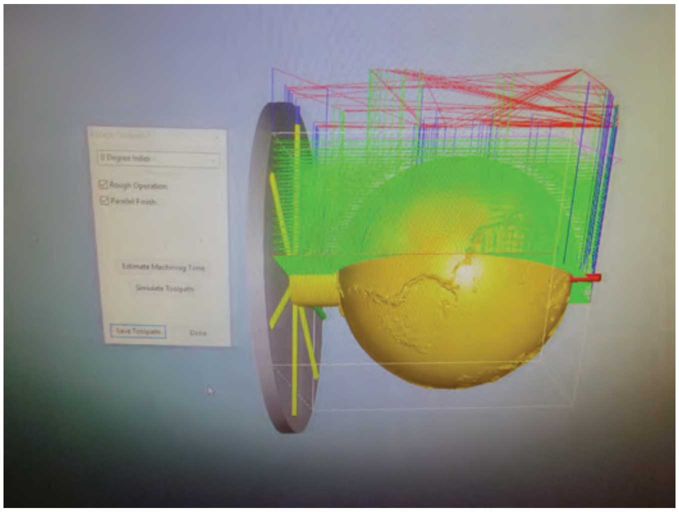


Figure 22. Globe continents in relief modeled on a computer. COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

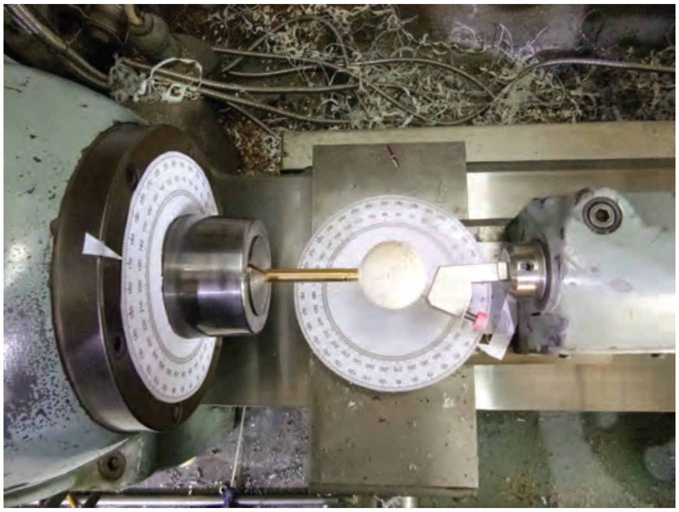
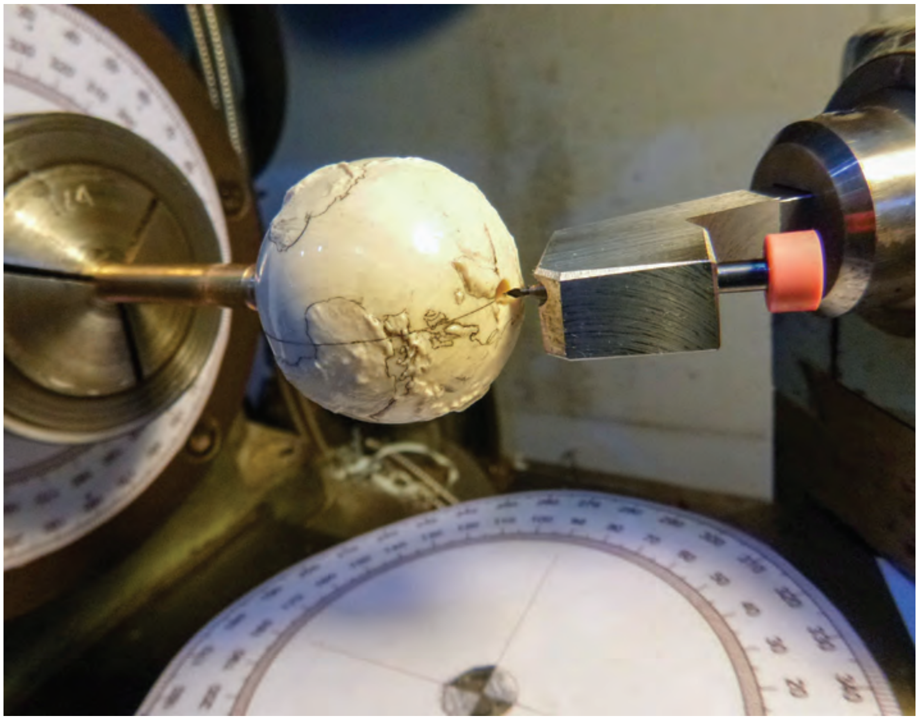


Figure 23. Setup with X-Y scales for latitude, longitude lines. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

Figure 24. Close-up of the latitude, longitude scrimshaw lines. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.



and the descending node, lowest point, is at the 6 o'clock position. The Moon's nodes are in precession around the Earth, orbiting once every 18.6 years as does the ring.

A smaller sector dial is seen near the 12 o'clock position outside the node ring. This is the eclipse season window. When a node is within the season window and the Moon is directly between the Earth and Sun, an eclipse will occur somewhere on the Earth's surface. One can use the degree scale on the season window dial along with a movable latitude ring around the Earth to locate where an eclipse will begin. The "E" on the season dial is the eclipse window, the approximately eight-hour window through which the Moon moves and that an eclipse will be visible upon the Earth, covering about one-third of Earth's rotation. The same principles apply for a lunar eclipse when the Earth is between the Moon and the Sun. When the celestial train is in demonstration mode, one can use the 400-year perpetual calendar and the 24-hour world time dial in conjunction with these components to predict where and when a solar or lunar eclipse will occur with an accuracy of a few hours. Since the demonstration also works in reverse, one can see when an eclipse has last occurred. And because the calendar is perpetual for 400 years, theoretically if one wanted to crank the demonstration dial the many thousands of times necessary, an 800-year period could be observed. This is the only tellurion I know of that has these capabilities. A video demonstration of how this works is available at https://youtu.be/HvTJ3G5qbZ8.

We explored a number of designs for the Earth globe. This and the Sun are the largest spheres represented in any of the celestial displays, thus it will command special attention. I wanted it to be immediately recognizable as the Earth, so a natural stone analogy would not work. There are commercially available globes made from stone mosaic representing the land surfaces, but these need to be much larger than our 1.5" (3 cm) diameter to get the detail necessary. We will be using semiprecious stone spheres for the remaining planetary bodies as well as the Sun in both the tellurion and orrery. The current Sun and other planets are still mock-ups.

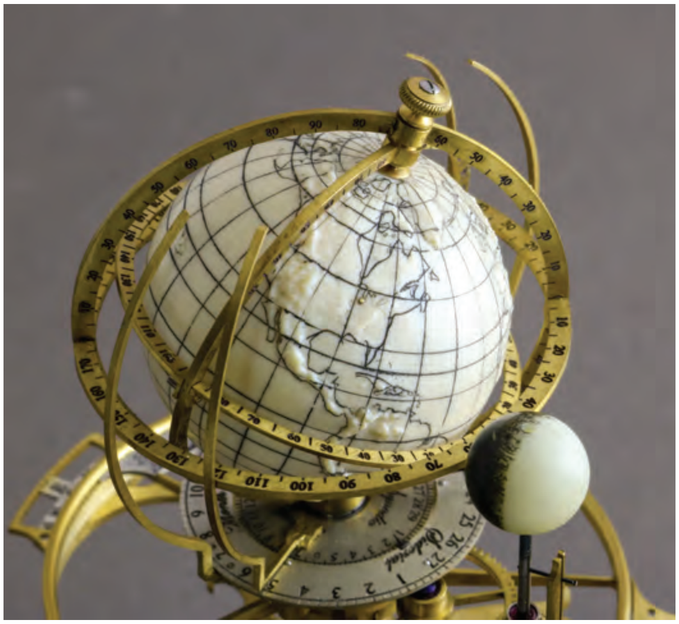


Figure 25. The completed globe and engraved rings. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

I wanted the Earth globe to have a special antique look, and I have always admired the look of walrus and ivory scrimshaw artwork. Scrimshaw allows the artist to create a very complex design on the bone surface and when dyed with black ink or tea, creates a beautiful effect and allows for fine detail. Since ivory importation has been banned in many countries as well as in this machine's ultimate destination, we had to use an alternate material. Walrus was the first choice, but it was too difficult to find a piece of walrus tusk large enough to obtain the piece we needed. One must remember that these are natural materials and most often have cracks and other imperfections around the perimeter radiating inward. One needs a large cross section of material to get a perfect area at the heart of the tusk to obtain a flawless piece. Any imperfections would be picked up in the dying process after the scrimshaw has been completed. Figure 21 shows the mammoth ivory piece we used. One can see how large it needed to be to get the perfect rough blank. Mammoth also has a nice patina, just the look I wanted. There is enough material left for us to use elsewhere for winding handles. Another feature that mammoth afforded was the ability to create land features on the globe. From the beginning we decided against political boundaries. First, these are simply too complicated for a globe of this size and second, these will change throughout the life of the machine. But we could outline the land masses as well as add longitude and latitude lines. This material also allows one to carve the piece in relief to illustrate the various continental mountain ranges, another departure from the standard smooth Earth globe found on other tellurions, especially at this scale. Mammoth also yields easily to the cutting tool and is not brittle, so an accurate model could be produced. Figure 22 shows the Earth globe modeled on the computer; a mountain range is clearly visible.

Figures 23 and 24 show the engraving process for cutting the latitude and longitude lines. Notice the two scales attached to the tooling used to rotate the globe and move the cutter. This gives an accurate positioning of both the globe and cutter in the X-Y axis for perfectly accurate lines. The scrimshaw work outlining the land masses was done by hand.

The completed Earth globe (Figure 25) shows all of the scrimshaw work and continental topography. The

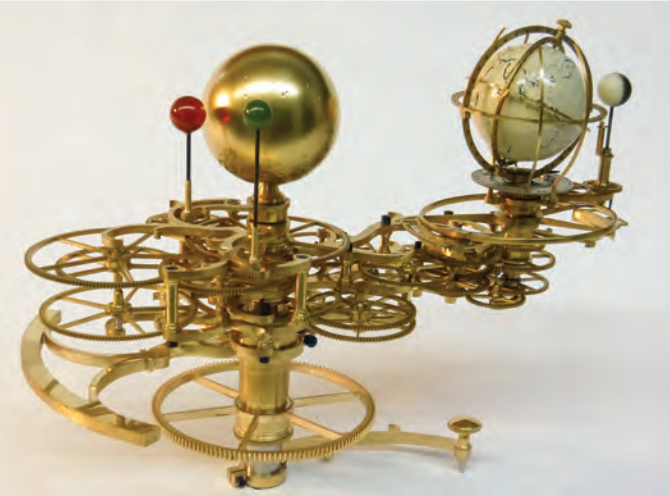


Figure 26. Completed tellurion mechanism, side elevation. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

Figure 27. Completed tellurion mechanism, top elevation. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

topography must be greatly exaggerated at this scale for one to comprehend its location. We did not inscribe all of the latitude lines because it would have become "too busy," detracting from the continental outlines. Notice the engraved detail of the longitude and latitude rings as well as the additional moveable latitude ring controlled by the small, knurled nut at the top used to interpolate the position of an eclipse in conjunction with the eclipse season dial, lower left. The two curved horizon markers for the Sun and Moon are seen in the foreground and the sidereal and synodic month dials below. If one looks very carefully, there is a tiny solid gold point for the location in the continental United States where the clock will reside. A video demonstration of the tellurion as shown in Figures 26 and 27 can be seen here: https://youtu.be/9BPT1vyB8Mc.

The completed tellurion is seen in Figures 28 and 29. It is easily removable from the mounting post as a module. This complication has 395 parts, including 30 jeweled pivots. Anyone who has seen tellurions made by the famous makers Raingo, Balthazar, Berthoud, or even Janvier will immediately recognize the superior visual appeal of this design. This is what the maker calls the "Buchananization" of what otherwise is a conventional design. This is not just restricted to making fancy designs for frames and parts, but is a unified philosophy that extends to the entire engineering design concept of the machine. Wheel diameters are stretched to fill in spaces, or multiple wheels often of varying diameters are used when visually appealing. Unusual and unique ways to accomplish an otherwise mundane functional task are designed and created. Examples abound throughout

Figure 28. The tellurion mounted within the clock. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

Figure 29. The tellurion mounted within the clock. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

the machine, from the animal analogues to the interior toothed sector gears, through the panoply of remontoire and their associated complex fly governors. We often do this for no other reason than we want to create a visual mechanical paradise.

The Sun/Moon Rise and Set Complication

Accurately representing the motion of the Moon as it appears in the sky in a mechanical fashion upon a dial is a very difficult effort. The combined gravitational influence of the Sun and Earth cause many perturbations. Together these are known as anomalies and over time they make the accumulated orbital positions of the Moon look more like a toroid than a circle or ellipse (Figures 30–33). In practice, there are five major anomalies associated with the Moon's orbital movement; in addition there are two anomalies associated with the Earth's tilt and orbit. In theory, there are dozens but the main seven will account for 98+% of these. The five anomalies are arranged in their order of the greatest to least orbital perturbations. The degree is the change in measurement from an idealized orbit. The first five corrections will give the degree the Moon leads or lags from the mean or average position of the Moon in its orbit.

1. **Great Anomaly**: This is the effect of the Moon's elliptical orbit around the Earth and has a ±6.58° equaling 26.322 minutes effect every anomalistic month, which is defined as the time between the Moon's successive perigees and is approximately 27.55 days.
2. **Evection**: This is the change in the Moon's ecliptic longitude. This is caused by the gravitational pull of the Sun and Earth, which causes the Moon to accelerate as it moves toward and decelerate as it moves away from the Sun. The period is 31.81 days. This is ±1.274° equaling 5.097 minutes.
3. **Variation**: The combined effect of the Sun and Earth on the Moon's orbit at lunar conjunction (when the Earth, Moon, and Sun, in that order, are in alignment) and at lunar opposition (when the Moon, Earth, and Sun, in that order, are in alignment). The Variation is ±0.658° equaling 2.632 minutes and has a period of half a synodic month or 14.77 days, commonly known as a lunar month, which is 29.531 days.
4. **Annual Equation**: This is ±0.186° equaling 0.856 minutes and has the period of one anomalistic year or 365.26 days. It is the combined influence of the Sun and Earth on the Moon owing to the Earth's elliptical orbit.
5. **Reduction:** This is ±0.214° equaling 0.8569 minutes and has a period of one-half the anomalistic month or 13.77 days and is due to the tilt of the Moon's orbit of 5.8° to the ecliptic.

However, to accurately show when the Moon will rise and set, two additional corrections are needed: the first is associated with the Earth and its orbit, and the second to a very minor extent is the Sun itself.

6. **Projection**: Two factors are needed to account for the Earth's 23.5° tilt from the ecliptic as well as its elliptical orbit around the Sun. These factors are the same as those needed to compute the equation of time. The projection is ±2.464°, which translates into about ±9.857 minutes in time. It has a period of one-half the tropical month or 13.661 days.
7. **Solar Equation**: This encompasses two further, very minor anomalies associated with the Sun.

Figures 30–33 depict the Moon's orbit around the Earth for one, five, ten, and sixty years, respectively. The last illustration shows a rather thick torus around the Earth. One can readily see why it is so difficult to accurately describe the Moon's orbit and therefore the rise and set times of the Moon on a two-dimensional dial.

We will correct only for the two greatest anomalies. These are the Great Anomaly at ±6.58° equaling 26.322 minutes and the Projection (which contains two corrections) at ±2.464°, which translates into about ±9.857 minutes in time. So the total maximum error involved is 36.179 minutes. All of the remaining anomalies amount to a combined 9.442 minutes. It is no accident that the dials on the Schwilgué and Festo clocks are large to take advantage of this information (see below). The combined total of all anomalies comes to ±45.621 minutes from a simple rolling Moon dial.

What has been discussed so far, however, concerns the movement of the Moon only, an astronomical discussion. We still need an additional correction that is far greater in magnitude than those astronomical anomalies to get a respectable representation of the Moon's movement on a dial. These are terrestrial corrections that account for the Earth's tilt to the ecliptic as well as its elliptical orbit around the Sun. The cam work needed is latitude-dependent, unlike the equation of time cam, which is not. Both draw upon the same characteristics of the Earth's tilt and orbit, but the equation mechanism relates to the position of the Sun when at its zenith as it relates to an observer on the Earth compared to the local time at noon on a clock; the horizon cams relate to when the Sun, or in this case the Moon, appears above or disappears below the Earth's horizon in concert to the seasonal variations,

Figure 30. The Moon's accrued orbital anomaly: one year. COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

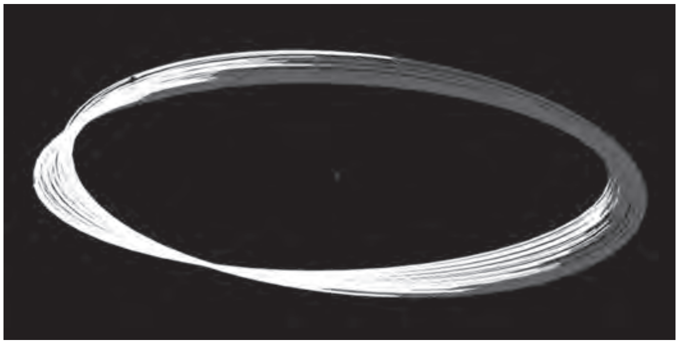


Figure 31. The Moon's accrued orbital anomaly: five years. COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

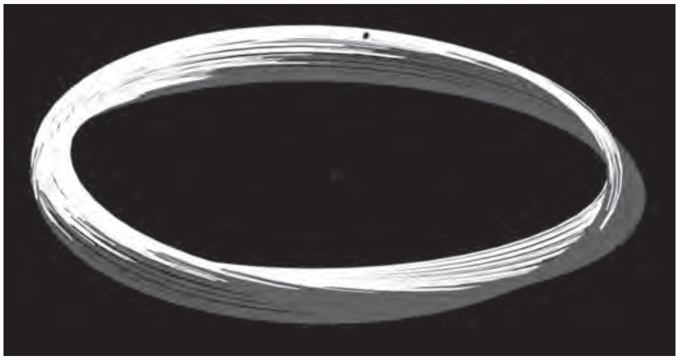


Figure 32. The Moon's accrued orbital anomaly: 10 years. COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

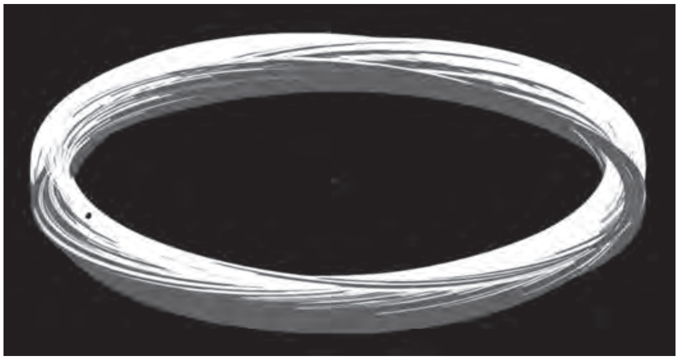


Figure 33. The Moon's accrued orbital anomaly: 60 years. COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

hence the need to calibrate the cams for latitude. The total difference in time is 6 hours 12 minutes from the shortest to the longest day. Using the prior two Moon anomalies as well as the horizon cam work, we have a total of four corrections that will allow for one to see on the dial the position of the Moon or Sun corresponding to what one sees in the sky at the latitude of Chicago, IL, at 41.88° N.

Our Moon rise and set dial is fairly small at just over 3.5" (10 cm) in diameter, so any further corrections would be barely noticeable at this scale. Even 36 minutes for the two Moon anomalies will be hard to discern. This is really more of an exercise to incorporate a classic complication rather than important additional informational accuracy in the dial.

Very few mechanical clocks have incorporated all nine corrections for these anomalies to allow for an accurate representation of the movement of the Moon. A few examples are Jean-Baptiste Schwilgué in his famous astronomical cathedral clock in Strasbourg, France, built between 1838 and 1843;[8] Jens Olsen, Copenhagen, Denmark, 1945–55;[9] Rasmus Sørnes, of Moss, Norway, 1958–66;[10] Hans Lang, of Essen, Germany, 1982–86;[11] and the multinational Festo Corporation, in Esslingen, Germany, 1995–2001 (this employs ten corrections).[12] There are surely others I have overlooked, but one interesting item that pops out is the fact that, other than Schwilgué's, all are of recent design and fabrication: all are less than 65 years old. This is probably due to the complexity of calculations and fabrication needed to make these corrections.

We looked to the few clocks that have these features for guidance. Only the Sørnes and Lang clocks were produced by a single maker (the Lang clock was not a skeleton style), and these two are also the only clocks that are small enough to fit into a domestic setting. The others were large, institutionally sized clocks and were the collaboration of many people, and the Festo was the product of a multinational corporation. These three were the ones for which there was some documentation of their design and construction. The Schwilgué offered the most information, which was found in the 1922 book by Alfred Ungerer, the son of Schwilgué's collaborator on the clock and whose company was the successor to the Schwilgué firm, *L'Horloge Asronomique de la Cathédrale de Strasbourg*, as well as the abstract from that book as represented in *Some Outstanding Clocks over Seven Hundred Years* by H. Alan Lloyd.[13] Other useful information was also contained in *Jens Olsen's Clock* by Otto Mortensen.

