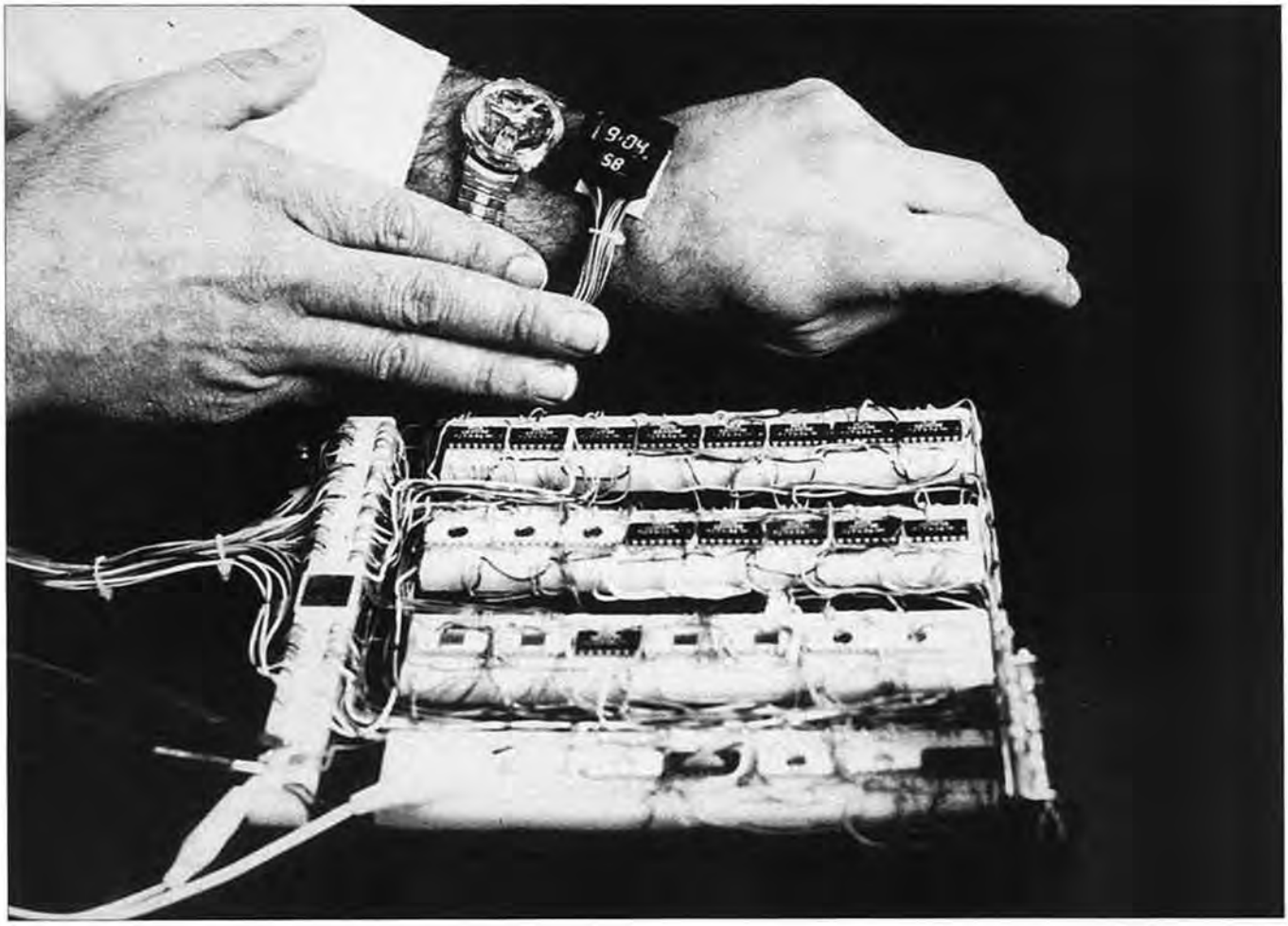
HOROLOGICAL TIMES

November 1998



American Watchmakers-Clockmakers Institute

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COVER

This month's cover feature is the Optel, the first digital LCD watch - 1970.



President's Message

By David A. Christianson

The various state and area chapters sanctioned by AWI are organized into an organization called the Affiliate Chapters. It is not so much a committee as it is a separate entity within AWI with its own Constitution, Bylaws and a voting position on AWI's Board of Directors. It forms a direct link between the membership and the Board of Directors, providing a simplified means of affecting Board policy, especially when it pertains to membership and chapters.

Unfortunately, many of our once very active chapters are suffering a serious decline in attendance. Apparently the large core of leadership that so many of the chapters enjoyed for so many years is rapidly diminishing and there just isn't a very large group from the next generation coming in to take their place. This translates into dramatically smaller participation; to the point that chapters are finding it far too expensive to sponsor quality programs and conventions for their members. It appears right now that we're witnessing the passing of an era. But...then again, we may be about to witness the beginning of a new one.

Seeking to bolster attendance, reach more members, and bring in a large program of quality instructors, Pennsylvania, Maryland, and Virginia formed the Mid-Atlantic Horological Symposium and combined their resources and talent to organize a week's worth of full-blown technical seminars, culminating in a weekend of technical short courses. AWI provided the instructors, but representatives from the three-state area planned and organized the event. The results were outstanding, the attendance impressive, and everyone walked away with a wealth of new knowledge, friends, and professional contacts.