There are two main ways to mechanically represent these anomalies—cams or differentials—or a combination of both. We use a very special type of variable differential invented by Antide Janvier in 1791 for his *chef-d' oeuvre* (masterpiece) clock made between 1789 and 1801 to represent the equation of time. In my opinion it is one of the most beautiful yet at the same time mind-bending mechanical contrivances seen in horology.

Lang and Sørnes used a cam stack in conjunction with conventional differentials to translate the many difficult calculations involved with the Moon's complex motion into a mechanical representation that could be displayed on a clock dial. The Schwilgué clock was designed to show the rise and set of the Moon as it would appear to a person located in Strasbourg. The Festo clock also accomplishes this along with a few additional, very fine adjustments that are beyond the scope of this project. The Schwilgué and Festo clocks used the Janvier variable differential and, along with Janvier's masterpiece, are the only three examples I have seen using these differentials in a clock.

Figure 34 depicts in graphical form the five anomalies of the Moon's orbit as outlined above. These can be directly translated, when curved into a circle, creating the topological surface of each cylindrical cam needed to depict these mechanically. When one tries to research the characteristics of these anomalies on the internet or other modern sources, there is little information as to how these orbital fluctuations are translated into a mechanical form; only the technical characteristic is explained in astronomical terms. We have chosen the two largest terms, the Great Anomaly and Projection, and when compared with the remaining four, are by far the greatest anomalies. The other factor to consider is that the dial diameter in Schwilgué's clock is over 6' (nearly 2 m). So

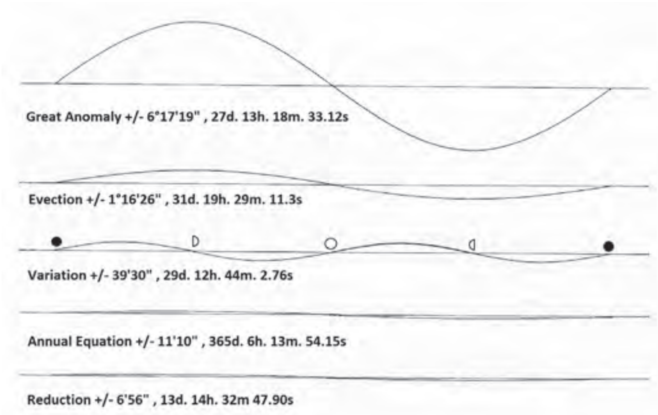


Figure 34. The five main anomalies represented as sine waves.
COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

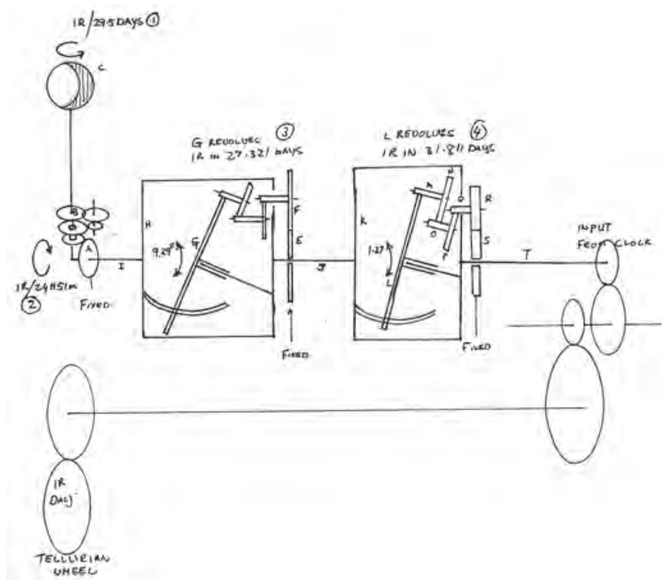


Figure 35. The initial design of Janvier slant wheel differentials.
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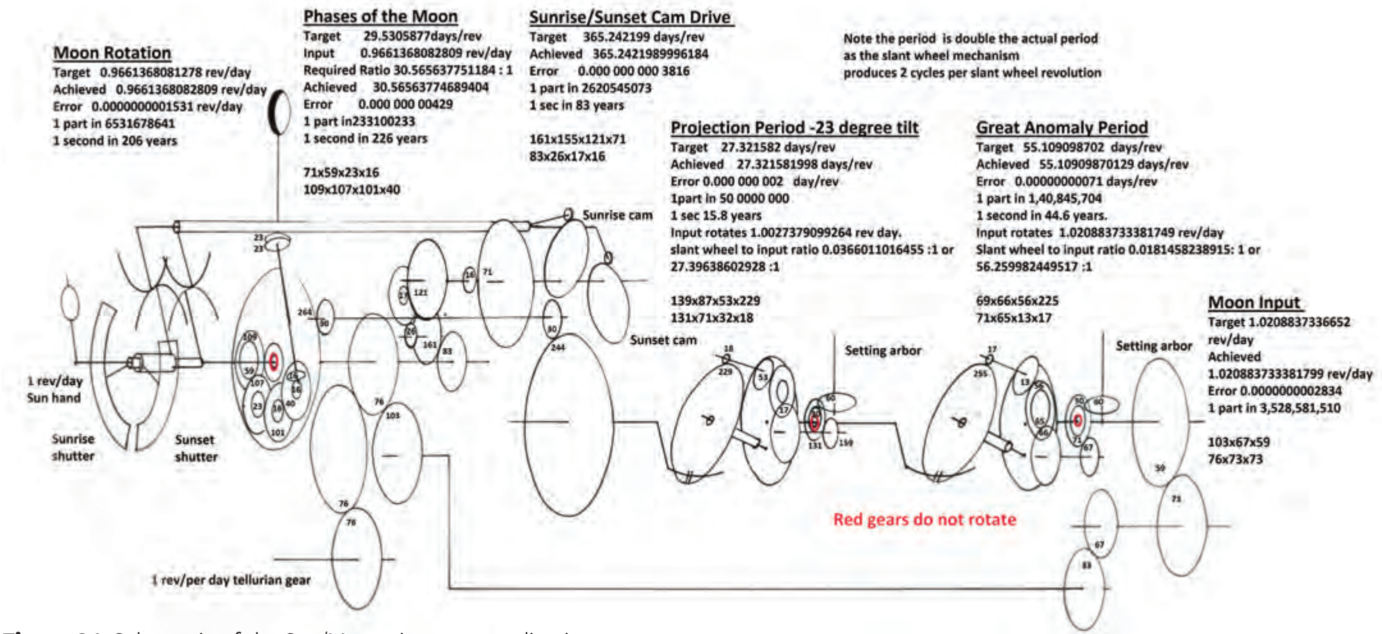

Figure 36. Schematic of the Sun/Moon rise-set complication. COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

all of these factors are far more consequential than in our dial, which is only about 3.5" (10 cm). We use a pair of slant-wheel Janvier variable differentials (Figure 35).

The complexity of this module becomes clear in Figure 36; note the accuracy achieved. Figure 37 illustrates the layout for the Sun/Moon rise-set dial. This is a good illustration of one of the design principles behind this project. We are trying to pack as much information, and by analogy, complications, into the fewest number of dials, thus allowing the viewer to see the beauty of the mechanics that create the information. It would be easy, as many past clockmakers have done, to create a dial for each complication in an effort to "show off" the many dials that represent each complication. The result, in my opinion, is a cluttered look resembling the cockpit of a large jet liner, distracting from my main objective, which is the machine.

The following information and complications can be read from this one dial and thus add 15 complications to the astronomical clock (see Figure 76 on page 396). We also have the date/month of the year on the horizon cam pack setting dial the same as the equation of time and planisphere setting dial.

1. Time of sunset
2. Time of sunrise
3. Visual position of the Sun in the sky
4. Visual indication of the phase of the Moon
5. Age of the Moon
6. Angle hour of the Moon (height in the sky) in degrees
7. Degrees to moonset
8. Hours until moonrise (we have a double hour scale on the rotating degree scale but stretched slightly compared to a real hour dial, the Moon rotates in the dial in 24 hours and 55 minutes), zero hours is at the Moon and the hours count away from the Moon, so the hour on the east horizon marker gives you hours until moonrise

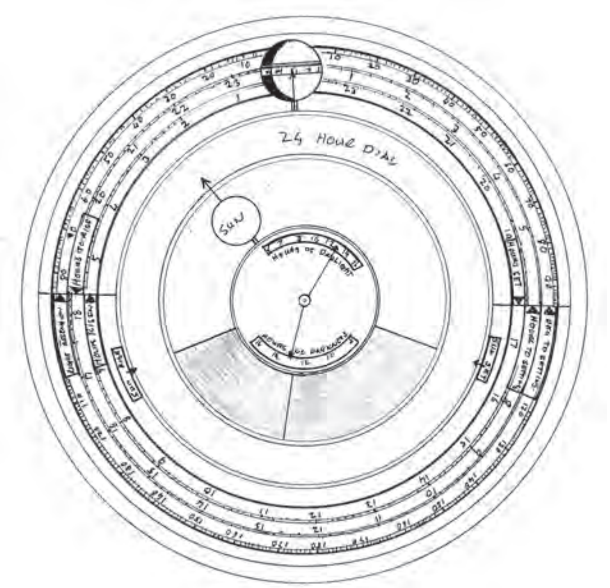

Figure 37. Dial layout. COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

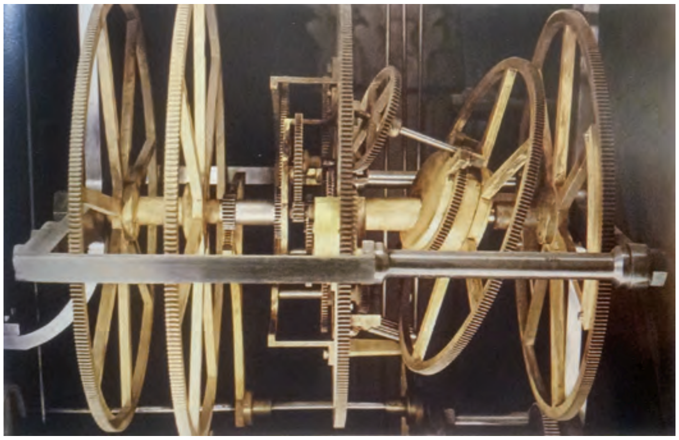

Figure 38. One of a pair of Janvier differentials within the Strasbourg Cathedral clock. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

Figure 39. A pair of Janvier's differentials in his masterpiece. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

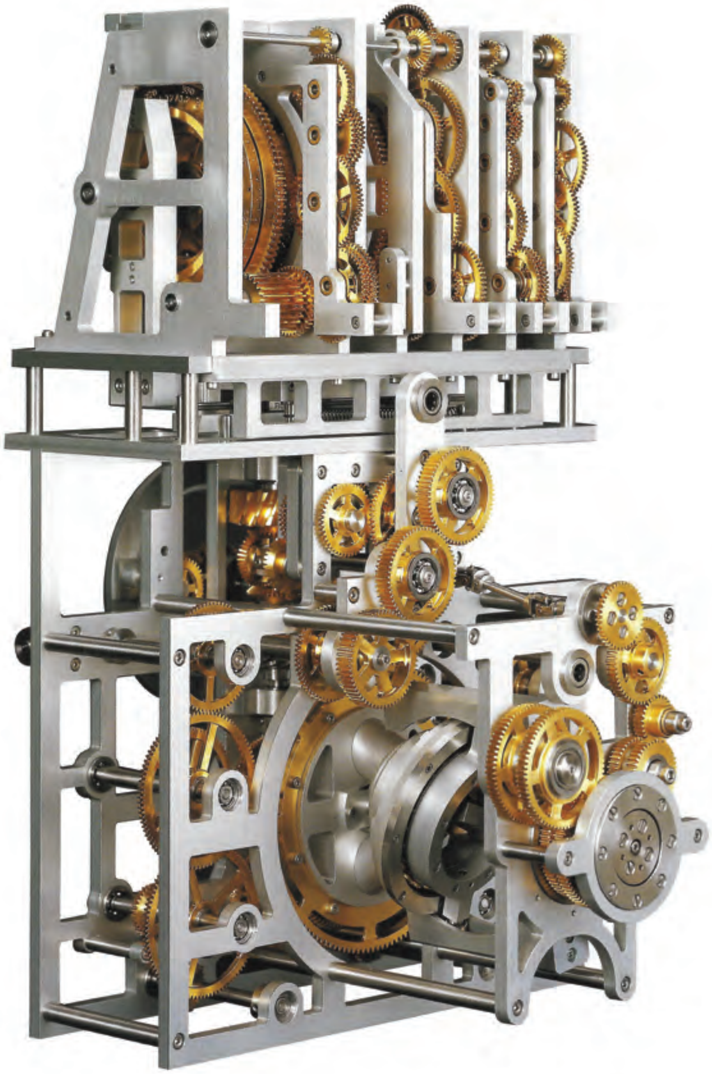

Figure 40. The Festo, which looks more like a machine tool than a clock. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

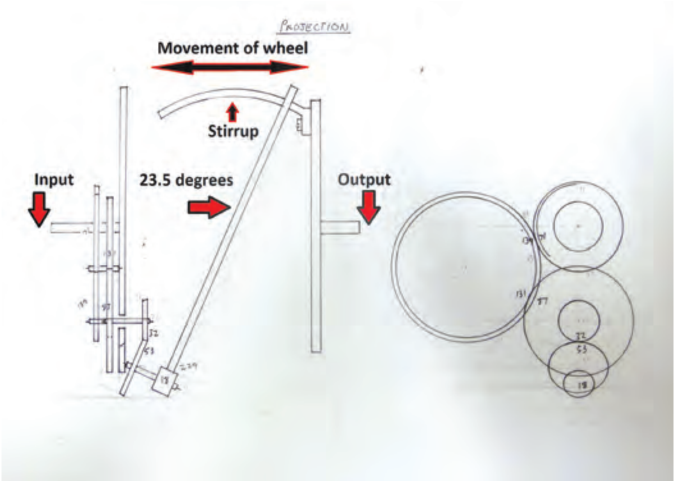

Figure 41. Scale drawing for the Projection differential. COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

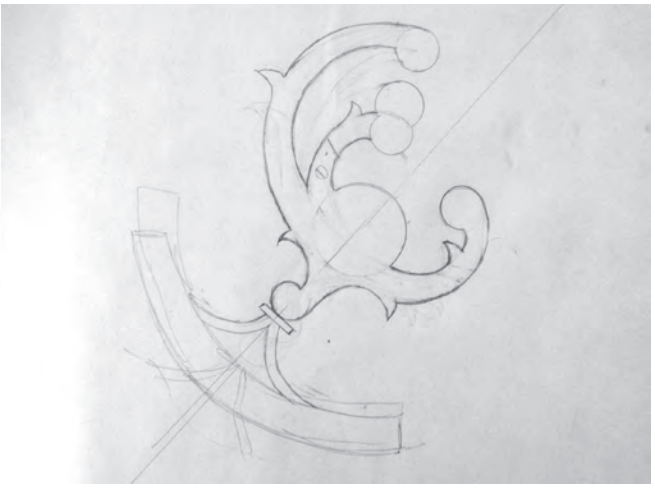

Figure 42. Initial frame design for the Projection assembly. COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

Figure 43. Fifty-four wheel blanks, pinions, plus miscellaneous parts. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

Figure 44. Setting jewel pivots with magnification equipment. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

Figure 45. The Projection differential "in the rough." PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

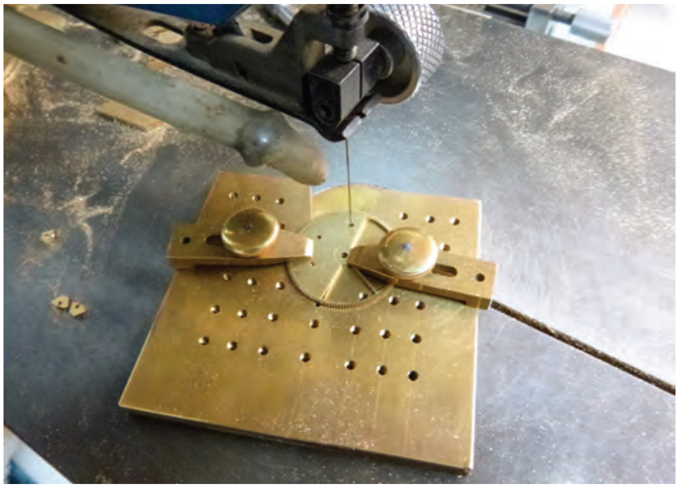

Figure 46. The spoking out process on the jeweler's fret saw. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

Figure 47. Setting and readout dials for the Great Anomaly, left, and Projection, right. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

Figure 48. Completed Projection differential. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

Figure 49. Projection and Great Anomaly in the demonstration frame. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

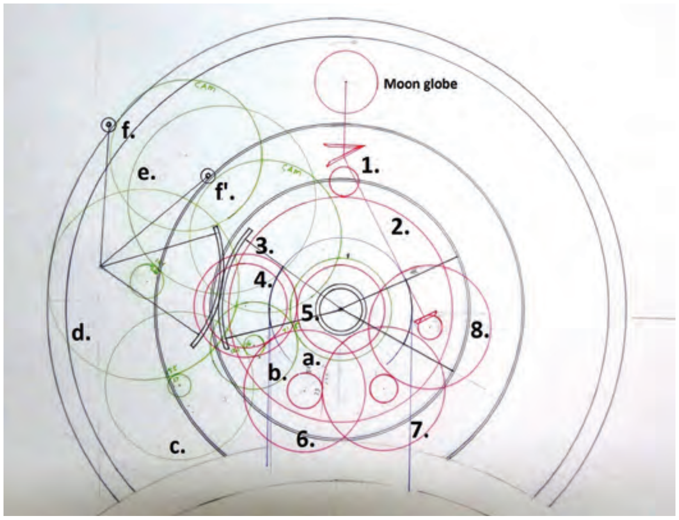

Figure 50. Functional schematic for the dial components of the Sun/Moon module. COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

9. Hours since moonrise
10. Hours until moonset
11. Hours since moonset
12. Length of day
13. Length of night
14. Visual position of the Moon in the sky
15. Mean solar time

Now that the concepts behind this module have been explored, let's delve into the construction highlights.

Figure 38 shows one set of Janvier slant wheel differentials behind the dial work of the Strasbourg Cathedral.[14] Given that this is a huge, cathedral-sized clock, it is not surprising that these wheels are quite large at about 12" (30 cm) in diameter. The dial upon which the Moon's rise and set is about 7' (2.13 m). In general, the larger the wheel, cam, and dial work, the more accurate a reading one will get. Janvier's invention of this method is seen in Figure 39.[15] Figures 38–40 show the only three examples I have seen of the use of Janvier's design in horology.

The first components to be made are the slant wheel differentials for the Moon anomaly correction. Figure 41 is a drawing of the projection differential. It takes a while to understand just how this works, given that there is a wheel that looks for all intents and purposes to be unable to function. But after some study, one comes to the "aha!" moment. The wheel is inclined 23.5 degrees, the same as the Earth's tilt to the ecliptic plane. Janvier described his device as "*equation du temps par les causes qui la produisent*" ("equation of time by the causes that produce it").[16] What better way to describe the slant wheel's mimicking of the Earth's actual tilt? The mechanism faithfully reproduces, as in nature, the discrepancy between solar time and mean solar time, resulting from the inclination of the Earth to the ecliptic and turning in mean time, and transmits its movement to a wheel inclined in the same plane as the Earth's equator, namely 23.5 degrees. The different angular speed of these wheels occurs as the wheel moves along the curve of the stirrup and results in their coincidence 180 degrees apart twice annually. Between these extremes, the angular speed of the second wheel (output-solar time) varies ether ahead or behind the driving wheel (input-mean solar time), just as in nature actual solar time is ahead or behind mean solar time throughout the year. Figure 42 illustrates the beginning of frame design drawings for the differential.

Figures 43 through 46 show parts of the differential fabrication beginning with the wheel blanks (Figure 43), the setting of pivot and jewel locations using a microscope for absolute precision (Figure 44), and the nearly completed projection differential before spoking (Figure 45). Figure 46 shows the jeweler's saw used to hand cut the wheel spokes.

Figure 47 shows the engraved setting dials for the pair of differentials. The one on the left is numbered 0 through 26; the actually tally is 27.5, repeated twice for the Great Anomaly. To the right is the Projection numbered 0 through 13; again, the actual tally is 13.6, repeated twice. The repeat of the dial numbering reflects the fact that the slant wheel moves back and forth along the stirrup, so a full course from start to finish requires two cycles. The dial on the right has been silvered. These dials will also show in real time the daily progression of each anomaly.