But most importantly, the Mid-Atlantic Horological Symposium provides a format for future symposiums around the country. It offers a viable alternative to providing high-quality technical instruction to more members in one location at one time.

If you're interested in the possibility of forming your own area symposium, combining the resources and talents of several chapters in your region, contact AWI, or Dewey Clark (MD), Dan Fenwick (PA), Dan Spath (MD), or Jerry Kincaid (MD) in care of AWI Headquarters.

As the Mid-Atlantic Horological Symposium showed, the three-state group could reach far more members as a group with far more programming than the three individual states could have done by themselves.



Executive Director's Message

By William J. Ewbank

Many members have commented on the venerable old *Horological Times*' "new look". Actually, the new look has extended beyond the cover. The magazine now features a "Letters to the Editor" column, reports of Board actions and other information about the inner workings of your AWI. In my own travels around the country and discussions with members I have learned that to many of you, AWI is a far-off and mysterious entity. I have to confess that our own internal organization has been structured to keep a low profile; not just to the rest of the world but to our own people. What better forum to do a little educating about what makes AWI tick than *Horological Times*?

Over the next few months we will be publishing feature articles about AWI, its history, and functions. This has already begun with a three-month series on the first annual report of our new Strategic Planning Committee. Other features will include the story of the James M. Dodson Perpetuation Fund, the Education, Library and Museum Trust, and the AWI Academy. We also would welcome suggestions concerning topics of interest to the members in our familiarization tour of AWI.

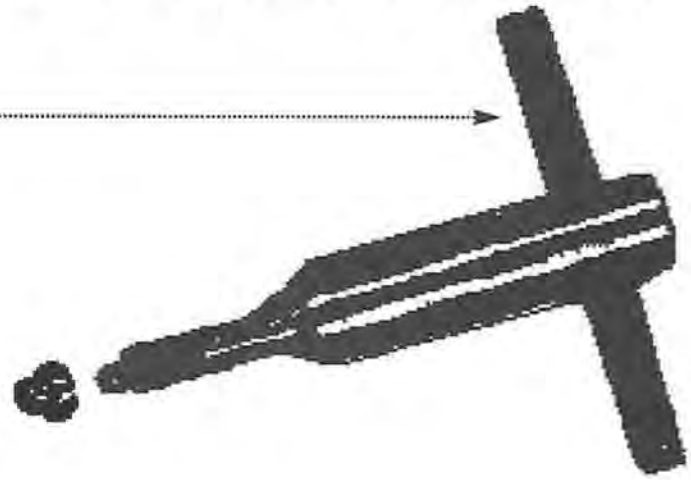
Speaking of the Education, Library and Museum Trust, this is one of AWI's better-kept secrets. The ELM Trust, as it is called, is AWI's charitable foundation. It is not an uncommon arrangement for trade associations such as AWI to have subsidiary charitable foundations that are organized under a different chapter of the federal tax code for the purpose of raising funds and accepting charitable donations. In AWI's case, the ELM Trust is the "owner" of our library and museum holdings, as well as the donor of grants and loans to worthy students attending approved schools of horology. The ELM Trust has been the major supporter of students attending the AWI Academy.

For most of you, the ELM Trust is best known for its role in collecting spent silver oxide watch batteries in an annual contest that culminates with the judging and awards at the annual Board Meeting. The Trust Board members are considering a more active role for the ELM Trust that will make for an even more exciting and rewarding role for the organization in the future. Keep your eyes peeled for further announcements!

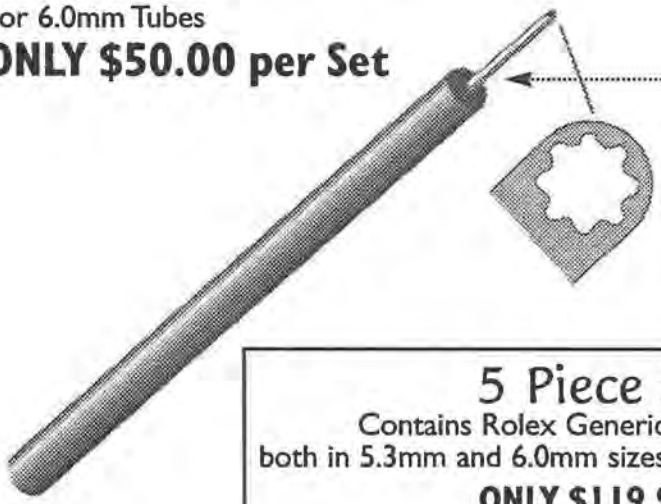
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Questions & Answers

Mr. Lionel Sutton of Ottawa, KS, offered the use of his C&E Marshall "Handy Manuals" to help in the identification of Marshall material systems. In addition to his offer he posed three questions, two of which we'll look at this time, the other one next month.

Question

It is my understanding that (Accutron) material such as index wheels are not available. Please correct me if I am wrong.

Answer

Most of the commonly needed Accutron material is no longer available through normal material channels. However, every once in a while a supply will come to light in one or more material houses as they buy out old stocks of material. Now and again someone will manufacture a run of specific material for sale through material houses. But for the most part, any excess material is in the hands of private individuals, usually those offering a repair service. If you need parts, you'll need to keep searching sales ads from the various suppliers around the country. Or send your repair problem to one of those offering a specialized repair service. Or... be active in your state chapter. Networking with others in your area could bring a few extra spare parts your way.

David A. Christianson

Question

How can I find out the value of all my material and equipment? What are watchmakers or their heirs doing with their equipment? Do you pass this information to schools and students?

Answer

The value of your material and equipment depends solely on your willingness to sell and the buyer's willingness to buy what you have. Watchmakers who have maintained a current material system up until the time of its sale will receive more value for their material than those who have let their systems deplete. Most watchmakers, slowing down in their practice, use the items as they need them without replenishing them. This leaves a material system that yields very few useful items out of a huge number of pieces that have never been used and probably never will be.

The value in a watchmaker's shop comes from his equipment. Timers, cleaners, lathes and accessories, and various finishing and testing equipment are useful to others. Although they may not be state-of-the-art, they would be useful to students and beginning repairmen for a few years until they can upgrade their equipment.

For most equipment, look to the NAWCC regional and local marts to help establish value... not what the asking price is, but what it is actually selling for. There are sites on the Internet where equipment is being sold. Be careful of this pricing, collectors seem to be able to pay more than practicing watchmakers for much of the available equipment. And the Internet is browsed continuously by collectors and dealers.

If you are contemplating disposing of your material and/or equipment, keep the student and beginning craftsman in mind. They can little afford to equip a shop, but your generosity could help launch a novice on the same very rewarding career that you have experienced. Choose your favorite school or contact AWI if you'd like to help a deserving student or beginner. They'll put you in touch with someone who will not only be eternally grateful, but who would undoubtedly do for a future novice, what you are willing to do for one now.

David A. Christianson

FORMING NEW AWI AFFILIATE CHAPTERS

AWI members can greatly benefit from belonging to a local Affiliate Chapter or Guild. If you are interested in establishing a group in your area contact

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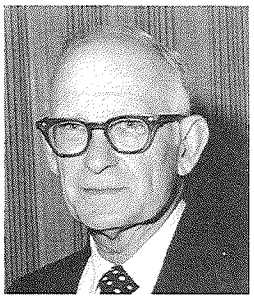
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Ask Huck

J.M. Huckabee,
CMC, FAWI, FBHI

Electricity in the Human Body

Question

I have electricity in my body; a watch stops when I wear it. How does this happen?

Answer

As a young man I did a pretty large quantity of watch repair. This is an old, old story. I never met one of these electrified customers, because when his watch was serviced properly "he lost his electric charge."

Very frankly, I think this is an old fable the watchmaker used to hide his poor workmanship.

It is my opinion that a good watchmaker has no problems with "an electrified individual." Of course, we all know that extremes of heat, cold, magnetic field, etc., can cause failure. However, they usually kill the customer before they kill his watch.

Movement Disassembly for Cleaning

Question

Is it really necessary to disassemble a clock for cleaning and repair?

Answer

I am very familiar with this subject. As a young watchmaker a half-century ago, it was and still is a common subject of "street talk." Where I grew up in the Southland, cleaning without disassembly was called "The Pawn Shop Swing."

Let's talk about medium-sized clocks. It is true that a few minor pieces may be left assembled, if the function and cleaning solutions permit. However, most moving parts (pivots, for example) are too important to risk that type of practice.

Residue from cleaning solution and lack of cleaning leaves so many items uninspected and unrepaired that the latent problems will wreck your business.

Be very careful of the consequences if you warm up to reduction in workmanship quality.

What Type of Oil Should I Use?

Question

What type of oil should I use in clocks? Are some brands really better than others?

Answer

Clocks range in size from those using watch movements to gigantic tower clocks. This means that the lubricants may range from watch escapement oil, through fluids of various viscosity, to heavy greases. Operating temperatures may range from very cold to very hot.

We currently have access to the best lubricants the world has ever known; and, I feel sure the choice may not be clear in every situation. Also furthermore, some lubricants surely have superior qualities in specific applications.

I personally have never had a lubricant problem. Most of my suspected lubricant problems turned out to be workmanship problems. Others usually were from improper choice of viscosity, or temperature range.

You will be on the right track if you fully understand your application, and accept the lubricant suppliers recommendations.

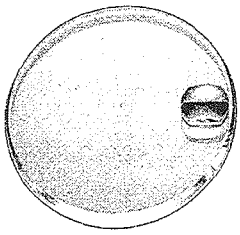
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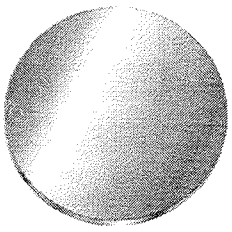
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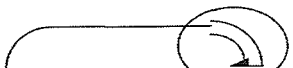
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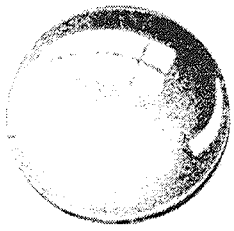


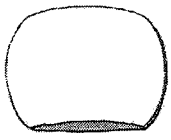












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Sections "I-A", "I-B" and "I-C" (pages 3 and 4) in your AWI *Battery Number System* book, list all of the AWI numbers, along with the *currently used* USA and Japan numbers.