Figure 48 shows the completed Projection differential. The sickle-shaped part acts as both a poising weight for the mechanism and a mount for a semicircular, enamel nameplate identifying the differential's anomaly correction. Figure 49 shows the completed pair of Projection and Great Anomaly differentials in their temporary plastic demonstration frame. The drive input begins on the right and flows left to the first differential output stirrup, which then serves as the input for the second to produce a rotation of the arbor from the combined results of the differentials. Several videos are available online to demonstrate how these work: http://www.my-time-machines.net/astro_02-17.htm.

Next, we turn to the dial components. In Figure 50, we have a completed drawing with both the Moon and Sun gearing represented. The drive wheels all revolve around the dial's axis according to the input of the two anomaly differentials. Their input is the first small red wheel at 12 o'clock (1). That wheel is fixed and moves the second large red wheel (2), upon which is mounted a nested pair of wheels (3, 4), which are fixed together. The larger of the pair (3) meshes with the center wheel (5), which is fixed. The smaller of the pair (4) meshes with wheel (6) and then to (7) and (8). Wheel (8) delivers rotation to the Moon globe through a pair of bevel wheels.

The rotation of the input wheel feed from the anomaly differentials, by rotating the large red wheel upon which the rest of the Moon mechanism is mounted, induces rotation of the nested pair of wheels engaged with the fixed center wheel, thus causing rotation throughout the rest of the wheel train through to the Moon globe.

These gear ratios are generated by a web-based calculator for a four-stage wheel set to obtain the accuracy of the Moon's rotation to seven decimal places. The other thing the calculator does besides giving extraordinarily accurate results is that it allows Buchanan to perform a trial-and-error exercise with various numbers and tooth counts instantly. He could try out a five stage to see how it might look versus a four but still retaining the correct results. It not only saves time but allows for a much better design both mathematically as well as aesthetically.

The Sun itself revolves around the dial once per day and is mounted to the center green wheel ("a" in Figure 50). That wheel drives the next four wheels (b, c, d, and e), which then turn a pair of cams (f, f′). These cams each, in turn, have roller follower arms that rotate upon their edges and are attached to a set of sector gears. Those, in turn, control the two shutters for the sunrise and sunset horizon. Only one set of sector gears is shown, as they are superimposed upon each other in this view.

Figure 51 is a side elevation of the dial components. Figure 52 shows the beginnings of the dial wheel work, with a pile of over a dozen wheel blanks. Figure 53 shows the Moon phase rotation wheel work, also known as a Halifax moon, in addition to the Moon rotating to show phases. The entire assembly revolves to indicate the Moon's rise and set above the horizon. Figure 54 shows the assembly installed on the rough brass plate.

The main rear frame design (Figure 55) shares many similar characteristics to that used for the perpetual calendar, illustrated in Figure 56, which was created five years ago. This is another demonstration of Buchanan's design consistency throughout the project. It makes the entire machine a harmonious whole despite its complexity and diverse subassemblies. There are fewer jeweled pivots in the current drawing because of the unique frame design. This is the first module that largely does away with a conventional plate and spacer frame where the majority of wheels are suspended between plates. Here, there will be one single plate that will have the rotating platform output system for the Moon suspended from the front, precluding the use of a conventional frame, and the slant wheel variable differentials drive this from the rear. The jeweling is spread throughout these systems rather than concentrated between two conventional plates.

Figure 57 shows the intricate ivy-shaped main and secondary rear frames. Figure 58 has a view of three different jewel configurations. The one on the far left is an original "out-of-the-box" purchased jewel. In some cases Buchanan has to make these a bit smaller in outside diameter as well as altering the inside hole diameter as

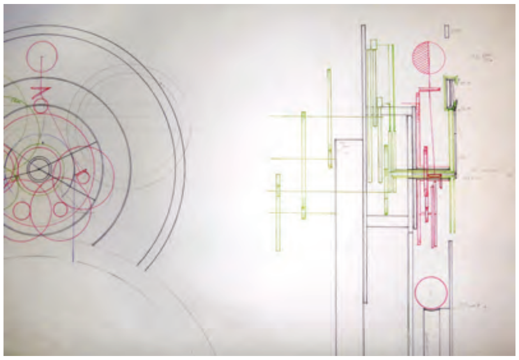

Figure 51. Side elevation of the Sun/Moon module dial work. COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

Figure 52. The beginnings of the dial work wheel blanks. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

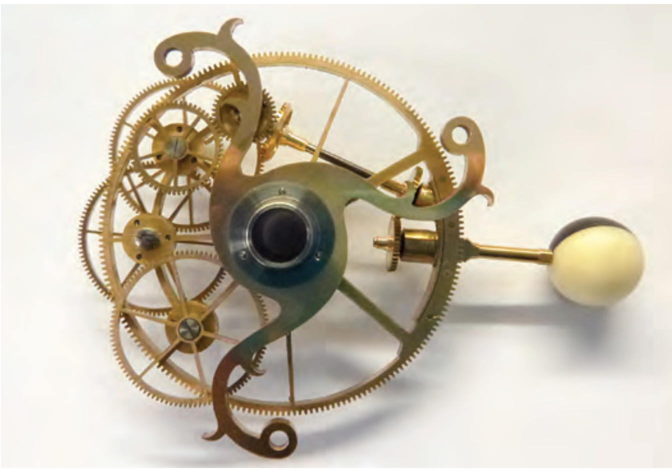

Figure 53. Moon rotation wheel work. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

Figure 54. Moon work trial fitting on a brass blank background. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

illustrated on those in the center and on the right. This same technique has been used on a few of the roller bearings where needed. The rendering in Figure 59 is one of a pair of sector gears for the sunrise, sunset horizon shutters.

The completed horizon shutter gear is shown in Figure 60. Figures 61 and 62 are drawings for the sunrise and sunset cams that will control the horizon shutter gears. We continue with our whimsical ideas of including some allusions to plants, animals, or other fanciful depictions. The Sun has a pair of small silver ball bearings for its eyes, and the sunrise shutter is appropriately seen rising with its eyes just peaking over the cam rim (Figures 61 and 63). The sunset cam anticipates the coming night with a crescent Moon and stars.

Two more examples of cams with allegorical connotations are seen in Figures 64 and 65. In Figure 64, the quarter- and hour-strike snail cams look like a cross section of a snail shell. Figure 65 shows the kidney-shaped cam for the equation of time, which represents the difference between mean time and the position of the Sun at noon. The spokes represent the rays of the Sun. It's this little mixture of fun, whimsy, and art that is one of many things that sets Buchanan's creation apart from what has been done before.

Another allegorical example is the full face of a tiny but content, old, and wizened Sun face for the Sun dial hand (Figure 66). The Sun ray at the 12 o'clock position is longer than the rest and is used as a pointer to indicate the time (Figure 67). If one looks closely at the eyes, you can see in this photo that they are blue. Buchanan installed tiny, threaded holes and inserted the ends of polished, blued screws; there will be more on this construction in the planisphere section.

Another innovative idea we used to make the complex dial look less dense was to make some of the dial surfaces out of glass. This was easy to imagine but very difficult to execute. This portion of the dial also contains the rotating Moon, and this section also revolves to indicate the Moon's rise and set. To make things even more

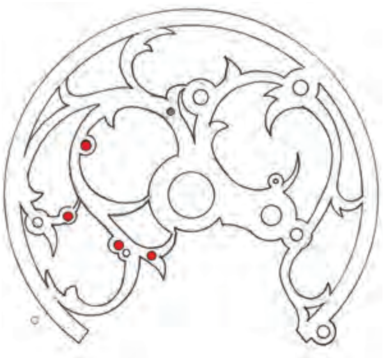

Figure 55. Rear frame design for the Sun/Moon module. COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

Figure 56. Comparative diagram of the calendar's rear frame. COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

Figure 57. Rear main frame with the smaller additional sub-frame completed. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

Figure 58. Original jewel, left, and the next two custom reconfigurations. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

Figure 59. Rendering of a horizon sector drive gear. COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

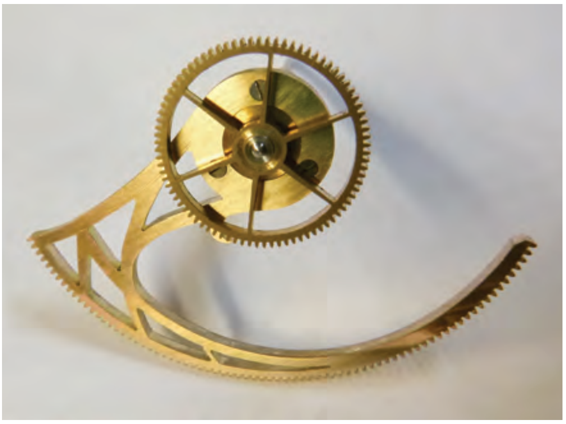

Figure 60. Completed horizon sector gear. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

interesting, the surrounding areas would only allow a glass thickness of 0.047″ (1.2 mm). This is about one-half the thickness of standard single-strength glass, the thinnest type commonly available. Fortunately, I remembered that cheap picture frame glass sold in stores has a very thin glass, and we found this to work. Cutting a ring of about 5″ from this material would be hard enough, but we needed it to be an open ring (Figure 68). Buchanan used a computer-controlled mill with a diamond burr that gave excellent results. Notice in Figure 69 that a metal spider holding the Moon mechanism must also be inserted into the inner rim, and an outer rim is also fitted. The process is extremely delicate and difficult but does lend some protection against breakage once completed.

The revolving Moon mechanism is now suspended from the inner metal spider (Figure 70). But having the main dial ring made from glass was simply not punishment enough, so we decided to have the horizon shutters also made from glass. Sourcing that glass turned out to be a bit more difficult as such thin glass was generally not available in a variety of colors. Many were too deep a blue to the point that it was nearly opaque, obviating the reason for glass. The correct color was eventually found (Figure 71). Tiny engraved plaques and pointers are attached to read the actual hour of sunrise and sunset.

The plaques in block letters refer to the Moon and are read off the outer glass ring. We have followed the convention where script lettering refers to the Sun and block lettering denotes the Moon. Since the shutters are made from a light blue glass, one can even read the time of where the Sun is after it falls below the horizon.

Figure 72 shows the artwork illustration for the glass dial ring. The three concentric sets of numbers are 1–360, indicating the angle hour of the Moon (height in the sky) in degrees. The other two are 1–24; the one in the middle reading clockwise and the inner one reading counterclockwise. We have a double-hour scale on the rotating degree scale but stretched slightly compared to a real hour dial, because the Moon rotates in the dial once in 24 hours and 55 minutes. Zero hours is at the Moon's center, and the hours count away from the Moon, so the hour on the east horizon marker gives you hours until moonrise on the second number ring. The same reasoning goes for the hours since moonrise on the inner number ring. The west horizon marker reads the same way for moonset.

The completed dial with the outer bezel and Moon surround is seen in Figure 73. The typography is very fine and yet needs to be resilient to last the life of the

Figure 61. Drawing for the sunrise cam. COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

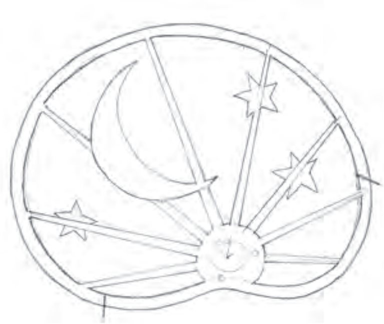

Figure 62. Drawing for the sunset cam. COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

Figure 63. Completed cam work; note the Sun's silver eyes. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

Figure 64. Strike snail cams: a cross section of a snail shell. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

Figure 65. Equation of time kidney cam with sun ray spokes. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

Figure 66. The Sun hand with what else but the Sun's face? PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

Figure 67. The Sun hand in place, now with a set of blue eyes. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

Figure 68. Glass dial blank, left, and cut out dial, right, 0.047″ thick. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

Figure 69. The glass now lined with thin metal bezels. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

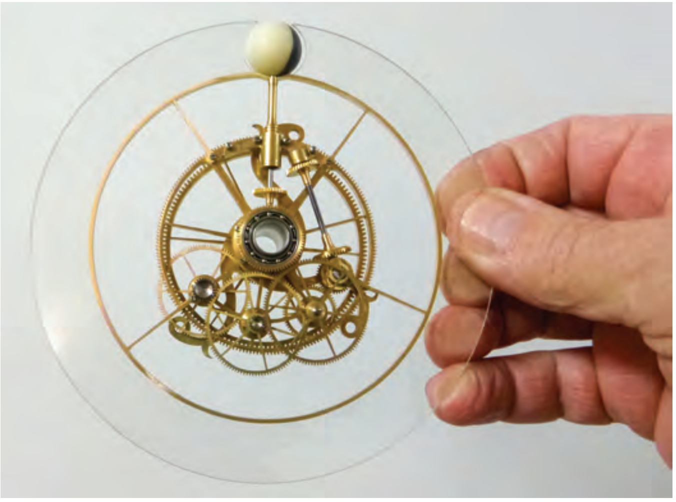

Figure 70. Revolving Moon mechanism suspended in a glass dial. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

Figure 71. Horizon shutters and time indicators. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

machine. Fortunately, in recent years the printing of everyday photographs on glass substrate has become popular. This process uses laser printing with a heated enamel ink that is very tough when cured. We later changed the font style from italic to block for legibility and coordination with our theme of using script for the Sun and block lettering for the Moon indications.

Figure 74 shows the western horizon marker for the moonset indicator. Figure 75 shows the Moon with its brass age ring countersunk into the sphere of ebony wood and mammoth ivory, allowing for a Moon with a maximum diameter fitting into the open ring structure. It would have been easier to put the brass ring on the outside, but then the sphere would have been smaller; this is another example of quality without compromise.

The completed dial showing all of the components in place is seen in Figure 76. In my opinion, what makes this dial superb is the fact that it has many complications within one dial and we were able to make that dial as unobtrusive as possible to view the machinery behind it through the use of glass. Conventional dial material would have resulted in only the upper inner ring sector above the horizon shutters being visible, where the Sun is residing, being open. The stars on the nighttime shutters are sterling silver, each hand made a bit differently.

One may ask why we did not substitute glass for the enamel mean time indicator ring, resulting in an all-glass construction. We already had this dial made; it could have easily been substituted for glass, but after some reflection it was decided to leave the enamel ring to connect this dial with all of the others that had enamel dial work. Without it, this area would have lost its continuity with the other dial work.

The Sun/Moon complication is now ready for reassembly (Figure 77), with the total parts count at about 550. This is very similar to the perpetual calendar that is mounted directly to the left on the clock. Figures 78, 79, and 80 show the assembled module. A video demonstration of the completed complication can be seen here: https://youtu.be/L1-rLapiTt0.

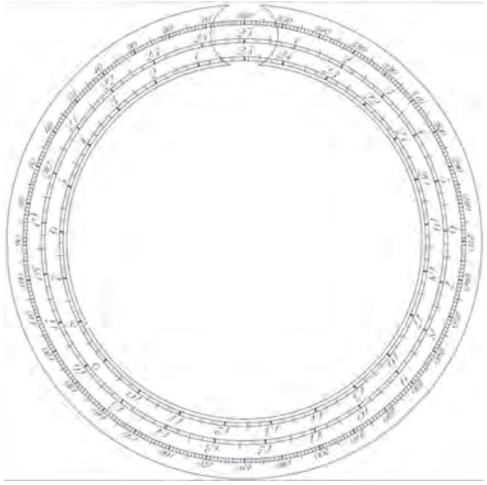

Figure 72. Artwork for the moon dial. COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

Figure 73. Completed dial with the outer bezel and Moon surround. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

Figure 74. Western horizon marker for the Moon. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

Figure 75. Countersunk age of the Moon dial ring on ebony and ivory. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

Figure 76. The completed Sun/Moon dial representing 15 complications on one dial assembly. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

In future issues of the *Watch & Clock Bulletin*, Parts 2 and 3 of this article will discuss the progress through completion (Figure 81).

Notes and References

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3. Mark Frank, “Halfway Point for the Astronomical Skeleton Clock,” *NAWCC Bulletin* 53, no. 391 (April 2011): 141–49.
4. Mark Frank, “Astronomical Skeleton Clock: Part 1 of a Two-Part Series,” *Watch & Clock Bulletin* 59, no. 425 (January/February 2017): 32–52; Mark Frank, “Astronomical Skeleton Clock: Part 2 of a Two-Part Series: Third-Order, Reversible Perpetual Calendar: Why Do We Need This?” *Watch & Clock Bulletin* 59, no. 426 (March/April 2017): 144-62.
5. The list of dial and special mechanical complications appears below on page 399.
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13. Ungerer and Ungerer, *L’Horloge Asronomique de la Cathédrale de Strasbourg*; H. Alan Lloyd, *Some Outstanding Clocks over Seven Hundred Years* (London: Leonard Hill Books, Ltd., 1958).

Figure 77. All of the parts and subassemblies of the Sun/Moon module ready for completion. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

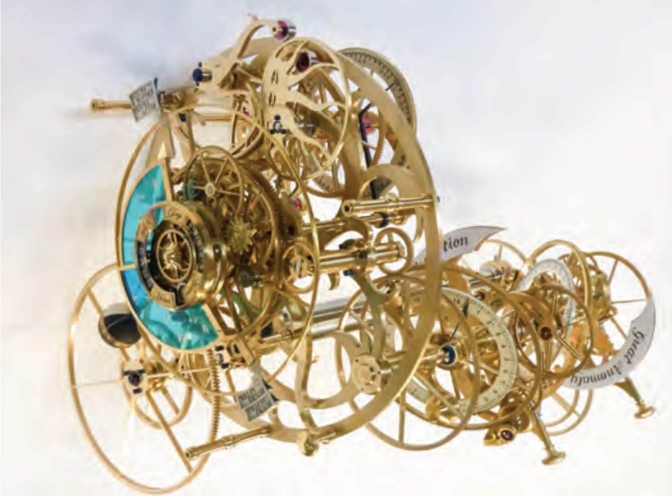


Figure 78. Front, right three-quarter elevation. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

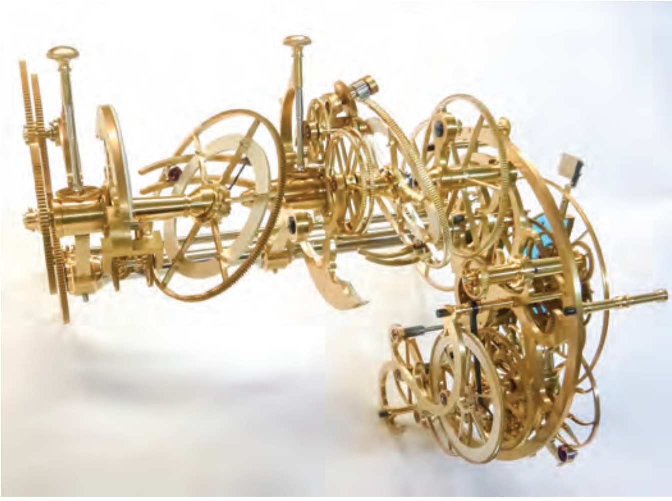


Figure 79. Left elevation. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

14. Monique Fuchs, *Cathedral of Strasbourg: The Astronomical Clock and the Angels' Pilar* (pamphlet, n.d.).

15. Jacques Kugel, *Spheres: The Art of the Celestial Mechanic* (Paris: J. Kugel, 2002), 205.

16. Kugel, *Spheres*.

About the Author

Mark Frank has recently retired from his Chicago residential real estate management and development company. His horological interests are in researching and collecting timepieces where one can view the mechanical works, particularly in skeleton clocks, tower clocks, and bank vault timers. His main interest is in those pieces that exhibit interesting mechanical characteristics as demonstrated through complexity, novelty, or visual appeal. The clock that is the subject of this article is the culmination of many years of research, observations, and examples drawn from his collection and other private collections as well as exhibits from museums throughout Europe and the United States, all combined into a personal fantasy machine. He has been an NAWCC member since 1993, and a member since 1995 in the British Horological Society and Antiquarian Horological Society. Updates on this project have been posted monthly at www.my-time-machines.net since its initial conception in 2003. Those interested in receiving email notifications when updates are posted should email mfrank1@rcn.com.

Figure 80. The Sun/Moon assembly mounted on the clock. PHOTO BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

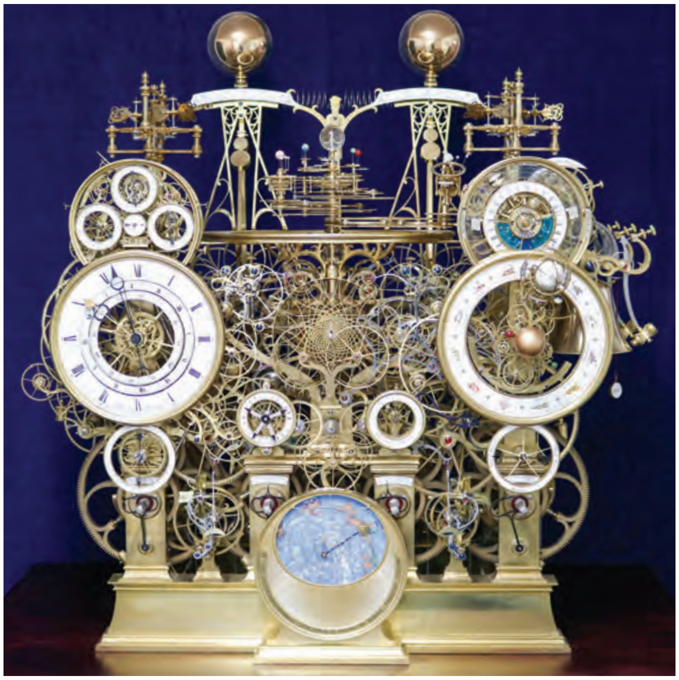


Figure 81. The completed clock (unpolished in these photos)—the work of 12 years. PHOTOS BY BUCHANAN, COURTESY OF BUCHANAN CLOCKS OF CHELMSFORD.

List of Complications

71, plus 5 special mechanical systems

Upper left-hand dial cluster, third-order, 400-year perpetual, reversible calendar (8)

1. Day
2. Date
3. Month
4. Year
5. Leap year indication, four-year exception, first-order correction
6. 100-year exception, second-order correction
7. 400-year exception, third-order correction offering accuracy to 400 years
8. Entire mechanism can operate in forward or reverse, giving an 800-year accuracy span

Center left-hand dial, telling the time (2)

Mean time (this does not count as a complication since every clock shows mean time)

1. Equation of time
2. Sidereal time

Lower left-hand dial, the equation of time (2)

Equation of time setting, annual calendar reads in real time

1. Date
2. Month

Upper right-hand dial cluster, the Sun and Moon (19)

Sun section (8)

1. Time of sunset
2. Time of sunrise
3. Visual position of the Sun in the sky
4. Mean solar time
5. Length of day
6. Length of night
7. Variable seasonal horizon shutters
8. Horizon shutter setting dial, annual calendar reads in real time

Moon section (11)

1. Visual indication of the phase of the Moon
2. Age of the Moon
3. Angle hour of the Moon (height in the sky) in degrees
4. Degrees to moonset
5. Hours until moonrise (we have a double hour scale on the rotating degree scale but stretched slightly compared to a real hour dial), the Moon rotates in the dial in 24 hours and 55 minutes, zero hours is at the Moon and the hours count away from the Moon, so the hour on the east horizon marker gives you hours until moonrise
6. Hours since moonrise
7. Hours until moonset
8. Hours since moonset
9. Visual position of the Moon in the sky calculated to the three major anomalies
10. Great Anomaly setting dial reads in real time
11. Projection anomaly setting dial reads in real time

Center right-hand dial, Earth's neighborhood (14)

1. Tellurian featuring the Earth, Moon, and Sun system, Sun also rotates
2. Additional inner planets of Mercury and Venus
3. Moon's orbital inclination in relation to Earth's ecliptic
4. Position of each planet in the Zodiac
5. Month
6. Date
7. Synodic month dial
8. Sidereal month dial
9. Adjustable 360-degree ring allowing user to set any point on Earth as zero time, reading the time from any other point
10. Approximation of time and location of solar eclipses
11. Approximation of time and location of lunar eclipses
12. Location of sunrise and set
13. Location of moonrise and set
14. Indication of Sun's zenith on the surface of the Earth

Lower right-hand dial, strike control (4)

1. Petite sonnerie
2. Grande sonnerie
3. Quarter repeat on demand
4. Strike and silent

Upper center, grand orrery, Sun's neighborhood (9)

1. Planets Mercury through Saturn, with Jupiter and Saturn each having four and five orbiting moons, respectively
2. Dials showing aphelion and perihelion, the orbital eccentricity, for Mercury, Mars, Jupiter, and Saturn and accurate distance from the Sun in astronomical units (AU) and millions of kilometers (Mkm)
3. Planetary orbital distance from Sun in AU and Mkm (average for eccentric orbits, see #2)
4. Correct depiction of eccentricity of orbits of Mercury, Mars, Jupiter, and Saturn
5. Planetary tilt for Mars, Jupiter, and Saturn in relation to the Sun's ecliptic
6. Information read off the main ring dial
    a. Planetary orbital time in years
    b. Diameter of orbits in AU and Mkm of each planet
    c. Mass of each planet in terms of the Earth (mE)
7. Rotating Earth with Moon phase dial
8. Position of all orrery components in degrees (0–360) and position in the zodiac
9. Two-speed transmission for slow and fast demonstration

Middle left center dial (1)

1. International time dial and celestial demonstration crank

Middle right center dial (1)

1. Thermometer

Lower center dial, planisphere, the stars above, man's neighborhood (4)

1. Planisphere, showing star field with major stars named, Milky Way, and zodiac figures
2. Sun traveling through the zodiac's houses across the star plate
3. Seasonal height of the Sun in the sky
4. Date and month readout, setting dial

State of wind indicators (1)

1. Wind indicators
    a. Time train
    b. Celestial train
    c. Quarter strike train
    d. Hour strike train

Special mechanical complications (6)

1. Dual Wagner rocking frame remontoire, time train
2. Robin remontoire, celestial train
3. Spring remontoire, perpetual calendar
4. Reverse coup perdu to derive single jump seconds from two-second pendulum
5. Antide Janvier-type slant wheel differentials within tumbling cages
6. Temperature compensation for pendulums

Compound remontoire flies

Epicyclical strike train flies

Celestial remontoire fly cam controlled to release at differing time intervals

Sidereal time read off double, inner concentric counterclockwise rotating dials within mean solar time dial

All calendar functions feature "instant trip" at precisely midnight

Nineteenth-Century Convertibles

By William Christie (CA)

I suspect most of us in the 21st century would envision a sporty automobile when hearing the word *convertible*. However, in the latter half of the 19th century, there were essentially no automobiles. So this article is about another kind of convertible: the convertible watch.

There were two basic styles of pocket watches known as "hunting" or "hunter" (Figure 1) and "open-face" (Figure 2). The hunter had the advantage of having a metal cover protecting the delicate glass crystal and was typically preferred by "the gentleman" as a sign of prestige. The open-face watch often had a very thick, beveled glass crystal, making it less likely to break, while not quite as well protected as in the hunting case.

The National Watch Co. in Elgin, IL (later called Elgin National Watch Co.) began making pocket watches in 1864, one of a half dozen watch manufacturers beginning at that time. Elgin intended to compete with the more established American Watch Co. (renamed American Waltham Watch Co. in 1885) and E. Howard & Co.

While E. Howard & Co. (Figures 3 and 4) was well known for its low-volume production, high quality, and expensive watches, American Watch Co. produced decent-quality, mass-produced, and more affordable pocket watches. After acquiring the high-quality but financially bankrupt Nashua Watch Co. of New Hampshire around 1862, American Watch Co. retained the Nashua craftsmen known for their high-grade products. The company went on to produce some of the highest-quality watches of its era, and I feel they were possibly the best ever made! The movement name, "American," was generally reserved for the higher-quality watches made by the former Nashua factory workers.

Outstanding among these is the American Model 1872, which is renowned for its remarkable quality and beauty.

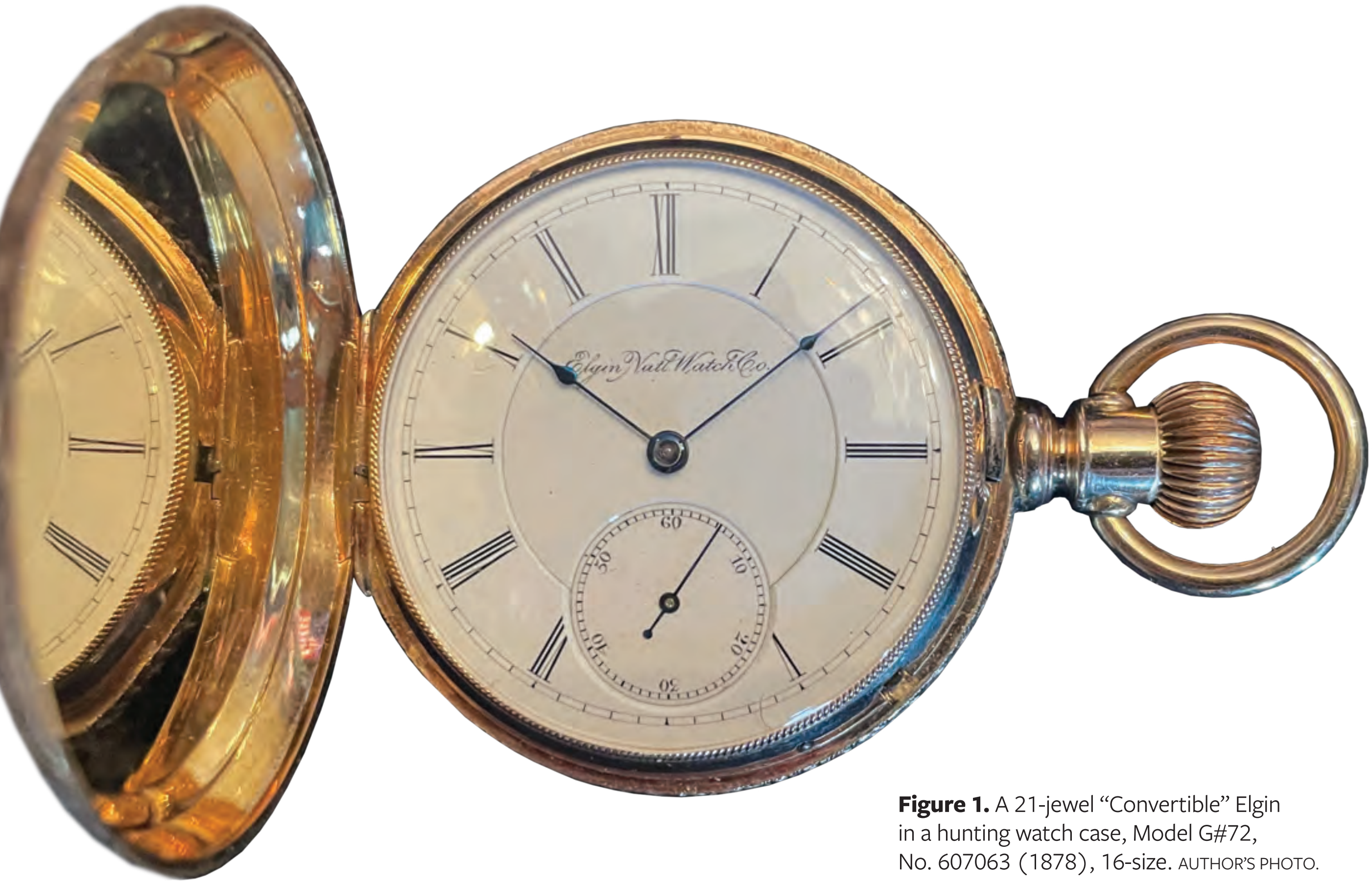


Figure 1. A 21-jewel "Convertible" Elgin in a hunting watch case, Model G#72, No. 607063 (1878), 16-size. AUTHOR'S PHOTO.

The American Watch Co.'s 21-jewel version is legendary in that, while made in very limited numbers, the decorative damaskeening pattern is remarkably varied on most of the 350 or fewer examples that are believed to still exist, according to rarity ratings in the *Complete Price Guide to Watches*[1] (Figures 5 and 6).

By the late 1870s, the Elgin National Watch Co. began to produce its own version of a high-quality, precision pocket watch called the "Convertible." While the prestigious American Model 1872 and the E. Howard & Co. watches were not made with a low jewel count, the Elgin National Watch Co.'s new Convertible was made in 7-jewel to 21-jewel configurations. The 15- and 21-jewel watches are especially esteemed. Rarity ratings show that there are fewer than an estimated 350 of each of the two varieties of the 21-jewel Elgin National Watch Co. Convertible watches (Figures 7 and 8).[2] Especially popular is the "3-finger bridge" version.

Figure 2. A 15-jewel "Convertible" Elgin Model G#50 in an open-face watch case, No. 1648824 (1884), 16-size. AUTHOR'S PHOTO.

Figure 3. E. Howard & Co. N-size hunting case, ¾ plate damaskeened nickel "Running Deer" (their best) movement, No. 224106 (1883–89), Model VII in 14-kt. case. The "N-size" is close to an 18-size. AUTHOR'S PHOTO.

Figure 4. E. Howard & Co. N-size open-face movement, Model VIII (split plate) damaskeened nickel, 17-jewel, No. 309247 (1895–1903). AUTHOR'S PHOTO.

Figure 5. American Watch Co. (AWCo), No. 2642833 (1884), 16-size, 21-jewel, exquisite damaskeening, ¾ plate nickel movement, raised gold set 21-jewel, gold train, blued screws, in an AWCo 18-kt. hunting case. AUTHOR'S PHOTO.

Figure 6. American Watch Co., Model 1872, 21-jewel, open face in 14-kt. AWCo gold case, No. 2605062 (1884), 16-size. Notice how different the lovely damaskeening is from the other 21-jewel American grade Model 1872 in Figure 5. AUTHOR'S PHOTO.

Figure 7. Elgin National Watch Co., No. 942088, G#91 (1881), in an exquisite 18-kt. box hinge gold hunting case, Convertible, 21-jewel, 3-finger bridge movement, 16-size. AUTHOR'S PHOTO.

In *American Watchmaking: A Technical History of the American Watch Industry, 1850–1930*,[3] Michael C. Harrold states that the 1885 retail prices for the 21-jewel American Model 1872 and the 21-jewel Elgin Convertible watches in 18-kt. gold cases were each priced at $250, at a time when you could buy a basic pocket watch for under $10. To put these costs in perspective, in the 1880s a US $10 gold piece was likely to be more than a week's wages for the average working man. Picture a stack of 25 $10 gold pieces to purchase one of these prestige watches. In 2021 the gold content of a $10 gold piece is valued at over $850![4]

It is clear the Elgin National Watch Co. was determined to elevate its reputation by producing a high-grade, prestige timepiece. It sought inclusion in the very limited, ultra-high-price market previously occupied primarily by American Watch Co. of Waltham, MA, and E. Howard & Co. of Boston. Each of these companies was seeking the prestige of patronage by very wealthy customers.

The Elgin Convertible's watch movement could be housed in either a hunting (see Figure 1) or an open-face case (see Figure 2). These watches were stem wound and lever set, so cases needed a cutout for the setting lever in the appropriate position to accommodate the placement of the movement in the chosen case. While incorporating the versatility of this convertibility likely contributed to higher manufacturing costs, it also gave Elgin a unique product. I have often wondered how many Convertible customers ever called upon this unusual feature. Nevertheless, I definitely admire the precision and quality of these Convertibles.

Another innovative approach to convertibility is shown in Figure 9. It was an invention of F. A. Muckle, of Rockford, IL, in 1888. He patented a watch case whereby the same pocket watch can be switched back and forth between a hunter and an open face by just swiveling the movement in its hinged support.

Around 10 years ago, I was amazed when shown four Muckle-cased watches, all different. Unfortunately, I could only afford to purchase the one pictured here. I have not yet seen another.

Figure 8. Elgin National Watch Co., No. 607063, G#72 (1878), 21-jewel in a 14-kt. gold hunting case, Convertible, 16-size. AUTHOR'S PHOTO.

Notes and References

1. Tom Engle, Richard E. Gilbert, and Cooksey Shugart, *Complete Price Guide to Watches*, no. 37 (Mount Pleasant, SC: Tinderbox Press, 2017).
2. Engle, Gilbert, and Shugart, *Complete Price Guide to Watches*, no. 37.
3. Michael C. Harrold, *American Watchmaking: A Technical History of the American Watch Industry, 1850–1930*, Supplement No. 14 (Columbia, PA: National Association of Watch & Clock Collectors, Inc., 1984).
4. According to JM Bullion Spot Prices, www.jmbullion.com, accessed August 16, 2021.

About the Author

William Christie first became interested in pocket watches in the early 1950s when a kind, elderly watchmaker in Stockton, CA, Otto Zimmerman, taught him how to disassemble a watch. Over the years William has pursued his fascination with these mechanical wonders and collected watches, with a particular interest in high-quality American pocket watches. After working for 47 years as a dentist, William is now retired and enjoys the “company” of his “old friends,” his pocket watches. If you have news to share on 19th-century convertibles or enjoy talking watches, contact the author at wm.b.christie@gmail.com.


9A


9B

Figure 9. Muckle Convertible coin silver case containing an Illinois Watch Co., Springfield, IL, No. 776934 (1887), 18-size, stem wound/key wound (transitional), stem set damaskeened and gilded full plate, 11-jewel movement: (A) Muckle Convertible case as a hunter, (B) Muckle Convertible case in transition, and (C) Muckle Convertible case as an open face (“Sidewinder”). AUTHOR'S PHOTOS.


9C

The T. Eaton 18-Size Movement: A Canadian Imitation of a Waltham Model '92?

By Selman A. Berger (NY)

Recently, I acquired two 18S Eaton movements (Figure 1, left and center) with remarkable structural similarities to the Waltham 18S Model 1892 (Figure 1, right). These movements were produced by the Swiss company Gallet & Co., and marketed by the Canadian T. Eaton Co. of Toronto. The 17-jewel and 21-jewel movements were produced circa 1890–1910, and the 21-jewel movement is described in the *Bulletin*'s Railroaders' Corner, with its use for railroad service noted as being uncertain.[1] The markings on the movements are noted in the captions for Figure 1. An obvious feature is the plate design for the two Eatons and the Waltham Model 1892.

General Description of the Movements

The major similarities and differences between the Eaton and the Waltham movements are described below.

Balance Bridge and Regulator: Stepped bridge or cock with a similar overall shape, and with a curved triangular section at the base. Rate adjustment is achieved by means of a version of the same "star wheel" regulator design that first appeared on the Waltham 18S '83 models.

"Barrel Bridge": Similar in overall shape and curvature on both the Eaton and Waltham movements. The Eaton movement barrel bridge is secured to the dial plate by three bridge screws, with the click spring located at the far side of the ratchet wheel from the crown wheel. This Waltham movement is fastened by three bridge screws, while some older Waltham movements use two. The click spring is located between the crown and ratchet wheels.

Jewels and Settings: Both Eaton movements have train jewels of unknown composition in gold settings flush

Figure 1. (left) T. Eaton 18S, 17-jewel, pendant set, marked "17 jewels ADJUSTED" and "made in Switzerland", SN 218,492; (center) T. Eaton 18S, 21-jewel, lever set, marked "21 jewels ADJUSTED to 5 POSITIONS", SN 149,142, no location of manufacture is marked; (right) Waltham Vanguard 18S, 21-jewel, lever set, marked "21 RUBY JEWELS, ADJUSTED" (later models were marked "adjusted to 5 positions"), SN 10,083,407. AUTHOR'S PHOTOS.

with the movement top plates, whereas the Vanguard movement has ruby jewels in raised gold settings.

Bridge Screws: The Eaton movements have flat-headed screws, whereas the Waltham movement has domed screws.

Other differences between the Eaton and Waltham movements include the shapes of the regulators and hairspring studs, the styles of the crown and ratchet wheels, and the locations of case screws.

Swiss Fake Versus Imitation

Swiss Fake

A question can be raised as to whether the 18S Eaton is a Swiss fake, which really depends upon definition. Swiss fakes were Swiss-made movements that usually have (1) fictitious, American-sounding manufacturer's names and markings, and (2) a general design resembling that of some well-known American watch movements.

As an example, a recently viewed 18S movement has the name "Marvin Watch Co" engraved on the train bridge and the name "Springfield" engraved on the barrel bridge. The website for this company indicates that it dates back to 1850 in Switzerland. Clearly, this name could be confused with that of the Marion Watch Co., of Marion, NJ. It falsely identified the location as Springfield (there are many American cities with this name), which would also lead customers to believe that it is of US origin. Other Swiss fakes have been documented and have such names as Hampton and Camden (for Hampden), Elfin (for Elgin), P. S. Barton., P. S. Barzlet, and P. S. Barnett for Waltham's P.S. Bartlett.[2]

Imitation

Whether intentional or coincidental, the T. Eaton design does appear to be very similar to that of the 18S Waltham Model 1892. However, it is interesting to note that the higher serial numbered 17-jewel Eaton movement pictured in Figure 1 has a marking indicating that it was Swiss made, while the lower serial numbered 21-jewel is not marked.

Eaton also sold a 16S, 23-jewel Gallet Interocean movement with a one-piece train bridge covering the center, 3rd, 4th, and escape wheel pinions. This design is similar in shape to that of the 16S, 23-jewel Waltham Vanguard except that the latter has a recess between the 4th and escape pinions.[3]

Conclusion

In my opinion, the T. Eaton Co. would not be dubbed as a Swiss fake as it does not satisfy both criteria listed above: having a fictitious name similar to that of an American-made watch and having a similar design. The Eaton appears to be similar in bridge design as the Model '92, but it has no fictitious name. As Eaton is a highly reputable retail establishment in Canada, it contracted with Gallet in Switzerland to produce pocket watch movements. In this instance, Gallet imitated the Model '92 movements that were cased and sold on the retail market.