An understanding of the Japan Number System will make this "quick reference" portion of your book even more useful. All of the currently used Japan numbers are prefixed with two alphabetical letters which denote the chemistry and the shape of the battery. If three to five numbers follow this prefix, they will indicate the metric diameter and thickness of the battery. (Note that this will not be the case if there are only two digits following the prefix.)

If there are **three** digits, the *first one* is the diameter of the battery, not including the decimal portion. If you will look at the "Dimensions Chart" on pages 46 and 47 of your *BNS* book, you will notice that the standardized list of diameters includes only one listing for each "whole number." For example, there is only one "4" and it is "4.8"; there is only one "9" and it is "9.5". For this reason, it is not necessary to include the decimal part of the diameter in the battery number.

If there are **four** digits, the *first two* indicate the diameter. For example, "12" is 12.5 mm and "20" is 20.0 mm. If there are **five** digits, the *first three* indicate the diameter, including the decimal portion. For example, "116" is 11.6 mm.

The *last two* digits always indicate the exact thickness of the battery in tenths of a millimeter. For example, "12" is 12 tenths or 1.2 mm.

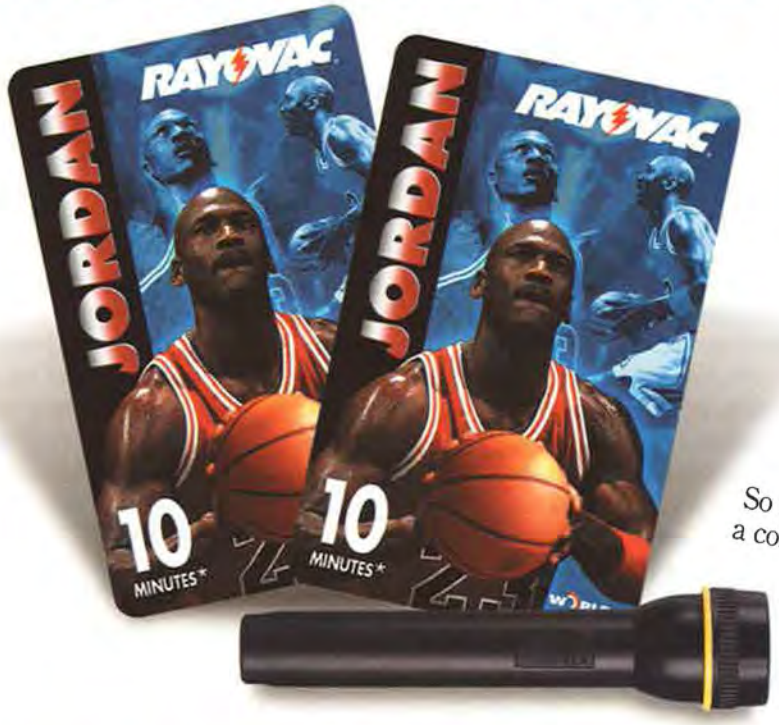
An "SR621SW" battery is, therefore, 6.8 x 2.1 mm. A "CR1216" is 12.5 x 1.6 mm. An "XR11630W" is 11.6 x 3.0 mm.

You will notice that the "quick reference" (pages 3 and 4 in your *BNS* book) includes the Japan numbers as a part of the AWI listings and the USA listings. In a majority of the listings, these Japan numbers give you the size without further reference. This is especially helpful if you need to locate that particular battery on the "Dimensions Chart," or if you need to know the diameter and/or thickness for any reason.

The new AWI battery cabinet labels will conform to the "quick reference;" you will therefore know the dimensions of most of the batteries in your cabinet by checking the Japan number on the label.



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Replacing a Center Wheel Post and Restoring a Cannon Pinion

Stewart Lesemann, CW, CEWT

I recently had the pleasure of working on a nice Patek Philippe pocket watch which had evidently spent some time in the care of an unskilled craftsman. The watch had apparently required some tensioning of the cannon pinion, as it was split almost in half and the center wheel post was broken off at the arbor. My guess is that someone attempted to increase tension with the cannon pinion in the watch—a bad idea in any case but certainly on a watch of this caliber!

The task at hand was twofold: repivot the center wheel (technically this is not a pivot) and repair the cannon pinion.

The repivoting presented no real problem other than the practical aspect of dealing with such a long workpiece in the lathe. The design of the center wheel and pinion prevented turning between centers, so a collet in the lathe was used. This may raise eyebrows among purists; however, a high-quality collet in an accurate spindle will offer a maximum eccentricity of no more than .005 mm, more than adequate for this job. The arbor was faced off and the center struck with a sharp graver. Then a shop-made carbide drill was used to drill for the new pivot. I make these drills out of either dental burrs or round drill stock, grinding them freehand with a pinvise and diamond wheel. The shape should be that of a traditional spade drill.

With the luxury of two lathes, I left the center wheel chucked up as not to disturb its truth. A replace-ment post was turned to within .10 mm of the proper diameter; the portion to be fitted into the arbor was turned to .02 mm more than the size of my drill. This made for a very satisfying friction fit in the center wheel arbor. Final diameter was now turned and the end polished to match the original.

Now for the fun! The cannon pinion was definitely unusable in its present state. I decided to salvage the actual pinion and replace the tube; this way as much of the watch remained original as possible. Once again a collet was used; the pinion was gripped and trued while loosely held in the lathe. The tube was turned away, leaving about .75 mm above the pinion. The pinion was then drilled; the drill was made to a size midway between the diameters of the old tube and the center post. A plug was turned, hardened, tempered to a dark blue, and pressed in using a staking tool. The pinion was then chucked and trued again. I turned the diameter, the step (in the middle), the diameter at the end to accept the minute hand, and final length; now it was necessary to drill to accept the center post. This was a critical point: to regain the smooth feel of a high-grade watch when setting, this fit must be very good, free but with no play. A drill was made .02 mm smaller than the center post diameter, but it was not possible to make one long enough to drill all the way through. This meant that I had to drill from both ends of the pinion; risky, but better than breaking a long thin piece of carbide deep in my new piece! This operation was successful, and the pinion was a no-go fit on the center post, as planned.



The restored cannon pinion prior to installation on the new center post.



The job completed.

Now a simple five-sided reamer was made by turning a piece of steel to the exact diameter of the center post, filing five tapered flats on it similar to a broach, and hardening. It was left dead hard to contend with the blued cannon pinion. After reaming, the cannon pinion was a perfect fit on the center post, with slight friction. "D" tweezers were used to pinch the pinion at the normal friction point while turning in the lathe, with a round broach inside to prevent collapsing. Now there was sufficient friction for setting and a test in the watch showed that it didn't "ride up" on the post. Success!



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Hamilton Electric - 1957



Bulova Accutron - 1960



Seiko Quartz 35 SQ Astron - 1969

The Smithsonian Institution Presents:

A Brief History of the Quartz Watch

The development of the quartz watch into the "revolution" that changed the science of horology forever, and so dramatically affected the livelihoods of everyone involved in the craft, was far from an overnight sensation. In fact, the quartz revolution was nearly a century in the making.

Unlike Thomas Edison, Alexander Graham Bell or the Wright brothers, no single individual can claim to be the parent of the quartz watch. The quartz watch was the product of an international research and development effort that began in the nineteenth century and continued into the mid-twentieth. In truth, the quartz watch was an exercise of "pure" scientific inquiry in search of a useful product application. Simply put, the quartz watch is the fusion of the quartz crystal vibrating at a constant rate in response to an electric charge provided by a miniature battery. The vibrations are measured by electronic circuitry that translates the quartz vibrations into units of measured time. The trick was to fit all the components and gadgetry into a reasonably sized watch.

Pierre Curie, husband of the celebrated Marie and a notable scientist in his own right, while working on pure research with his brother Jacques in 1880, discovered that some quartz crystals would begin to vibrate when subjected to an electrical charge. In 1927, Warren Marrison, a Canadian who worked at Bell Telephone Laboratories, built the first quartz clock. The clock was very large, but also very accurate, and within a decade, quartz clocks had replaced mechanical timepieces in astronomical observatories and other settings that required extremely precise measurement of time. The next step in the chain of innovation and invention was the invention of the integrated circuit, the device that could count the quartz vibrations and convert the count into a practical measurement of time.

Working separately, Jack St. Clair Kilby of Texas Instruments and Robert Noyce of Fairchild Industries simultaneously invented a way to concentrate numerous electrical circuit connections on a single silicon chip. This "integrated circuit" was an essential step in the development of the modern consumer electronics industry. The first applications were in the transistor-based hearing aid, electronic calculators, and the quartz watch. The final step in the construction of the quartz watch was the miniature battery that provides a power source to the circuitry that vibrates the quartz crystal and converts the vibration count into time.

Miniature batteries were developed during World War II. The first attempts had a tendency to leak and simply did not last long enough to be feasible to power a watch. In the early 1950s, a team of researchers at the Hamilton Watch Company, led by chief chemist Phil Lichty, joined forces with Union Carbide to develop a long-lasting miniature battery for the first electric watch, the Hamilton Ventura. This watch was still a traditional mechanical movement with the battery replacing the mainspring as a power source. From this first step, the quartz revolution grew over the next twenty years to encircle

the globe, with commercial superiority passing from one nation to the next as ever more technologically sophisticated models were produced for ever lower expense.

On these pages is a gallery of the evolution of electric-mechanical watches to the pure quartz prototypes. First is the Hamilton Electric, the electro-mechanical hybrid described above. The Bulova Watch Company introduced the Accutron in 1960. This new variant of battery power used a tuning fork to provide the vibrations to drive the mechanical movement instead of a hair-spring and balance wheel. Instead of the traditional ticking, consumers were encouraged to hear the Accutron hum.

In response to the competitive threat posed by the battery-powered electromechanical watches being introduced by the American companies, the Swiss and Japanese manufacturers continued intensive research into developing the first electronic watches. The Swiss manufacturers produced the first quartz prototypes in 1967. The Beta 21 is described on page 14. The Japanese, however, made it to market first with the Seiko 35SQ Astron in December of 1969.