Notes and References

1. E. Ueberall and K. Singer K., "Some Older Swiss Standard Watches," The Railroaders' Corner, *NAWCC Bulletin* 40, no. 312 (February 1998): 82–83; see also E. Ueberall and K. Singer, "Gallet-Eaton," The Railroaders' Corner, *NAWCC Bulletin* 41, no. 322 (October 1999): 659–60.
2. "'Swiss Fake' Pocket Watches," Renaissance Watch Repair, http://www.pocketwatchrepair.com/histories/swiss-fakes.html.
3. Ueberall and Singer, "Gallet-Eaton," 659–60.

About the Author

Selman A. Berger, PhD, is a retired professor of chemistry in the City University of New York system. He has been collecting, restoring, and researching primarily the Keystone-Howard pocket watch for nearly 45 years, and has made multiple contributions to the *Watch & Clock Bulletin*.

An Easy, Inexpensive Technique for Recreating Reverse-Painted Dials

By Carl Dreher (NC)

This article describes an easy technique for *recreating* reverse glass-painted dials. It is not a technique anyone should consider for a valuable or historical clock, but for a run-of-the-mill clock with a bad dial, this is an inexpensive approach.

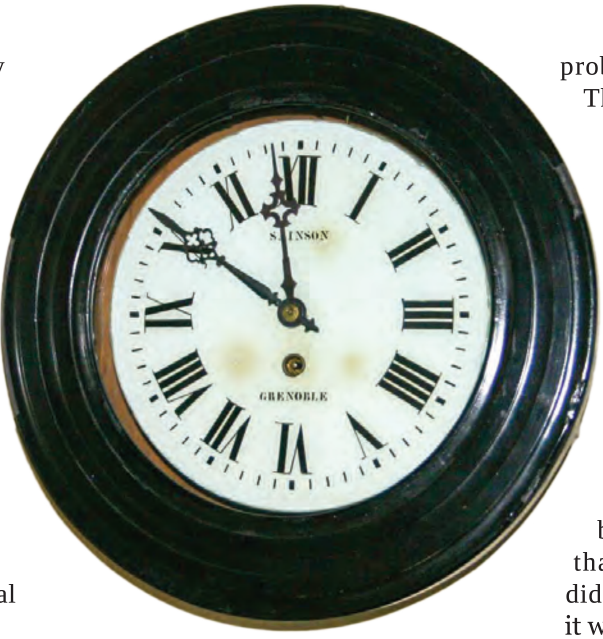


Figure 1. Original dial with stains. AUTHOR'S PHOTO.

About 10 years ago I purchased a French wall clock at an NAWCC mart. The clock is circa 1931 (more about that later). It has a reverse-glass dial with black numerals on a white background. The clock had a few warts but it ran, and for $90, a deal was struck.

Some of the warts that increasingly bothered me were three yellow stains on the dial (Figure 1). I decided to service the clock and see what could be done about the stains. Disassembly showed the source: the dial sat on a metal pan with the three dial feet attached by rivets (Figure 2). Between the pan and the dial was a piece of newspaper, now quite yellow, likely placed there to protect the back of the dial (Figure 3). Where the metal rivets touched the paper, a chemical reaction had taken place, probably due to the acid in the paper. The dial's white background paint was irreversibly stained.

I consulted a half-dozen dial restorers who advertise in the *Mart & Highlights*. The consensus was that the dial numerals were printed with India-ink and then coated with white gesso. Any attempt to remove the gesso would destroy the numerals. I did receive one estimate of $275 to strip the dial and repaint it, but the clock simply wasn't worth that. Also, stripping the dial just didn't feel right to me. Even though it was flawed, it was still original. That was when I started looking into creating a new dial.

Various companies sell water transfer decal paper for putting designs on coffee cups, plates, or other hobby-related items. The idea is simplicity itself: you print an image, carefully cut it out, soak it in water until the decal separates from the backing paper, and slide it onto your item. You then squeegee out the bubbles and let it dry.

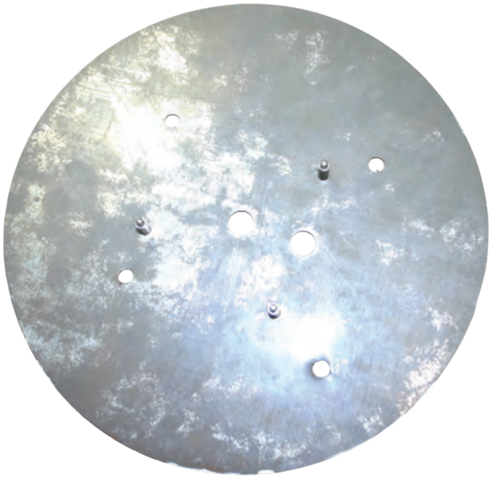


Figure 2. Dial pan and three riveted dial feet. AUTHOR'S PHOTO.

Figure 3. Newspaper backing. AUTHOR'S PHOTO.

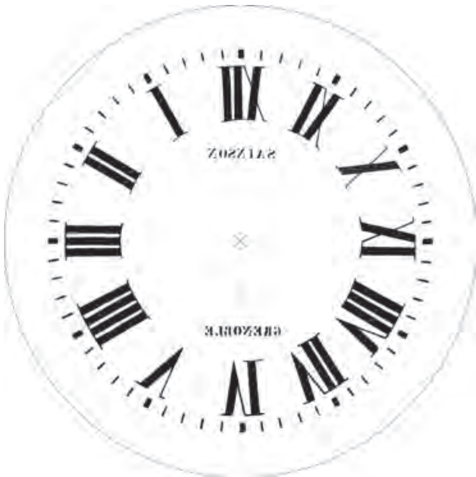


Figure 4. Dial with outline, reversed.

I started by using a scanner to get a high-resolution image of the original dial. I had to scan the dial in sections because it is larger than the 8.5″ x 11″ scanner I have. Using digital imaging software, I carefully stitched the scanned images together. The same software allowed me to remove the white background and the yellow stains from the image. While I was at it, I cleaned up flaws in the numerals and removed scanning artifacts. Since I was going to use a laser printer, which only prints in black and white, the image color was reduced to 1-bit. Finally, I flipped the image so when it was put on the *back* of a glass dial it would appear correct from the front (Figure 4).

Since the dial image was larger than my letter-size printer, I took the image file to a print shop that has large-format laser printers. I had multiple copies printed so I could practice placing the decal on some scrap glass until I was sure I could cleanly place it and remove all the bubbles. The decal material itself turned out to be quite strong, and I never experienced any problem with a decal tearing.

The next step was getting a glass shop to cut a piece of 1/16″ thick glass to a 9″ diameter. That job must have been more difficult than I expected because, after a week, the glass shop handed me one dial and told me never to come back again. The difficulty apparently stemmed from the thickness, or rather the thinness, of the glass.

Now I faced the problem of drilling two holes in the glass for the winding key and the minute/hour arbors. An Internet search revealed multiple techniques that are all basically the same: use a cutter specially designed for glass or ceramics, create a moat around the hole you want to drill, fill the moat with water, and take your time.

In my case, I needed two 11 mm holes. On Amazon, I found a set of five diamond-coated hole saws (Figure 5). I used a hot-glue gun on a scrap piece of glass to build a round moat about 1″ in diameter and 3/8″ deep (Figure 6). A hole saw was chucked in the drill press running at its slowest speed, and light pressure applied. When the water became cloudy with cutting dust, I simply poured in more water, flushing out the old (Figure 7). I was delighted to find that after only a minute, I had a hole. I experimented multiple times to make sure it wasn't just beginner's luck. I saw success every time, and so moved on to the "don't come back again" dial glass. Working slowly, I was rewarded with two neat holes.

After scrupulously cleaning the glass, I applied the dial decal. After letting it dry for a couple of days, I sprayed the back with some white enamel paint. I made brass clips to attach it to the dial pan, and a piece of acid-free paper replaced the old newspaper. I now have a beautiful new dial that is almost indistinguishable from the original (Figure 8).

Some notes:

- The decal paper is made for either an inkjet or laser printer, so be sure to buy the appropriate kind for the printer you will use. The inkjet type requires that a fixative be sprayed on after it is printed, while the laser paper does not.
- When scanning the original dial, use the highest resolution available. Likewise, when creating the image, use the resolution that matches the highest resolution of your printer.
- When you create the dial image, don't forget to mark the position of the original holes for the arbors and winding key. You will need them to accurately center the decal on the glass dial.
- You will probably need to adjust the image dimensions, electronically shrinking or expanding it a fraction, to get the exact diameter when printing.
- The five hole saws in the set I purchased all had some run-out, that is, the circular end of the cutter was not concentric with the drill

Figure 5. One of the 11 mm diamond-coated hole saws. AUTHOR'S PHOTO.

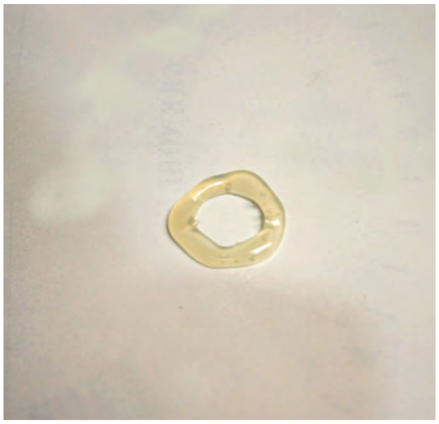


Figure 6. Moat of hot glue. AUTHOR'S PHOTO.

Figure 7. Moat with water. AUTHOR'S PHOTO.

shank (that would produce a hole that is oval instead of round). I picked the one with the least run-out and it was good enough.

- The edges of the drilled holes were not perfectly smooth. There were tiny chips. My clock originally had brass grommets in the holes, which perfectly covered any imperfections.
- When drilling the holes, use the slowest speed and light pressure. Flush the water frequently. Practice and patience ensure success. While you might be able to use a hand drill, I believe a drill press is essential for steady control.
- Although I created a black and white dial, I don't see any reason why a full-color dial cannot be created with a color inkjet or color laser printer.
- The entire project came in under $45. Plus, I now have enough decal paper to do many more clock dials.

Is the result as good as a professionally restored dial? No. Under extremely close examination, you can see differences. If this were a valuable clock, I would not hesitate to employ the skills of a professional. However, for a commonplace clock with a bad dial, this technique is quite satisfactory.

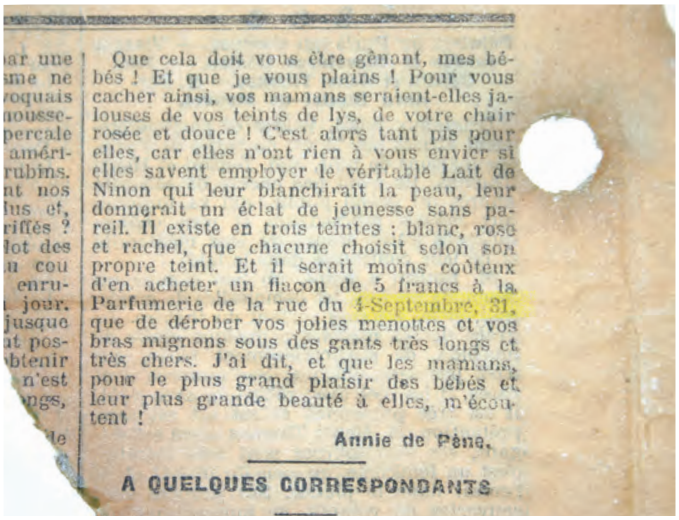
A final note about the clock itself and how I determined its date. Although the clock is definitely French, an NAWCC Forum member identified the movement from a photo of the trademark as AU/HAC (Hamburg-Amerikanische Uhrenfabrik/Hamburg-American Clock Factory). The pendulum is marked "Made in France." But here is the fun part: remember the piece of newspaper inserted between the dial and the pan? After carefully looking at the fragile newspaper, I found a paragraph with "4-Septembre, '31" (Figure 9). I had a French-speaking friend translate it, who reported that the newspaper column was about beauty tips. It talked about where and when you could obtain a special skin cream that will cause "babies to be jealous of your lily-white, rosy, soft skin."

The original dial, along with the piece of French newspaper, now sleep in a cloth pouch sewed by my wife, and the pouch resides in a custom wooden box designed to protect it. The original dial will stay together with the clock if I ever sell it.

About the Author

Carl Dreher is a retired electrical engineer living in Brasstown, NC. A long-time NAWCC member, he has an interest in high-precision mechanical clocks or anything with an unusual movement.

Figure 8. Finished dial. AUTHOR'S PHOTO.



Que cela doit vous être gênant, mes bébés ! Et que je vous plains ! Pour vous cacher ainsi, vos mamans seraient-elles jalouses de vos teints de lys, de votre chair rosée et douce ! C'est alors tant pis pour elles, car elles n'ont rien à vous envier si elles savent employer le véritable Lait de Ninon qui leur blanchirait la peau, leur donnerait un éclat de jeunesse sans pareil. Il existe en trois teintes : blanc, rose et rachel, que chacune choisit selon son propre teint. Et il serait moins coûteux d'en acheter un flacon de 5 francs à la Parfumerie de la rue du 4-Septembre, 31, que de dérober vos jolies menottes et vos bras mignons sous des gants très longs et très chers. J'ai dit, et que les mamans, pour le plus grand plaisir des bébés et leur plus grande beauté à elles, m'écoutent !

Annie de Pène.

A QUELQUES CORRESPONDANTS

Figure 9. Newspaper backing with date. AUTHOR'S PHOTO.

Updates to "The English-Style Watch Cock Re-examined: James I through George III"

By Vincent Cherico (RI)

Since the publication of my article "The English-Style Watch Cock Re-examined: James I through George III" in the *Watch & Clock Bulletin* (Part 1 in March/April 2021 and Part 2 in May/June 2021), I am gratified to report that many readers have commented on, improved upon, and added information to several aspects of my research.

❶ The guidebooks for Mont-Saint-Michel (see Part 1 of my article, pages 88–90), published between 1889 and 1935 with 41 editions in French and 35 editions in English, are one of the earliest and most widely distributed sources of information on watch cocks. The covers state that these books were composed from the notes of the Marquis de Tombelaine. Unbeknownst to me at the time of publication was the fact that the Marquis de Tombelaine is actually a fictional persona created to boost the tourist trade on Mont-St-Michel. The role of the Marquis was played to great effect by a local vagrant, part-time fisherman (aka Jean LeDeluge, possibly born Joseph-Marie Gauthier, 1853–92). The rights to use his image and persona were acquired by Amedee Maquaire, who is the true author of these guides, and not so coincidentally, also the founder of the museum in which the watch cock collections were held.

Maquaire's museum held several random collections including arms and armor, watch cocks, and dials. These collections, although interesting, had little to no connection to Mont-Saint-Michel or the region. Maquaire's assertion in his guidebooks that the local residents of Brittany and Normandy used watch cocks as a part of their traditional dress and his attribution that Ives Leroadec (whose collection formed the base of the museum's collections) was the inventor of watch cock jewelry seems highly suspect now, given the P. T. Barnum-like nature of the man who was not above spinning a good story to enhance tourists' experience at his museum. I suspect that both of these statements may have been an attempt to justify the presence of the watch cock collections at his museum and the watch cock jewelry trade he was engaged in. Further research on the subject is definitely warranted.[1]

❷ The identity of Tic-Tac is the second mystery regarding Maquaire's guidebooks to the museum of Mont-Saint-Michel. Maquaire credits Martial Imbert and the enigmatic, hither-to-unidentified author Tic-Tac for the bulk of his watch cock information. Didier Rousseau of Villeneuve D'Ascq, France, has pointed out that his research clearly shows that Tic-Tac was in fact Paul Combes, a prolific science and technology writer who was believed to have been involved in cataloging the museum's collection of watch cocks.[2]

❸ Regarding the subject of engraving before piercing (Part 1, page 83), Abraham Rees and Dudley C. Falcke have both made contradictory statements in their writings about the order of the processes of engraving and piercing. I have always maintained that the engraving must have come first. It is hard to imagine the piercer would have known where to pierce without the engraving having first been done. A correspondent from Boulder, CO, who is versed in the art of engraving, also supports this view, pointing out that the piercing must have come after the engraving as the engraver would tend to fall into or get caught in the pierced holes or areas.

❹ Regarding the bibliography, Leigh Extence of Exeter, UK, noted that Mathieu Planchon authored another publication on the subject of watch cocks: "Musée rétrospectif de la classe 96: Horlogerie: à l'Exposition universelle internationale de 1900, Paris/rapport," Conservatoire numérique des Arts et Métiers, http://cnum.cnam.fr/CGI/redir.cgi?8XAE543.

❺ A clarification from David Penney of Elsenham, UK, pointed out that the angles as described in Part 2 (page 170, Figure 30) should have contained a statement indicating that all the angles are approximate and are calculated from an imaginary vertical center line.

❻ Regarding the present location of some of the "Private and Public Watch Cock Collections of Note" (Part 1, page 91), Leigh Extence of Exeter, UK, has reported that he is in possession of the entire Clive Ponsford collection. Dr. Joel Shugar of Westchester, NY, has reported that he is in possession of six framed collections of watch cocks comprising approximately 550 pieces, formerly part of the personal collection of Charles O. Terwilliger Jr. Didier Rousseau of Villeneuve D'Ascq, France, has reported that he is in possession of many cocks that formerly formed part of the museum collection of Mont-Saint-Michel.

I am exceedingly grateful to all my correspondents for adding to our collective knowledge of this fascinating subject.

Notes and References

1. Marie-Eve Bouillon, "Le Marquis de Tombelaine: récits et construction médiatique d'une figure du tourisme au tournant du XXe siècle" *Bulletin annuel des amis du Mont Saint-Michel*, Association des amis du Mont Saint-Michel (2011), ffhal-02511623f, accessed July 29, 2021, https://hal.archives-ouvertes.fr/hal-02511623; Marie-Eve Bouillon, "The Marquis de Tombelaine: Stories and Media Construction of a Tourism figure at the turn of the 20th century," accessed July 29, 2021, https://photogenic.hypotheses.org/117; Sophie Chmura, "The Marquis of the Emerald Coast and the Bay of Mont-Saint-Michel, postcards from Rennes or elsewhere," posted on May 2, 2016, accessed July 29, 2021, https://cartes-postales35.monsite-orange.fr/page-57261777c6090.html.

2. *Le Mont Saint-Michel et ses Merveilles* d'après les notes du Marquis de Tombelaine, accessed July 29, 2021, http://www.le-mont-saint-michel.org/merveille127.htm.

About the Author

Vincent V. Cherico Jr., CMW, is an avid collector of watch cocks. He is a 1984 graduate of the North Bennet Street School, Boston, MA, specializing in watch repair. He was awarded a Certified Master Watchmaking certificate from the American Watchmaker-Clockmakers Institute, Harrison, OH, in 1999. He was for many years the owner of a professional watch and clock restoration business, Union Watch & Clock, in Providence, RI. Vincent is presently employed as a toolmaker in the biomedical research and development industry. He welcomes feedback at vincherico@gmail.com.

Lantern Clock Query

The finials and feet of most lantern clocks are attached to the pillars using a threaded iron insert, which can be adjusted to allow the square bases to align with the edges of the top and bottom plates. However, two very early clocks are now known with screw threads integral with the pillar, rather than using a separate iron insert. Does any owner or restorer know of other examples of integral pillar threads? Replies will be treated with strict confidentiality.

—John Robey (UK), john@mayfieldbooks.co.uk

Insight on the Interruption Indicator

In the 1920s and 1930s, electric clocks were becoming very popular. The problem was that frequent power interruptions, usually lasting less than a few minutes, upset the correct time. Solving the problem meant to somehow indicate these time errors.

General Electric solved this problem with its patent of the "Interruption Indicator." The clocks had a dot opening in the dial that was the color of the dial. If there was a power interruption, the dot's color changed to red, showing that the time was incorrect. This feature was used in Minneapolis Honeywell Co.'s heating control thermostats that had G.E. clock units to time their controls.

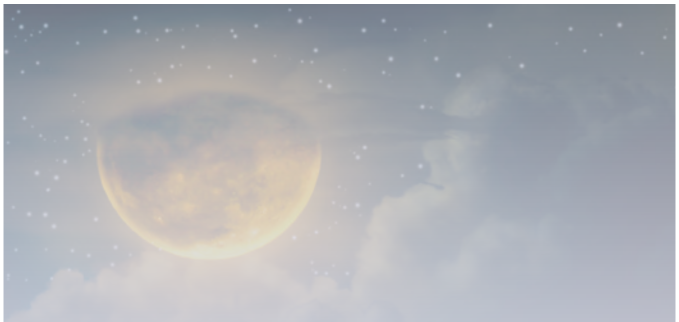
—M. R. Lewbel (FL)

An NAWCC Duo

The NAWCC'S Old Timers and Fellows Chapter 22 boasts an unusual duo among its members. One of the oldest members and surely one of the youngest members age-wise is a father–son duo. Aubrey Wilkerson (90 years old) joined the NAWCC on July 1, 1963, not long after graduating from the University of Missouri with a degree in civil engineering in 1962. He earned a master's degree in engineering from the University of Memphis in 1968. On July 1, 1965, Aubrey enrolled his son, Mark, in the NAWCC when Mark was only six days old! Thus began a lifelong love of clock collecting. Aubrey and his twin brother, Audley (also an Old Timer), enjoy collecting American calendar clocks and wooden works clocks. The brothers both live in Memphis, TN, and belong to King Cotton Chapter 48. Mark Wilkerson lives in Wynne, AR. Recently, Aubrey and Mark travelled to Hampton, VA, to attend the NAWCC National Convention. This Old Timer duo is the first—and currently only—pair of father–son Old Timers and is truly unique and rare.