These first quartz production models were still the familiar analog design. Other inventors were busy developing new ways to display time with the power available through the integrated circuit and new long-lasting batteries. A team at the Optel Corporation, headed by Nunzio Luce, introduced the first LCD watch in 1970. The cover of this month's magazine shows the challenge faced by these inventors. The initial design for the digital LCD watch was contained in the large "breadbox". The team then reduced the size of the movement to fit in a wristwatch case by using a CMOS chip designed by Seiko to drive the LCD display. Digital LCD watches were introduced in the Hamilton Pulsar and Gruen ILIXCO in 1972. The competition had raced from the electromechanical hybrids to the first bulky analog digital watches to the true digital LCD displays in little more than a decade. By the mid-70s, the quartz revolution was in full swing. As technology and manufacturing methods improved, the quartz watch went from being a luxury gizmo to the most common of throwaways.

The apparent replacement of the mechanical by the electronic appeared to be the death knell of the ancient craft of watchmaking. This can best be noted in a nearly forty percent loss of membership in the AWI from the mid-seventies to the mid-nineties. However, reports of the impending end of the profession appear to be premature. Watch and clock imports have become over a two billion dollar business annually. High-grade mechanical timepieces are enjoying a resurgence as consumers show their appreciation for skill and craftsmanship. New hybrids that combine mechanical power with electronic timekeeping are making their appearance, and all of a sudden, we are experiencing a shortage of watchmakers!

Photos courtesy of the Smithsonian Institution



Optel LCD Prototype - 1970



Hamilton Pulsar - 1972



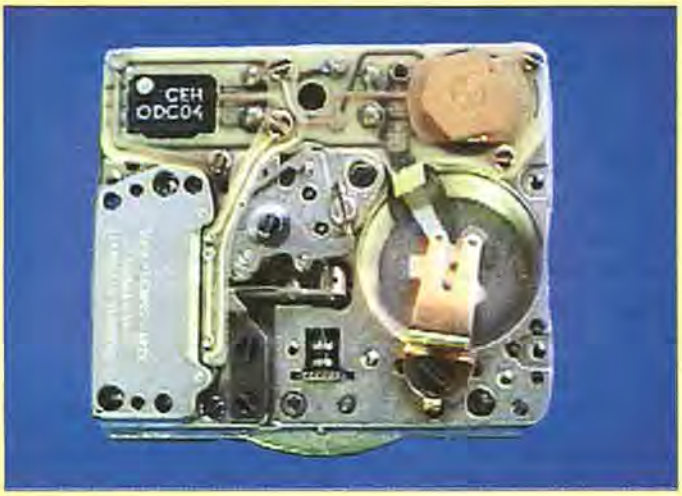
Gruen Liquid Crystal Display - 1972

The Search for Beta 21

As our story relates, the quartz watch was the product of nearly a century of research and experimentation. The first actual prototype movement to be mass-produced was the Beta 21. The story begins in 1962, with the founding of a cooperative research laboratory, Centre Electronicque Horologer, or CEH, in Neuchatel, Switzerland. Nearly five years of development was revealed at the International Chronometric Competition held in Neuchatel in 1967. CEH model B21, or the Beta 21 as it came to be known, set new records for precision timing accuracy.

The following year, a consortium of Swiss manufacturers was created to put the Beta 21 into mass production. Sixteen Swiss watch companies began selling quartz watches with Beta 21 movements under their own brand names in 1970.

Since the first mass-production models were introduced less than thirty years ago, one would think that these watches would still be fairly common. However, the story of the quartz watch has been one of accelerating innovation and ever-shrinking cost. The initial production models were quickly replaced as the quartz revolution circled the globe. After the Swiss introduction, the United States, then Japan, later Hong Kong and other far eastern nations dominated the manufacture of quartz watches. The poor Beta 21 was quickly replaced by slimmer, cheaper models.



When the Smithsonian Institution's National Museum of American History was preparing the quartz watch exhibit, the curators were able to obtain samples of virtually every one of the pioneer models of the quartz revolution, with the notable exception of the Beta 21. During a recent visit to the museum, AWI staffers Bill Ewbank, Jim Lubic, and Tony DePrato learned of the continuing search for the Beta 21 from curator Carlene Stephens. A search of the AWI ELM Trust holdings revealed that the museum held one movement in its collection (pictured above). A second movement was donated by AWI museum curator Jim Broughton. One of the AWI movements has been offered as a permanent gift to the Smithsonian. We also request that our members join the search for a complete watch, with casing, band, dial, and hands for exhibit in the Smithsonian's collections. Interested donors should contact Bill Ewbank at AWI Headquarters or Dr. Carlene Stephens at the Smithsonian, National Museum of American History, Washington, DC 20560.