—Carroll Wolfe, FNAWCC (AR)

Aubrey (left) and Mark (right) Wilkerson in the mart room at the 2021 National Convention in Hampton, VA.



Looking Up at Bedtime

Night
Sweet night
Alive in my loose
Cozy blankets
In my arms
Crisscrossed against my ribs
And in my knees
Flexing for a comfortable spot
Thank you for being around
Like a cat
That senses a heart still pumping
And a body in quasi-repair
And listens
For sleep-filled murmurs
Of a loved one inches away
And the rumor of distant cars
Far off far off
Like time when I was 10

© Raymond Comeau, March 2020

Here is a poem about night and the passage of time. It is a poem of thanks for the peace and comfort that we sometimes can feel as we look up, at bedtime, through the mist of the night. Ray Comeau is a retired dean and current lecturer on literature and management in Harvard University Extension School. He is a member of Chapters 8 and 87 in his native Massachusetts. His email is comeau@fas.harvard.edu.

FNAWCC denotes a recipient of the Fellow Award.

World War II US Military Wristwatches and Their Bands: Part 2

By Edwin Fasanella, FNAWCC (VA)

This article is a continuation of Part 1 with the same title, which appeared in the November/December 2019 issue of the *Watch & Clock Bulletin*.[1] Part 2 provides information on Guss watch straps produced by Guss Strap Co. of Philadelphia, PA, as well as historical information about David Guss, his partners, and his company. Plus, a short "aside" on the very first watch straps and watch holders is also included.

Figure 1. David Guss, ca. early 1920s. COURTESY OF THE GUSS FAMILY.

Guss Strap Co., Philadelphia, PA

The Guss Strap Co. supplied high-quality canvas watch bands (straps) for the US military during World War II. A picture of David Guss, the company founder, that was taken around 1922 is shown in Figure 1. Examples of some of the company's bands that were produced near the end of the war, around 1945, are shown in Figure 2. The bands were packed in individual paper boxes (7¾″ x 8 ¾ ″ x 1½″), as shown in Figure 3. There were a total of 36 bands per box, which had a stock number of 25-B-535. (The stock number is probably the military specification, as the Brite band boxes were marked the same.) Like the Brite military bands that were described in Part 1, there was a variety of differently sized bands in each box. Twenty-four of the bands were ⅝″, six were 9/16″, and six were ½″ wide. Only four were extra long. These bands all had metal-reinforced eyelets and were supplied in both silver- and gold-color buckles and eyelets. Since the war was ending, these bands were never issued, and each band was found in its original packing with a cellophane covering over the paper backing that housed the band.

In researching the Guss Strap Co. of Philadelphia, PA, I was fortunate to be able to correspond with Peter Guss, the grandson of the company's founder, David H. Guss. Peter, his brother Jonathan who did most of the family research, and their uncle Brian provided me with information that was invaluable in my search.[2] According to Peter and Jonathan (and Ancestry.com), David Guss was born in 1894 in Latvia and came to the United States in 1911. His older brother, Joseph, had arrived in the United States a year earlier. The Guss family in Latvia had dealt in hides and leather. In the family leather tradition, David at age 23 worked as a "shoe fitter" (shoemaker) in 1917 for Laird, Schobar & Co. in Philadelphia. This information was found on David Guss's 1917 draft registration card (Figure 4).[3] His brother, Joseph, worked as a leather belt-maker at another Philadelphia company, Eagle Suspender & Belt Co.

In Peter Guss's own words, "The family lore always has said that my grandfather David invented the

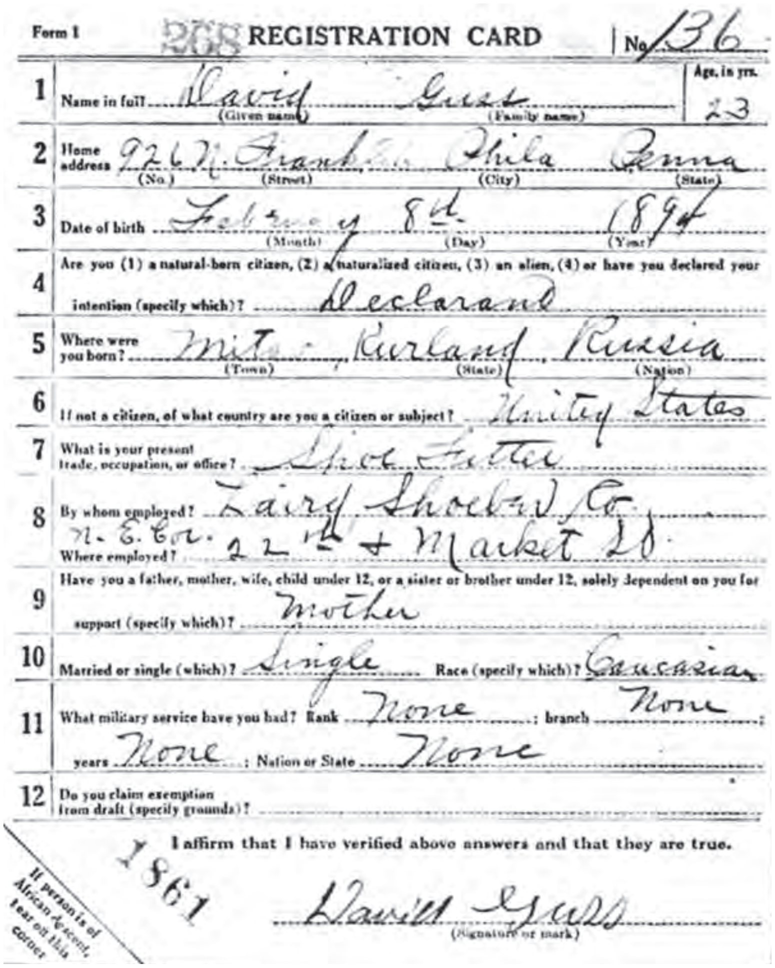
Figure 2. Guss military bands in original packaging. AUTHOR'S PHOTO.

Research Activities & News is currently accepting submissions. Contributors may send information directly to Ed Fasanella at edwinfasanella@gmail.com.

FNAWCC denotes a recipient of the Fellow Award.

watch strap, whatever that means. . . . My Uncle Brian remembers going to the Smithsonian Museum with his father (David) and they saw an exhibit that stated Speidel invented the watch strap in the 1920s. My grandfather said that he in fact first commercialized watch straps a few years before Speidel, in the teens after World War I. Watch straps were given to soldiers in World War I, where they actually used pocket watches attached to their wrists by a single piece with a leather cover to protect the crystal in the trenches. My grandfather David saw the potential and started making leather straps and marketing them to soldiers who returned home, figuring they'd be used to this new thing called a watch strap."

Figure 3. Box with 36 assorted Guss military bands. AUTHOR'S PHOTO.



Form 1 REGISTRATION CARD No. 136

1 Name in full David Guss (Given name) (Family name) Age, in yrs. 23

2 Home address 926 N. Franklin Phila Penna (No.) (Street) (City) (State)

3 Date of birth February 8th 1894 (Month) (Day) (Year)

4 Are you (1) a natural-born citizen, (2) a naturalized citizen, (3) an alien, (4) or have you declared your intention (specify which)? Declarant

5 Where were you born? Mitau Kurland Russia (Town) (State) (Nation)

6 If not a citizen, of what country are you a citizen or subject? United States

7 What is your present trade, occupation, or office? Shoe Fitter

8 By whom employed? Dairy Shoe? Co. Where employed? N. E. Cor. 22nd + Market St.

9 Have you a father, mother, wife, child under 12, or a sister or brother under 12, solely dependent on you for support (specify which)? Mother

10 Married or single (which)? Single Race (specify which)? Caucasian

11 What military service have you had? Rank None ; branch None years None ; Nation or State None

12 Do you claim exemption from draft (specify grounds)?

I affirm that I have verified above answers and that they are true.

David Guss (Signature or mark)

If person is of African descent, tear off this corner

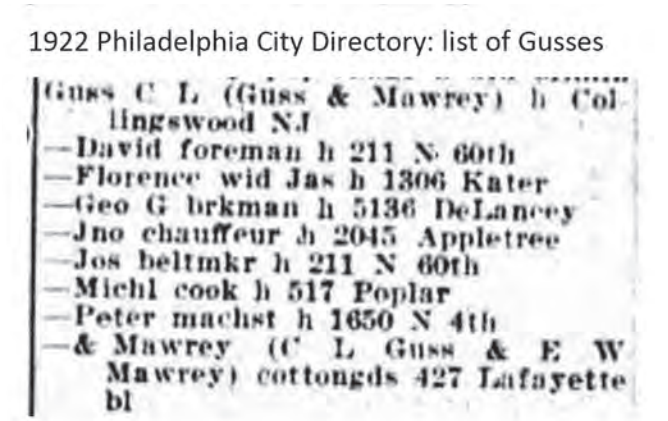
Figure 4. David Guss's World War I draft registration card.
COURTESY OF THE GUSS FAMILY AND ANCESTRY.COM.

Ideal Shoe Fitting Co.

In the 1922 *Philadelphia City Directory* (Figure 5), David Guss was listed as a foreman and "Jos" as a "beltmkr." In the 1923 *City Directory*, David Guss is listed as "Ideal Shoe Fitting Co" and was a co-owner of the company along with Joseph Paisner.[2] The company was formed on December 21, 1924. In a search of the *Philadelphia Inquirer*, an ad was found that was placed in March 1925 for "top stitchers" needed for shoemaking (Figure 6).[4]

Apex Novelty Co.

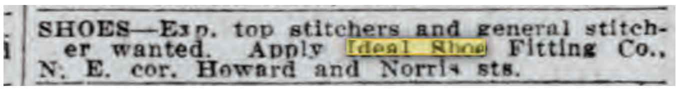
David's next enterprise was the Apex Novelty Co. In another search of the *Philadelphia Inquirer*, I found an ad placed on August 26, 1928, for a pocketbook maker



1922 Philadelphia City Directory: list of Gusses

Guss C L (Guss & Mawrey) h Collingswood NJ
—David foreman h 211 N 60th
—Florence wid Jas h 1306 Kater
—Geo G brkman h 5136 DeLancey
—Jno chauffeur h 2045 Appletree
—Jos beltmkr h 211 N 60th
—Michl cook h 517 Poplar
—Peter machst h 1650 N 4th
—& Mawrey (C L Guss & E W Mawrey) cottongds 427 Lafayette bl

Figure 5. From the 1922 Philadelphia city directory. COURTESY OF THE GUSS FAMILY AND ANCESTRY.COM.



SHOES—Exp. top stitchers and general stitcher wanted. Apply Ideal Shoe Fitting Co., N. E. cor. Howard and Norris sts.

Figure 6. Advertisement by Ideal Shoe Fitting Co. for top stitchers, *Philadelphia Inquirer*, March 14, 1925, Newspapers.com.

POCKET-BOOK MAKER, expd. on Fortuna skiving machine. Apply Apex Novelty Co., 72 N. 4th st.

Figure 7. Advertisement for a pocketbook maker with experience on the Fortuna skiving machine, *Philadelphia Inquirer*, August 26, 1928, Newspapers.com.

OPERATORS wtd., expd. on leather watch straps. Apply David Guss & Co., 121 N. 8th st., 4th floor.

Figure 8. Operators wanted with experience on leather watch straps, *Philadelphia Inquirer*, August 20, 1947, Newspapers.com.

with experience on the Fortuna skiving machine (Figure 7). This brand of machine is apparently still used to split, cut, and work leather. A search of corporate records by the Guss family found that Apex Novelty Co. was created on June 6, 1926. The company was listed in the *Philadelphia City Directory* as being in business in 1930.

David Guss & Co.

In the corporate records of David Guss & Co., the owners were listed in 1945 as David Guss and his brother, Joseph Guss. Ads were found in the *Philadelphia Inquirer* from January 1945 for operators wanted for shoe or leather goods at David Guss & Co., 121 N 8th St., 4th floor.[5] Also, in August 1947, an "OPERATORS wtd." advertisement in the *Philadelphia Inquirer* requested experience on leather watch straps (Figure 8).[6] No information was found concerning the military contract for the Guss canvas watch straps that were produced during World War II as shown in Figure 2. Apparently, by 1948, Guss & Co. had converted its operations back to civilian leather watch straps. It is interesting that a military canvas band was found in the wrong paper marked "shell cordovan," a fine leather. Hence, by accident a canvas band was inserted in a paper meant for a leather band (Figure 9). Perhaps Guss was also making leather watch bands during the war years to sell to officers and civilians.

The 1950 list of Guss families in Philadelphia still listed "Guss David & Co watch straps 121 N 8th." However,

Figure 9. Guss canvas band on the wrong paper backing that is marked "Shell Cordovan". AUTHOR'S PHOTO.

Figure 10. A picture taken in the David Guss & Co. factory (date unknown). COURTESY OF THE GUSS FAMILY.

no advertisements were found seeking employees after 1950. After the company closed, the family noted that David Guss still worked as a distributor of watch straps. In Figure 10, an undated photo of David Guss & Co. employees was supplied by the Guss family. The picture is quite faded but appears to show two standing men and six ladies seated behind sewing machines. David Guss died in 1984 at 90 years old.

As an aside, let's determine what we can find out about the earliest watch straps. David Guss became interested in making and selling leather straps around World War I. However, no patents have been found by David Guss or his company. A little research shows that the Swiss company Dimier Freres & Cie registered a leather strap and buckle design in July 1903 (Depose No 9846) for a wristwatch with closed wire lugs.[7] They called the design "Montre a bracelet-courroie," which loosely translates as a watch with a bracelet belt. Ladies' watches had been made for years with bracelets. The idea of a man's watch with a leather belt was new. A registered design, however, is not the same as a patent. It was a copyright and was only good for a small number of years.

Also, in St. Louis, MO, Charles Wallerstedt Mfg. Co. was making leather goods. Wallerstedt patented a pocket watch fob in US patent 843050A in 1907 (Figure 11). I also have a Wallerstedt leather watch strap in my collection. This watch strap encloses the watch in leather similar to his pouch, and the watch does not require

Figure 11. US patent for a leather pocket watch "fob" granted in 1907 for C. Wallerstedt, https://pdfpiw.uspto.gov/.piw?Docid=843050&idkey=NONE&homeurl=%252F%252Fpatft.uspto.gov%252Fnetahtml%252FPTO%252Fpatimg.htm.

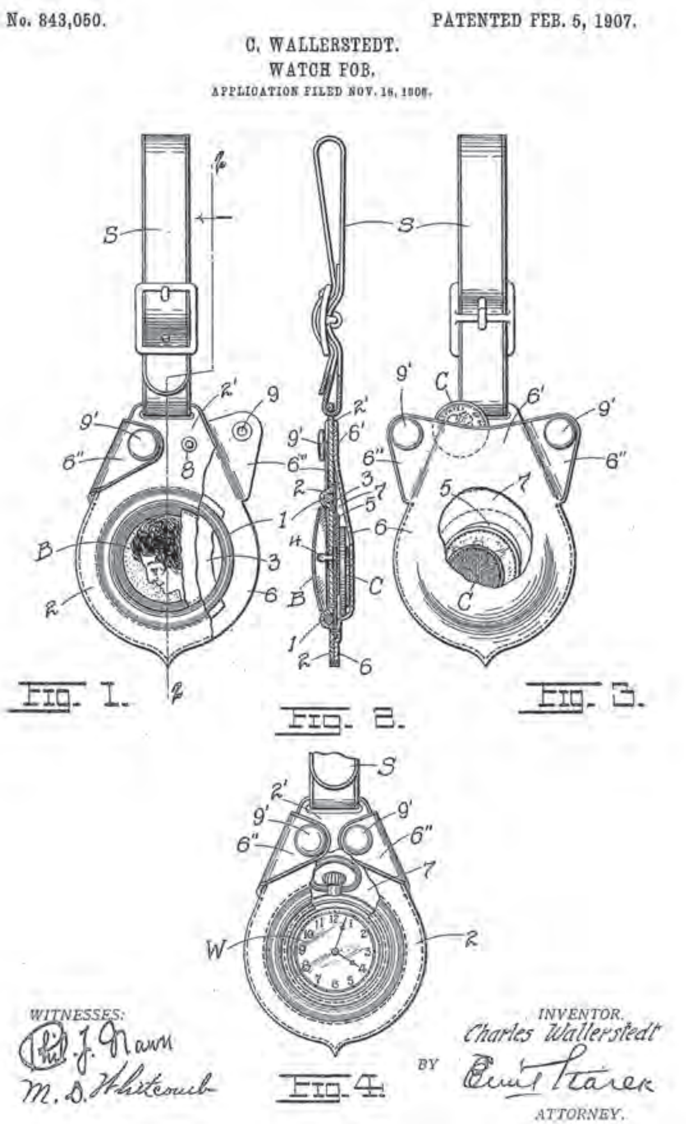


Figure 12. Charles Wallerstedt watch strap, early 1900s. AUTHOR'S PHOTO.

wire lugs (Figures 12 and 13). On checking the *St. Louis Post* and the *St. Louis Star* newspapers, I found Charles Wallerstedt advertisements for operations and stitchers from 1905 until the 1930s.[8] He made all kinds of leather goods including shoes and purses (Figure 14).[9]

I hope to continue in a future column with a discussion of the American Strap Co., Inc., in New York City that also supplied World War II military bands. I need more information on this company. If any of our readers have information that might help, please email it to edwinfasanella@gmail.com.

Notes and References

1. E. L. Fasanella, "World War II U.S. Military Wristwatches and Their Bands: Part 1," *Watch & Clock Bulletin* 61, no. 442 (November/December 2019), 501–6.
2. Genealogy data on David Guss, courtesy of Ancestry.com and personal emails from Peter and Jonathan Guss, June–September 2019.
3. World War 1 draft registration card, courtesy of Ancestry.com and personal email from the Guss family, September 3, 2019.
4. Newspapers.com, *Philadelphia Inquirer*, March 1925.
5. Newspapers.com, *Philadelphia Inquirer*, January 1945.
6. Newspapers.com, *Philadelphia Inquirer*, August 1947.
7. The registered design was from Dimier Freres & Cie (Depose No 9846) for a leather strap and buckle design for a wristwatch with closed lugs. See David Boettcher's website Vintage Watchstraps for the early history of watch straps, accessed November 2020, www.vintagewatchstraps.com.
8. See Newspapers.com, where advertisements by Wallerstedt can be found in the *St. Louis Post* from 1905 until the 1930s.
9. "The 'Slip-in' Sandal" advertisement, Newspapers.com, *St. Louis Post*, September 17, 1934.

Figure 13. Inside back cover of a strap marked "Charles Wallerstedt MFG CO MAKERS St LOUIS Mo U.S.A." with "1½" inside a diamond shape. AUTHOR'S PHOTO.

Figure 14 ▼. Wallerstedt "'Slip-In' Sandal" advertisement, *St. Louis Post*, September 17, 1934, Newspapers.com.

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2021 NAWCC National Convention Recap

By Judy Draucker, FNAWCC* (VA) and Richard Newman, FNAWCC (IL)

The 2021 National Convention took place on July 15-18 in Hampton, VA, at the Hampton Roads Convention Center and Embassy Suites Hotel. It was great to see so many familiar and new faces after a long year of the pandemic.

We extend a big Thank You to members, friends, committee chairs, volunteers, NAWCC staff, sponsors, and donors for helping to make this convention so successful.

On Thursday, July 15, incoming Executive Director Rory McEvoy gave the keynote speech via a recorded video. Volunteers and staff were kept busy at the Registration area each day of the event. All of the presentations were well received and well attended. Grateful thanks go to the lecturers and workshop presenters:

Lectures

- Nicholas Butt: "Chelsea Clock: 1897-Today"
- Bob Frishman: "Timing a Revolution: Preview of the 'Horology 1776' Philadelphia Symposium"
- Philip Poniz: "Pocket to Wrist: Collecting Watches Right Now"
- Pat Hagans: "Benjamin Banneker: 18th-Century African American, Self-Taught Astronomer, Mathematician, and Clockmaker and Civil Rights Champion"
- Ron Price: "James Russell Pocket Watches & Aaron Lufkin Dennison"
- James Campbell: "David Winship's Ledger Book 1827-1864"
- Chuck Roeser: "Restoration of a Four-Dial McClintock Post Clock"
- Alan Bomar: "The Tower Clocks of Fort Monroe"
- Craig White: "James Ferguson Astronomical Clock"
- Lee Davis: "Artist's Use of Father Time in Publication"
- Ralph Pokluda: "Southern Horology"
- Ed Fasanella: "Virginia Watches, Silversmiths, Hallmarks, and Jewelers from Colonial America to the Civil War"
- Jerry Maltz: "Amassing and Selling My Advertising Clock Collection"

Workshops

- Lee Davis: "Early American Clock Case Stenciling"
- Dave Gorrell: "Clock Making Tools, Gadgets and Fixtures" and "Pocket Watch Disassembly"
- Richard Robinson: "Glass Cutting for Clock Cases"
- Bruce Brown: "Casting Clock Finials and Other Case Parts"

Jim Dyson presented two excellent walkthrough lectures on the stellar nautical and maritime timekeeping exhibit. The exhibit featured an outstanding private collection of carefully curated and historically documented Chelsea clocks—the finest collection of Chelsea clocks ever assembled. A second display of historic marine chronometers rounded out the nautical theme of this year's convention.

The Crafts Competition room had beautiful creations on display. A live auction took place on Friday evening with over 100 entries that sold. Five silent auctions took place in the mart room on Saturday and Sunday, concluding with a Super Silent Auction on Sunday. The mart room was bustling with nearly 400 dealer tables, and the Gift Shop had record sales.

The Awards Banquet was held on Saturday evening, with 135 in attendance. It was a wonderful evening to acknowledge the contributions of many individuals and Chapters.

Two groups of Convention attendees visited The Mariners' Museum in nearby Newport News: 28 on July 15, and 15 on July 18. These groups enjoyed the rare opportunity to view a portion of the museum's chronometer collection not normally on public display.

More than 700 people attended this year's Convention, including 25 new members. We hope everyone who attended had a great time meeting old friends and making new ones. Be sure to mark your calendar for the NAWCC National Convention in Dayton, OH, on June 23–26, 2022. We'll see you there!

FNAWCC denotes a recipient of the Fellow Award.
FNAWCC* denotes a recipient of the Silver Star Fellow Award.

A huge Thank You goes to all our sponsors, donors, those who provided door prizes, Chapters, and members. Each of you was an important part of making our 2021 National Convention a success!

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BANQUET GRAND PRIZE

Jones & Horan – Commemorative WWI Pocket Watch

CRAFTS COMPETITION PEOPLE'S CHOICE AWARD

Donegan Optical Company, in memory of Bill Donegan – Hand-Blown Glass Trophy

PLATINUM ($500-$1,000)

Ch. 34 – Old Dominion (VA)

AntiqueAmericanClocks.com

Brent L. Miller Jewelers & Goldsmiths

Donegan Optical Co.

Griffen's Clock Parts and Supplies

Jones & Horan

Rockwell Horological Arts

Schmidt's Antiques

INDIVIDUALS - PLATINUM

Steve Berger

Judy Draucker

Jay Dutton

H. Glen & Sherry Kitts

Richard Robinson

GOLD ($200-$499)

Ch. 2 – New York (NY)

Ch. 22 – Old Timers & Fellows

Ch. 24 – Atlanta (GA)

Ch. 35 – Kentucky Bluegrass (KY)

Ch. 63 – Sunflower Clock Watchers (KS)

Ch. 68 – Jean Ribault (FL)

Ch. 126 – Western Carolinas (NC)

Ch. 139 – San Jacinto (TX)

Ch. 148 – Connecticut (CT)

Ch. 159 – British Horology

Marathon Watch Company

Vortic Watch Co.

Windycitywatchcollector.com – Chris Hooper

INDIVIDUALS - GOLD

Virginia LaFond

Jack & Ann McBroom

Rich Newman

Russ & Janet Oechsle

Jim & Sandy Price

Dennis Radage

Lu & Steve Sadowski

SILVER (Up to $199)

Ch. 1 – Philadelphia (PA)
Ch. 6 – Great Lakes (MI)
Ch. 8 – New England (MA)
Ch. 10 – Ohio Valley (OH)
Ch. 12 – Washington DC
Ch. 13 – Western New York (NY)
Ch. 15 – Southwestern (TX)
Ch. 17 – Carolina (NC)
Ch. 21 – Colorado (CO)
Ch. 23 – Buckeye (OH)
Ch. 25 – New Jersey (NJ)
Ch. 27 – Delaware (DE)
Ch. 33 – Toronto (INTL)
Ch. 36 – Heart of America (KS)
Ch. 37 – Allegheny (PA)
Ch. 40 – Rip Van Winkle (NY)
Ch. 41 – Magnolia (MS)
Ch. 42 – Tennessee Valley (TN)
Ch. 43 – Creole (LA)
Ch. 48 – King Cotton (TN)
Ch. 53 – Inland Empire (WA)
Ch. 55 – Central New York (NY)
Ch. 71 – Sacramento Valley (CA)
Ch. 73 – High Desert (CA)
Ch. 74 – Sooner Time Collectors (OK)
Ch. 75 – San Fernando Valley (CA)
Ch. 77 – Little Egypt (IL)
Ch. 83 – Peace Pipe (IN)
Ch. 84 – Mid-Hudson (NY)
Ch. 89 – Maine (ME)
Ch. 109 – Green Mountain Timekeepers Society (VT)
Ch. 111 – Ottawa Valley (INTL)
Ch. 120 – Horological Art
Ch. 124 – Lone Star (TX)
Ch. 134 – Tower and Street Clock
Ch. 135 – Mt. Rainier (WA)
Ch. 142 – Central Jersey (NJ)
Ch. 154 – Daytona Beach (FL)
Ch. 162 – Watauga Valley (TN)
Ch. 171 – Madison (WI)
Ch. 173 – Horological Tool
Ch. 175 – Industrial Time Recorders
Ch. 190 – Ventura and Santa Barbara County (CA)
Ch. 193 – Susquehanna (PA)
Ch. 194 – Cog Counters
Merritt's Antiques
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Timesavers

INDIVIDUALS - SILVER

John Acker
Dorothy & Richard Baker
John R. Bell Jr.
William Burwinkel
John Colwell
David Cooper
Renee & Jim Coulson
Larry Crutsinger Sr.
Larry Crutsinger Jr.
Mary Jane & Stan Dapkus
Lee Davis
Suresh Dhanjani
Tyler St. Gelais
James Gilmore
Frank Del Greco
Andy Dervan
Frank & Patty Dey
Mark Frank
Robert Gunning
In Memory of Walter Hankins
Marc Hanrez
Earl Harlamert
Elden & Rhona Hoskins
Mary Johnson
H. Van Johnson
Joseph Libaridian
John Lombardi
Tom Manning
Tom & Carolyn Marren
Son Duy Pham
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2021 Crafts Competition

By William "Bill" Slough (TX)

The 2021 National Convention in Hampton, VA, was wonderful. Among the successes of the Convention was the beautiful display of entries in the National Crafts Competition.

I would like to thank the Crafts Committee for their work in putting on the Competition. The Committee helped check in entrants, made sure they filled out forms, and placed their items in the room. They also helped visitors to view entries and vote for their favorite entry as well as assisting with the tabulation of the judging and the display of winners with ribbons and medals. Committee members welcomed 225 people at the competition this year.

Entries were submitted for 5 out of 27 classes. The Crafts Committee wants to thank each contestant for their work and effort to bring their items to the Competition.

The entry form and rules for the 2022 National Crafts Competition are in the November/December 2021 issue of *Mart & Highlights* and at nawcc.org.

List of Winners

People's Choice Award—Russ Oechsle

Class 12 Clock Restoration

1ST PLACE: Michael Schlotterbeck

2ND PLACE: Russ Oechsle

Class 18 Gold Leafing

1ST AND 2ND PLACES: Lee Davis

Class 22 Horological Parts

1ST PLACE: Randy Naber

Class 25 Chapter Clock Restoration

1ST PLACE: Maine Chapter 89

Class 26 Institutional & Public Clock Restoration

1ST PLACE: Maine Chapter 89

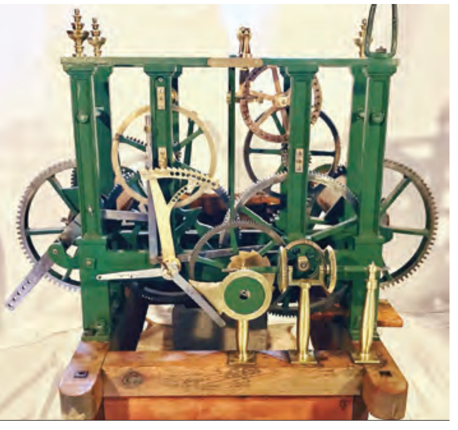
2ND PLACE: Russ Oechsle

2021 People's Choice Winner: Russ Oechsle

Also Voted Class 12 Clock Restoration: Second place

Also Voted Class 26 Institutional and Public: Second place

As with all antique clocks, few survive, and many collectors are attracted to the hobby with an interest to save rare examples from extinction. This is especially true of early tower clocks, when the replacement or loss of the public or religious buildings in which they were installed also led to the loss of the rare clocks. Prominent 19th-century bell and instrument maker Andrew Meneely of West Troy (now Watervleit), NY, made a small number of tower clocks in the 1826–50 period, and only four are known to have survived. Collector and researcher Russ Oechsle of Homer, NY, had monitored the existence of one of these survivors in an upstate New York community for over 40 years. Made in 1848, this clock had long been out of working order; dormant, abandoned, and covered with pigeon droppings, eventually all evidence of a once-working clock was obscured when the church building was covered in vinyl siding. After three changes in church ownership, the latest pastor actually did not know that there was even a clock in the tower. The clock was purchased, and over the winter of 2020–21 the clock was restored by Russ. Original colors were identified and all parts painted/restored as original. Interesting features of the Meneely movement include a knife-edge suspension, pin-wheel escapement, and rack and snail strike.



Class 12 Clock Restoration

FIRST PLACE: Michael Schlotterbeck

This is a Chelsea clock that was sold under Tiffany & Co. of New York. However, when I saw the clock at the auction, it was apparent this clock had led a hard life. The polished, Navy G-bronze case had been stripped and had tarnished to a dingy tan color. The dial was stained, scratched, and dirty. The clock was inoperable. But the major problem was that the original cast bronze bezel was missing! In its place, someone attempted to remedy the problem by soldering a thin, stamped brass bezel to the hinge and used that to cover the dial. It was a ghastly looking substitution. Now, the real work had started. One of my principal concerns during the project was if the color of the G-bronze in the new bezel would match the color of the G-bronze used in the original base, cast back in 1919. SAE material specifications have been in existence since 1905, and thanks to the creation of, and adherence to those standards, an ingot of SAE 620 Navy G-bronze cast just over 100 years ago by an unknown

foundry, and a separate piece of SAE 620 Navy G-bronze pipe cast by a second foundry 100 years later, matched perfectly. I have completed turning, positioning, and installing the new bezel alignment pin (not shown in this presentation), which is a feature common to all Chelsea "Wardroom" clocks. At this time, the clock is assembled and running with one item remaining—installing the decorative "torpedo"-shaped handle used to open and close the bezel. I have completed turning this part and am proceeding with its polishing.

Class 18 Gold Leafing

FIRST PLACE: Lee Davis

Copy of an E. Terry & Sons 8-day tablet gold leaf etched border and bob opening.

SECOND PLACE: Lee Davis

Copy of an E. Terry & Sons 8-day tablet gold leaf etched border and bob opening.

Class 22 Horological Parts

FIRST PLACE: Randy Naber

Circa 1907–10 Ingraham black mantel case replacement of pillars.

Class 25 Chapter Clock Restoration

FIRST PLACE: Maine Chapter 89

Also Voted Class 26 Institutional and Public: First place

This Seth Thomas street clock was purchased and installed at its current location in 1924 to commemorate 25 years of service of the Hay and Peabody Funeral Home Company. Maine Chapter 89 completed its restoration, and the City of Portland proudly celebrated their historic landmark. Eleven members of our proud Chapter participated in this restoration. We removed and totally restored the movement and made new parts. When necessary, we made four new bezels from scratch. We cleaned and painted the hands and then removed, cleaned, and restored the four large dials. We also cleaned and polished the brass retainers that keep the bezels in place. We restored the motion works and electrically wired the clock lighting system and the self-winding system.

Clock Restoration

By James Campbell (PA)

As you approach the front entrance of the National Watch & Clock Museum, you'll see a four-dial Seth Thomas #4 Serial No. 2128, made on April 14, 1920. It was originally erected in Greenville, SC. In 1967, it was purchased by Mr. and Mrs. James Bruce Bell and placed outside of Bell Photography Studio in Seneca, SC. Mrs. Louise Bell donated it to our Museum in 1992, and it was placed outside the front entrance to the Museum, where it still resides today.

The current work that has been completed involved repairing the movement, taking care of some leaks in the clock, and sequencing the dials to read the correct time. Bob Desrochers and Randy Bunnell completed the restoration and installation with a little bit of help from me. The pinions and shafts that needed replaced were purchased from Chuck Roeser.

Teamwork in action: James Campbell (left) and Bob Desrochers (right).

School of HOROLOGY
NAWCC

Introduction to Antique Clocks
Date: Sat., 12/4/21 & Sun., 12/5/21
Time: 9:00 a.m. - 5:00 p.m.
Location: NAWCC School of Horology, 454 Poplar Street, Columbia, PA 17512
Instructor: Ken De Lucca (kdelucca@nawcc.org)
Scope: Basic functions of a time-only mechanical clock movement; take the movement apart, reassemble it, put it in beat & lubricate it
Tools: Hand tools & movements provided; bring your own binocular magnifier or similar device
Cost: $695
Visit nawcc.org > Events to sign up today!

There's Always Something New to Learn!

As an NAWCC member for over 20 years and a graduate of the NAWCC School of Horology (2007), my primary goal is to reestablish our education outreach commitment to our members and those interested in clockmaking. It's time to refocus and revitalize by starting with beginners' classes at the School of Horology. My plan is to start with introductory classes and build upon them to reach more technical and complex offerings in Columbia. I also hope to develop our online educational video library for those who cannot attend in-person classes. It's an exciting time to be a part of this undertaking and an exciting time to be a member of the NAWCC! *—Ken De Lucca, NAWCC Director of Education*

Thank You to Our 2021 Writers

Editor's note: The staff of the *Watch & Clock Bulletin* thanks all our 2021 writers for their hours of research, writing, and rewriting. We all have benefited from their labors. The authors are listed alphabetically with brief bios and a list of articles and features published in 2021.

Darrah Artzner, FNAWCC
Artzner served in the US Marines and received degrees in geology (paleontology). He worked for the oil industry for several years, followed by 24 years as a computer programmer and networking specialist for the US government. Artzner has been working with clocks and watches for more than 35 years and during that time has studied various aspects of the Rockford Watch Co. He is an active member of the NAWCC and has been past president, current Board member, and webmaster for NAWCC San Jacinto Chapter 139 of Houston, TX, and member of Chapters 115, 124, 139, and 149. He is currently a volunteer moderator for the repair forum on the NAWCC Forums. • No. 452 "Rockford Watch Co. Aluminum Prototype"

Joseph Arvay
Dr. Arvay has been a collector and researcher of antique American clocks for 25 years. His interests have spanned wood works clocks and early production 19th-century shelf clocks. He has created a collection of miniature 18th- and 19th-century clocks, including dwarf tall case clocks produced by Simon Willard, Joshua Wilder, and Ruben Brackett. Dr. Arvay has researched and written about American fused clocks and has also focused on Salem Bridge clocks. His passion for Curtis & Clark miniature shelf clocks has spanned his collecting and researching avocations. Dr. Arvay is a practicing orthodontist in Morristown and Flanders, NJ. • No. 452 "Curtis & Clark Shelf Clocks"

Spiridion Azzopardi
Azzopardi studied mechanical engineering and spent most of his working life employed as a research and development engineer. He has had a lifelong interest in restoring and conserving period clocks, which in turn fueled a desire to research their history. Azzopardi has been researching monastic clocks on the Greek peninsula of Mount Athos for the last 21 years, documenting, recording, photographing, and making detailed studies of all the horological artifacts he has encountered. • No. 453 "Origins of the Mechanical Clock"

Selman A. Berger
Selman A. Berger, PhD, is a retired professor of chemistry in the City University of New York system. He has been collecting, restoring, and researching primarily the Keystone-Howard pocket watch for nearly 45 years, and has made multiple contributions to the *Bulletin*. • No. 454 "The T. Eaton 18-Size Movement: A Canadian Imitation of a Waltham Model '92?"

Carlos E. Blanco
Blanco lectures at the European University in a Master in Telecommunications program. He is interested in the history of science and has a substantial collection of antique scientific instruments, mainly mathematical instruments. He holds several patents both in Europe and in the United States. Blanco is a member of the Spanish Society for the History of Science and a member of the Spanish Forum of the History of Telecommunications. • No. 449 "A Le Roy et Fils Regulator Clock with an Ellicott Pendulum"

Richard Cedar
Cedar studied mechanical engineering before becoming a jet-engine designer. While searching online for something to amuse himself on a cold winter's night in 2004, Cedar came across Jeff Schierenbeck's Wooden-Gear-Clocks kits. He bought one and quickly constructed it, not realizing that this would be the start of a quest to design clocks that balance the hypnotic beauty of a kinetic sculpture and an accurate timekeeper. • No. 454 "Some Thoughts on the Status and Future of Contemporary Clockmaking with Digressions into Modern Studio Pottery"

Vincent V. Cherico Jr., CMW
Cherico is an avid collector of watch cocks. He is a 1984 graduate of the North Bennet Street School, Boston, MA, specializing in watch repair. He was awarded a Certified Master Watchmaking certificate from the American Watchmaker-Clockmakers Institute, Harrison, OH, in 1999. Cherico is presently employed as a toolmaker in the biomedical research and development industry. • No. 450 "The English-Style Watch Cock Re-examined: James I through George III: Part 1"; • No. 451 "The English-Style Watch Cock Re-examined: James I through George III: Part 2"; • No. 454 "Updates to 'The English-Style Watch Cock Re-examined: James I through George III'"

Tara Chicirda
Chicirda is the Curator of Furniture at Colonial Williamsburg, VA. • No. 450 "Tall Clocks in the Colonial Williamsburg Collection"

William Christie
Christie first became interested in pocket watches in the early 1950s when he learned how to disassemble a watch. Over the years he has pursued his fascination with these mechanical wonders and collected watches, with a particular interest in high-quality American pocket watches. After working for 47 years as a dentist, he is now retired and enjoys the "company" of his pocket watches. • No. 454 "Nineteenth-Century Convertibles"

Burt Cifrulak
Burt Cifrulak is a Vietnam veteran and retired police inspector who served 30 years with the Allegheny County Police, Pittsburgh, PA. Upon his retirement he became interested in studying and collecting Hamilton railroad grade and early Lancaster Watch Co. pocket watches. Burt has been a member

FNAWCC denotes a recipient of the Fellow Award.

of the NAWCC since 2007. • No. 453 "The Adams & Perry Watch Co. and the Early Watch Companies of Lancaster, PA: Part 2"

Raymond Comeau
Ray Comeau is a retired dean and current lecturer on literature and management in Harvard University Extension School. He is a member of Chapters 8 and 87 in his native Massachusetts. Poems: • No. 449 "Time and Poetry Meeting Up"; • No. 450 "An Awful Time for Nurses"; • No. 451 "The Watchmaker and His Heart"; • No. 452 "Oil for Extra Time"; • No. 453 "Humpty-Dumpty in Post-Pandemic Time"; • No. 454 "Looking up at Bedtime"

Mary Jane Dapkus, FNAWCC
Dapkus, formerly curator of the American Clock and Watch Museum (ACWM) in Bristol, CT, is a certified history researcher. She was the 2014 Willard House & Clock Museum Robinson Lecturer; the 2017 recipient of the NAWCC James Gibbs Literary Award; and the 2019 feature speaker at the Eastern States NAWCC Regional. Together with the late Dr. Snowden Taylor, she is coauthor of the book *Antebellum Shelf Clock Making in Farmington and Unionville Villages, CT* (NAWCC, 2019). Dapkus is the author of *Joseph Ives (1782-1862) and the Looking Glass Clock*, published by ACWM. • No. 449 "A New Look at Benjamin Banneker (1731–1806): African American Astronomer, Philomath, and Clockmaker"

Judy Goldsmith DenHerder
A 1975 graduate of the Kendall School of Design, DenHerder was hired by Colonial Mfg. Co on July 12, 1976, as designer and in early 1979, she was named to design/research and development. She remained in this role until late 1980 when operations moved to Kentwood, MI, closing her chapter at Colonial. Over 36 years in clock sales led to a focus on clock repair and a collector's interest in antique and vintage American clocks. • No. 449 "Designing Modern 20th-Century Colonial Mfg. Co. Grandfather Clocks"