Photo by American Watchmakers-Clockmakers Institute

The Smithsonian Horological Exhibits: Present and Future

Exactly one year ago, *Horological Times* made a brief report on a new exhibit created by the Smithsonian Institution's National Museum of American History of the Quartz Watch. This article is a very abbreviated synopsis of the contents of the quartz watch exhibit. What makes the quartz watch exhibit unusual is that, unlike the traditional museum exhibit, it can only be viewed in cyberspace. In fact, the quartz watch website is right now the only exhibit on watches and timekeeping that is on public display by the Smithsonian Institution. It is worth pondering that the exhibit on the quartz revolution, now distant history thirty years after the first clumsy prototypes were marketed, appears as a harbinger of the future: a virtual museum on the internet. The quartz watch exhibit can be visited at

www.si.edu/lemelson/Quartz

The Smithsonian began collecting quartz watches in the mid-1980s in order to document then recent developments in timekeeping technology. The museum's collection includes watches and prototypes, as well as photographs, trade literature, engineering drawings, and research documents. The museum staff are currently conducting a series of oral history interviews with the pioneers of quartz watch technology. One of these pioneers must be Ben Matz, AWI member and longtime AWI official liaison with the Smithsonian.

The National Museum of American History is planning a new permanent exhibition "On Time" to open in the Spring of 1999. The "On Time" exhibit will explore the changing ways Americans have measured, used, and thought about time over the past 300 years. The exhibition will look at how and why we have come to equate time with the clock. The new exhibit will take up 4,500 square feet of the first floor of the National Museum and will display approximately 400 clocks, watches, and a surprising array of objects and images from everyday life that reveal changing perceptions of time. *Horological Times* will do a full report on the new exhibit next Spring. The "On Time" exhibit is sponsored by the Timex Corporation.

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Robert D. Porter, CMW

How to Make a Winding Pinion and Clutch

Part 9
How to Cut Clutch Teeth with a Two-Way Slide Rest

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We cut the winding pinion clutch face with a three-way slide rest in Part 8. Today we will look at a practical way to use a two-way slide rest to cut clutch teeth. Figure 51 shows a typical two-way slide rest that has been set 30 degrees off its normal zero position. Figure 52 pictures the setting in better detail. A small brass plate with a scribed line in its center, aligned with the 60-degree mark, and 90 degrees from zero, has been epoxied to the side of the slide rest as shown in Figure 53.

Figure 54 is a view of the slide rest with the upper slide set to a new zero reference on the brass plate, and parallel with the bottom slide. The upper slide has been set to 6.8 degrees in Figure 55 to cut the clutch teeth. The slide rest clamping bolt is loosened slightly and the rest is carefully tapped and adjusted by hand to position the cutter into touch-off position with the corner of the clutch face, as we did in Part 8. The clamping bolt is tightened to hold the setting. Several methods can be used to set the depth of cut.

Some tip-over-tee rests have a flat end

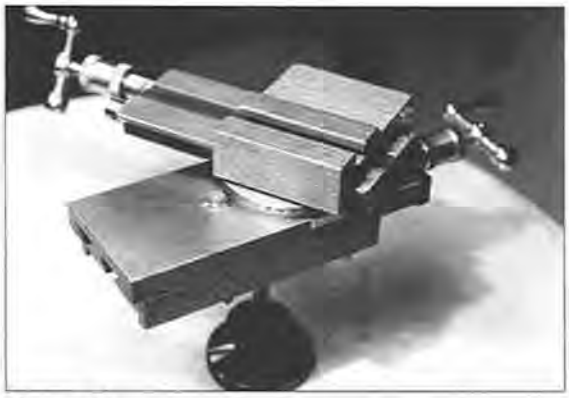


Figure 51.



Figure 53.

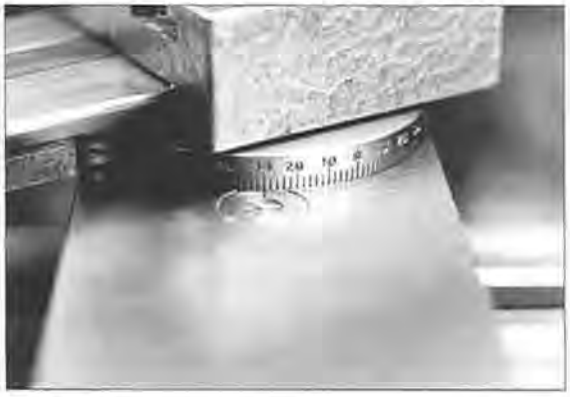


Figure 52.

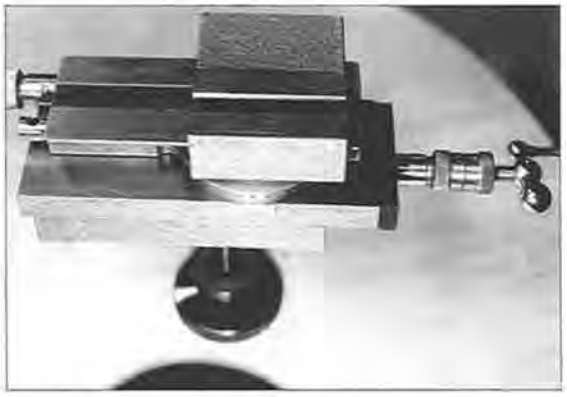


Figure 54.

that can be positioned against the side of the slide rest and clamped parallel to the lathe bed. The cutter is moved away from the part with the upper slide micrometer. The slide rest clamping bolt is loosened slightly to permit a feeler gage of the same thickness as the depth of cut (3.48 mm clutch diameter times the .1191 depth of cut factor = .41 mm, or .016") to be inserted between the tee rest and the