Andrew H. Dervan, FNAWCC*
Dervan began collecting antique clocks in 1997 and joined the NAWCC. Researching the manufacturing histories of various makers and companies was more challenging than simply collecting; he has published many articles in the *Watch & Clock Bulletin*, *American Clock and Watch Museum Electronic Timepiece Journal*, and *Clocks Magazine*. In 2011, he retired from DuPont Performance Coating and now volunteers at the Henry Ford Museum, runs a clock appraisal business, and continues his horological research. In 2011, he became an NAWCC Fellow, in 2016 he was awarded the NAWCC James W. Gibbs Literary Award, and in 2017 he became an NAWCC Silver Star Fellow. • No. 449 "Designing Modern 20th-Century Colonial Mfg. Co. Grandfather Clocks"

Damon Di Mauro
Di Mauro teaches in the Department of English, Languages, and Linguistics at Gordon College in Wenham, MA. • No. 453 "*Mulliken v. Wingate*: 'A Dispute about an Apprentice'"

Carl Dreher
Dreher is a retired electrical engineer living in Brasstown, NC. A long-time NAWCC member, he has an interest in high precision mechanical clocks or anything with an unusual movement. • No. 454 "An Easy, Inexpensive Technique for Recreating Reverse-Painted Dials"

Michael Edidin
Edidin is Emeritus Professor of biology at the Johns Hopkins University. His major horological papers focus on the history of the Tobias watchmaking family of Liverpool and London. He maintains a continuing interest in early 19th-century Liverpool watchmaking, a complex and creative period of English watchmaking. • No. 452 "Saturation Collecting, or It's Not Junk, It's a Data Point"

Jon Edwards
Edwards graduated from Canada's National Horology School in 2007 and has furthered his training as a watchmaker at Rolex and at The Swatch Group. He has been involved in the development of timekeeping apps for iOS, including Kello and Twixt Time, which have previously been covered in the *Watch & Clock Bulletin*. • No. 451 "Henry Playtner and His Legacy: First Director of Elgin Watchmakers' College and Founder of the Canadian Horological Institute"

Gary Fox, FNAWCC
Fox, a 40-year member of the NAWCC and long-time member and director in Ottawa Valley Chapter 111, is the author of *Canada's Master Watchmaker: Henry Playtner and the Canadian Horological Institute*. • No. 451 "Henry Playtner and His Legacy: First Director of Elgin Watchmakers' College and Founder of the Canadian Horological Institute"

Mark Frank
Frank's horological interests are in the research and collecting of timepieces where one can view the mechanical works. His main interest is in those pieces that exhibit interesting mechanical characteristics as demonstrated through complexity, novelty, or visual appeal. He has been an NAWCC member since 1993. • No. 454 "Astronomical Skeleton Clock Completed after 12 Years of Construction, Part 1"

Jim Kane
Kane is a retired mechanical engineer living in Sonoma County, CA. He has been an NAWCC member for more than 50 years. His current interests are tall case clocks, porcelain clocks, and shelf cuckoo clocks. Jim is currently a small business counselor with SCORE. • No. 450 "Someone Left the Clock out in the Rain"

Steven M. Lash
Lash has been a member of the NAWCC since 1969. He is an avid period furniture maker and is the co-founder and past president of the Society of American Period Furniture Makers. When not in his woodshop, Lash practices orthodontics in West Bloom-field, MI, and is an adjunct professor of orthodontics at the University of Michigan, School of Dentistry. • No. 451 "From Mock-up to Mozart: Building a Reproduction Bracket Clock"

FNAWCC denotes a recipient of the Fellow Award.
FNAWCC* denotes a recipient of the Silver Star Fellow Award.

George Meyer
Meyer grew up in Lancaster, PA. He started collecting watches about 20 years ago and became interested in early American pocket watches about 10 years ago. This led him to realize the rich history of watchmaking in his hometown of Lancaster. This interest led him to the NAWCC and then to the Early American Watch Club Chapter 149. • No. 453 "The Adams & Perry Watch Co. and the Early Watch Companies of Lancaster, PA: Part 2"

Alan Myers
Myers is Emeritus Professor of marine zoology at the National University of Ireland. He has written books for IWC Schaffhausen on their earliest pocket watches and articles on Swiss full-plate watches, Bonniksen karrusels, and Howard factory tools. He has been researching E. Howard watches for many years. • No. 452 "The K-Size Movement of E. Howard & Co. of Boston"

NAWCC Staff
NAWCC staff members have written features and brief articles throughout 2021. We thank them for their contributions.

Richard Newman, FNAWCC
Newman is an active supporter of the NAWCC's education mission and serves on the Board of Directors. He has lectured at the NAWCC Ward Francillon Time Symposium, National Conventions, and Regional events, and has written more than 20 articles for the *Watch & Clock Bulletin* and other publications. • No. 450 "A Well-Traveled Fromanteel Watch"

Louis Arthur Norton
Dr. Norton, Professor Emeritus at the University of Connecticut, has published extensively in scientific literature and on seafaring topics, including five nonfiction maritime history books plus one children's book. His articles have been awarded several prizes for nonfiction and one for fiction. • No. 453 "The Pocket Watch and Its Nautical Accoutrements"

Philip Poniz, FNAWCC
Poniz is a mathematician turned horological historian, collector, author, certified master watchmaker, and restorer. Many of the world's ultra-complicated watches have passed through his restoration and forensic studio. His work ranges from being a court expert to a custodian of one of the largest horological e-libraries with over 8 million files. He is the manager of WatchInvest and the owner of European Watch & Casemakers. He moderates the NAWCC Complicated Watches Forum and has helped form several major horological collections. Poniz is considered a leading expert on Patek Philippe, Breguet, and Cartier timepieces and their histories, as well as an expert in watch fakes and forensic horology. • No. 449 "TAG Heuer and 'Its' Oscillating Pinion"; • No. 451 "Adolphe Nicole and the True Beginning of the Modern Chronograph"; • No. 453 "Henri-Féréol Piguet or Adolphe Nicole: Who Invented the Final Version of the Modern Chronograph?"

Jeff Schwarzwaelder
Schwarzwaelder has spent years reading about and studying design and manufacturing methodology in his quest to fabricate one-of-a-kind, complex, multifunction timepieces. This decades-long process of building increasingly complex clocks with great attention to aesthetic appeal and functionality has resulted in his current creations. • No. 451 "Aesthetics, Design, and Functionality of Two Clocks: The Bling Complexity and Napoleon's Complexity"

Robert E. Wagner
Wagner graduated with a degree in chemistry from the State University of New York at Oswego and was employed as a materials engineer/chemist in the aerospace industry for 33 years. His passion for vintage pocket watch and wristwatch history, repair, and restoration flourished over that same time period. This passion was instigated, at least in some respect, by his father, who was a jeweler and stone-setter in the New York diamond/jewelry district on West 47th Street in Manhattan. Retirement has allowed him to devote more of his free time to further explore and develop his horological interests. • No. 452 "An American Pocket Watchcase of an Unusual Design"

Column Contributors

Horologica: • No. 449—Bob Holmström, Philip Kuchel, Fortunat Mueller-Maerki, FNAWCC*; • No. 452—Jim Dubois

In Memoriam: • No. 449—Byron Tekippe (Bernard J. Tekippe, FNAWCC*), Andrew H. Dervan, FNAWCC* (Robert "Bob" Alpaugh and Rocco "Rocky" Romeo), Jim and Renee Coulson, FNAWCC* (William Bryan, FNAWCC*); • No. 450—Andrew H. Dervan, FNAWCC* (Robert C. Booth, FNAWCC), Frank Del Greco, FNAWCC* (Stanley Kaufman, FNAWCC), Mike Schmidt, FNAWCC (Ken McWilliams, FNAWCC); • No. 451—William Ward (Stephen Kramer III, FNAWCC), Jim Holmgren (Ian Wetherly), Robert Gary, FNAWCC (James F. Chamberlain, FNAWCC*), Kevin Cole and Fred Robjent (Frederick Christopher Tahk), Randy Jaye (Edward "Eddie" Epp); • No. 452—Molly Lentz (Robert A. Lardon), Denis Devane (Paul Hopkins), Eric Hooker, FNAWCC (Paul Kostelny and Siegfried E. Thewke); • No. 453—J. Alan Bloore, FNAWCC (Henry J. "Les" Lesovsky, FNAWCC); • No. 454—Judy Draucker, FNAWCC* (George Orr, FNAWCC*); Mary Jane Dapkus, FNAWCC (George Bruno, FNAWCC); Peter Elmendorf (John M. Kocsis); James Dyson (Roger Conner)

Research Activities & News: • No. 449—Edwin Fasanella, FNAWCC; • No. 450—Jim Abbott, Richard Fyans, Ted Orban; • No. 451—Philip Kuchel; • No. 452—George Douglas Gehr, Mary Jane Dapkus, FNAWCC, Paul Foley, Andrew H. Dervan, FNAWCC*; • No. 453—Thomas L. De Fazio, FNAWCC, Andrew H. Dervan, FNAWCC*; • No. 454—Edwin Fasanella, FNAWCC

Vox Temporis: • No. 452—David Penney; • No. 454— John Robey, M. R. Lewbel, Carroll Wolfe, FNAWCC

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FNAWCC* denotes a recipient of the Silver Star Fellow Award.

George Orr, FNAWCC*

George Elwood Orr of Oklahoma City, OK, died on July 23, 2021, age 91. He was born in Junction City, KS. He received a Bachelor of Science degree in industrial engineering in 1953 from the University of Oklahoma and an MBA in 1972. George retired as a commander in the US Navy, serving three years on the destroyer USS *Fiske* based out of Newport, RI. He served more than 20 years in the Naval Reserve. As a Registered Professional Engineer in New York, Pennsylvania, and Oklahoma, George worked in manufacturing, industrial engineering, and management, producing both classified military electronics and commercial products. Prior to retirement, he spent years as an executive recruiter operating his company, Executive Resources Inc.

George enjoyed collecting early American clocks. He joined the NAWCC in 1966 with membership number 10473 and was a charter member of the Sooner Time Collectors Chapter 74 and served as president. In his retirement, George operated an antique clock repair service in central Oklahoma.

George was awarded an NAWCC Fellow Award in 1992 and the Silver Star Fellow Award in 1997. In 2016, he was recognized as an Old Timer. In 2017, he received the Golden Circle Award for 50 years of membership.

In 1993, George was elected as a director on the NAWCC Council. After serving two years, he was elected as Second Vice President in 1995, as First Vice President in 1997, and as President in 1999, a position he held for two years. During George's term as president, membership numbers ranged from 34,000 to 32,000 active members. While the headquarters and Museum expansion was initiated and designed by others before him, George was responsible for oversight of the project along with the Executive Director. The School of Horology received its formal accreditation under George's leadership. An eMart was established to enable members to buy and sell items on the internet. The Traveling Suitcase courses grew by leaps and bounds during this time. George supported, expanded, and promoted the courses of repair instruction and later became a traveling instructor.

George's presidency covered the years of the NAWCC's transition from an informal hobby group to a sizeable association of professionals as well as hobbyists. Several endowment funds were established to meet the long-term financial needs of the NAWCC. George supported and participated in the first overseas NAWCC Symposium in London, England. During his term as president, he started the Golden Circle Award program that recognizes 50-year members. He served as Convention Chair of the 2004 NAWCC National Convention in Oklahoma City.

George and his wife began their worldwide travels with the Navy, and continued with the help of *Europe on 5 Dollars a Day*. Alaska, Australia, China, and Egypt were fine, but two busloads of NAWCC members on a trip to newly opened Russia was truly memorable. The call of the sea was strong, and George helped crew a racing sailboat from Bermuda to Annapolis, among other sailing ventures. In Oklahoma City, he and Joanne spent 30 years as volunteer ushers for the Civic Center. He was active in the Oklahoma Genealogical Society, Arts Festival, United Fund, Chamber of Commerce, Boy Scouts, and his neighborhood association.

Of George's many accomplishments, probably his favorites were teaching, mentoring, and helping others. This mirrors my own experiences with him over many years; he always looked at all sides of an issue and carefully evaluated the facts before reaching a conclusion.

George is survived by his wife, Joanne, of Oklahoma City; their son, Dan, of Amarillo, TX; and granddaughter, Missy Harmon, and her husband, Tyler, and three great-grandchildren of Enid, OK.

George loved a good meal. He had a knack for finding the restaurant that the locals raved about. I enjoyed many good times with George and Joanne at those restaurants. He was a true friend to many, and we will certainly miss his bright smile and pleasant demeanor.

*—Judy Draucker, FNAWCC**

FNAWCC* denotes a recipient of the Silver Star Fellow Award.

George Bruno, FNAWCC

Longtime NAWCC member and Fellow George Bruno (CT) passed away on June 28, 2021, after a long illness. One of the best known and most skillful wooden movement clock makers and restorers in the United States, many members will also remember George as a table holder and presenter at numerous NAWCC Chapter meetings, Regionals, and Nationals over the past 50 or so years.

The sixth and youngest child born to Italian immigrants Antonio and Regina Bruno, the youthful George demonstrated great aptitude for mechanical pursuits. Upon graduating from Wolcott Technical School in Torrington, CT, he went to work as a machine designer and foundry engineer for the Turner & Seymour Manufacturing Co. in Torrington. After serving for three years in the US Army during World War II, George married his sweetheart, the late Barbara (Hultquist) Bruno. The couple settled in Torrington.

Sometime during the 1960s, a prominent collector approached George with a novel request: could he produce a movement for a certain early American wagon spring-driven clock? Being unfamiliar with antique American wooden clocks at the time, years later George enjoyed explaining how he went to work to study how to reproduce one. Eventually completing the task, George is said to have accepted a wooden movement shelf clock in payment.

Many repair jobs followed, and a hobby turned into a full-time second career. George produced and kept in stock not only gears, pinions, plates, pillars, bells, and lock work for wooden tall and shelf clock movements, but also cases, hands, weights, dials, carved eagle splats, whale's tail crests, and a host of other accessories. He also had detailed plans and technical drawings for numerous period examples that many modern craftsmen, attempting to follow in his footsteps over the years, have used to build, repair, and reproduce wooden clocks themselves.

From his work on repairing iconic early American wooden clocks, George became keenly interested in figuring out how Eli Terry's mysterious Porter Contract gear-cutting engine (for which no detailed description survived, other than a small clue) actually worked. George devoted decades of study and experimentation to this quest. From drawings and measurements of surviving examples, he constructed a number of working reproductions of early gear and pinion-cutting engines using modern parts and materials, but always with the goal of demonstrating how the original machinery was constructed and how it was operated. George's last working model, based on newly discovered primary source evidence, was also the last major design project he undertook in his too-brief lifetime (see M. J. Dapkus, "Conceptual Model of Eli Terry's Porter Contract Gear-Cutting Engine Proposed by George Bruno (CT)," *Watch & Clock Bulletin* 58, no. 422 [July/August 2016]: 342–46).

Over the years, George authored several articles that appeared in the *Watch & Clock Bulletin*. In addition, he was a frequent contributor to the *Bulletin*'s Research Activities & News column and to the *Cog Counter's Journal*. His observations and technical drawings appeared in a number of publications, notably, for example, the second (1996) edition of the classic work *Eli Terry and the Connecticut Shelf Clock* by the late Kenneth D. Roberts and Snowden Taylor. Many of us recall visiting him in his amazing workshop, where he generously gave of his time to consult with and instruct us in all matters wooden clock. George's beautiful exploded wooden movement diorama remains on exhibit at the American Clock & Watch Museum in Bristol, CT, an enduring tribute to his phenomenal skill and generosity. The museum also keeps on hand an assortment of George's wooden clock and clock case plans, reminders of good friends and pleasant work in days gone by.

At the time of his death, George was two months shy of his 98th birthday. He is survived by his son, Don Bruno, who is also an expert wooden movement restorer; Don's wife, Donna; one grandson; a great-granddaughter; and several nieces and nephews. Missing George's energy and humor, things won't ever be the same.

—Mary Jane Dapkus, FNAWCC (CT)

FNAWCC denotes a recipient of the Fellow Award.

John M. Kocsis

John M. Kocsis Jr. died peacefully at home on June 20, 2021, a week before his 93rd birthday. As he was throughout his life, he spent his final moments surrounded by family and friends. John is survived by three of his siblings, three children, seven grandchildren, and multiple nieces and nephews.

John was born on June 27, 1928, the eldest of eight children. He always had an extremely strong work ethic and held multiple odd jobs over the years until he graduated from the apprenticeship program at General Electric. He took some years away from GE to serve in the Army and was stationed in Germany. After his honorable discharge, he returned to GE, where he eventually retired as a Grade A Toolmaker.

He married his beloved wife, Gloria, on Valentine's Day in 1953, and together they raised their three children: Ann Marie, Susan, and John. He and Gloria celebrated 67 years of marriage together before she passed, with John by her side.

John had many different hobbies and interests and enjoyed building things and working with his hands. He built and flew model airplanes with a local club. He was a gifted clockmaker and could recreate historical clocks from photographs, often building skeleton clocks from brass, gears and all. One of his greatest sources of enjoyment was his tool shop in the basement of the home that he built, where he spent long hours working on personal projects and helping his family and friends. When not working, he loved learning about a wide variety of topics, especially history, and was looking forward to taking part in a Civil War reenactment. An extremely social person, John was always surrounded by numerous friends and loved ones. He joined multiple social clubs and maintained deep friendships with those around him. He loved to dance.

John possessed a keen knowledge of how things worked and was able to fashion diagrams, create blueprints, make necessary parts, and put it all together as a new creation or to bring something injured or no longer working to life again. Patience was his, in abundance—a truly kindhearted man with a vivid imagination, a twinkle in his eye, and a desire to create.

I met John in about 1995 at the Monday Nite Clock Group in Burnt Hills, NY. He was also a director of Rip Van Winkle Chapter 40, and he loved to attend their clock shows. One time when he was in my basement looking at the machinery I had just bought, he asked if I would like to learn how to use it and make a clock with him. I jumped at the chance. He was a patient teacher, and I learned a lot about clockmaking and also many new jokes. We became close friends, and I benefited greatly from his mentoring. One day years ago he called me up and said in case he died before me he wanted to tell me what he thought of me; he was always very complimentary. He would do anything to help people, and all he asked in return was their friendship. He was a national treasure with a mind that I have never seen equaled and possessed every craft skill with the ability to teach them to others. I plan to see him again in the next world we talked about.

—Peter Elmendorf (NY)

Roger Conner

It is with deep sadness that I report the passing of my longtime friend, neighbor, and clock mentor Roger Conner. I met Roger over 30 years ago when he was running a clock shop in a local antiques mall. Our friendship grew from our common careers in the Navy and interest in marine clocks. Roger joined the Navy at an early age and was the true definition of the term "mustang," since he rose from the enlisted ranks to retire as a lieutenant commander after 30 years of service.

Roger was one of those guys who was self-taught; he was a mechanical wizard who could fix anything. He took great pleasure in pointing out to me that college boys couldn't fix anything and how many times he had to fix stuff that I messed up. I will admit that Roger was way ahead of me in the repair department but our common interest in all things Joseph Henry Eastman blossomed into a peer relationship on his clocks and history. Roger had unsurpassed knowledge of Harvard, Boston, Eastman, Vermont, and Derry clocks, and his collection of these types was unequalled.

Roger was preceded in death by his dear wife, Betty, and is survived by his children, Michael and Patty, and numerous grandchildren. I will always remember fondly our countless conversations over Navy coffee at his kitchen table, where the favorite topic was marine clocks. Fair winds and following seas, my friend.

—James Dyson (VA)

In Memory Of

We recognize here those individuals and Chapters whose gifts to the NAWCC were given in memory of fellow members.

Gene Baker given by Atlanta Chapter 24

Jerry Cooper given by Jack and Elinor Goldberg

Jerry Cooper given by Mt. Rainier Chapter 135

David Gow given by Peter A. Nunes

David Gow given by New England Chapter 8

John Kocsis given by Rip Van Winkle Chapter 40

George Orr given by Jack and Elinor Goldberg

James Sprowl given by Stev Overstreet

Obituaries

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130659 Rancho Palos Verdes, CA

Ronald Chester Sr.
170034 Dawson Springs, KY

Roger A. Conner
95842 Virginia Beach, VA

Gerald (Jerry) Cooper
68256 Bothell, WA

Carl DiMarco
145584 Mohegan Lake, NY

David G. Gow
73428 Shrewsbury, MA

Hunter Kissam Jr.
125651 North Grafton, MA

John Kocsis Jr.
87597 Clifton Park, NY

Sol Kron
49206 Scottsdale, AZ

William Naples Jr.
32593 Rochester, MI

George E. Orr, FNAWCC*
11720 Oklahoma City, OK

Dennis Shughart
122313 Carlisle, PA

James Sprowl
178057 Wichita, KS

William Tapp
44935 Loveland, CO

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17426 Boulder, CO

Patrick Trainor
171561 Franklin, WI

FNAWCC denotes a recipient of the Fellow Award.
FNAWCC* denotes a recipient of the Silver Star Fellow Award.

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All Regional meetings must be scheduled through Convention Committee Coordinator John Koepke by emailing him at jskoepke@comcast.net, calling 510.236.2197, or mailing 2923 16th Street, San Pablo, CA 94806-2362.

For complete information about Regionals, the National Convention, and the NAWCC Ward Francillion Time Symposium, please see the *Mart & Highlights* or go to nawcc.org.

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