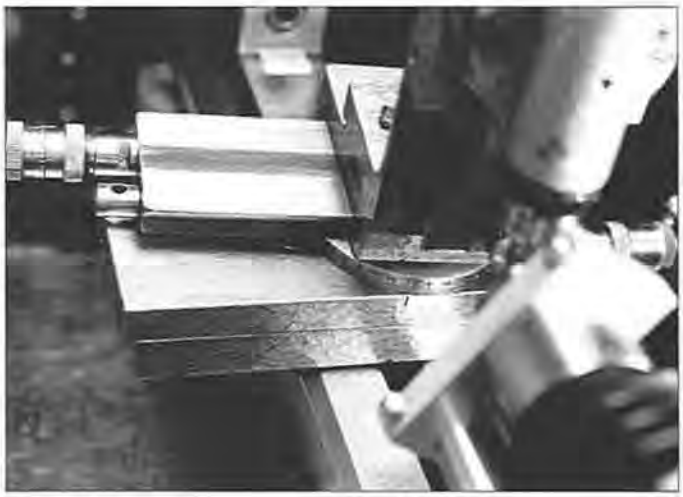


Figure 55.

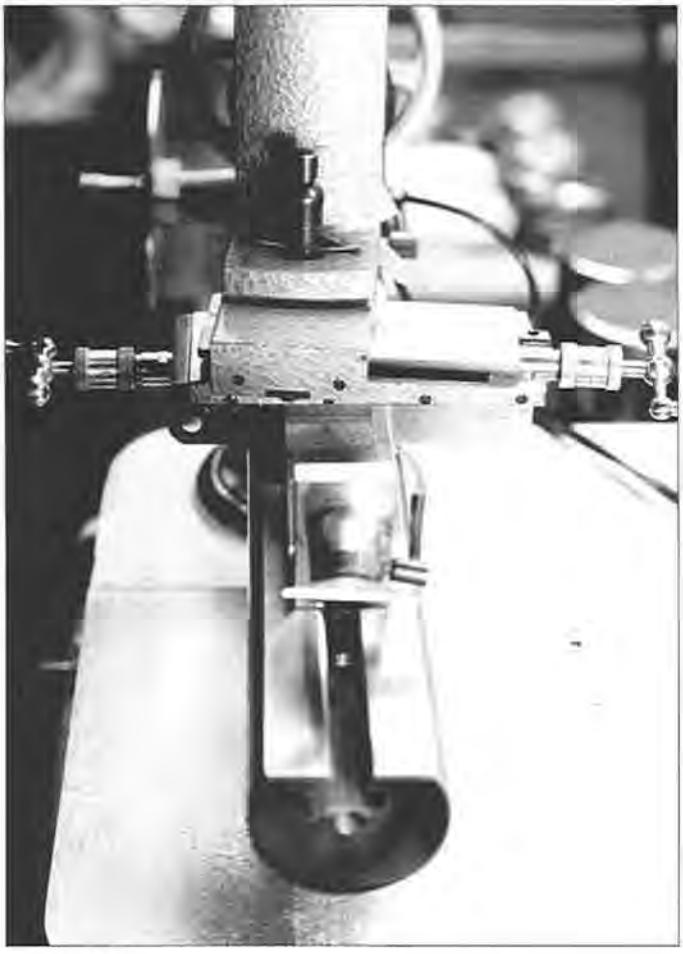


Figure 56.

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slide rest.The cutter is moved toward the work as illustrated in Figure 56.

Another method to position the depth of cut is shown in Figures 57 and 58. Two adjustable parallels and a feeler gage have been tightly positioned in the space between the headstock and the slide rest in Figure 57. The depth of cut feeler gage has been removed in Figure 58 and the slide rest moved toward the work until it is firmly against the parallels, and then clamped in place. A dial indicator can also be used to position the slide rest to the depth of cut value. Make sure the bottom of the cutter is on the horizontal centerline of the part. We are now ready to cut the clutch teeth. Figure 59 illustrates how the cutter can be fed into the part.

We will start on the clutch pinion in Part 10.

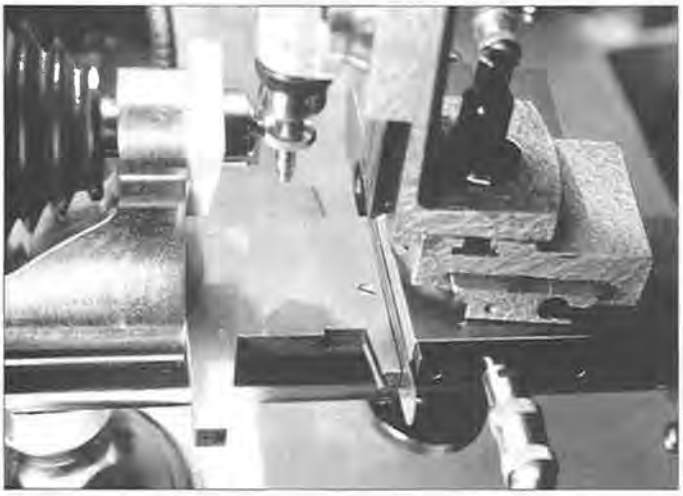


Figure 57.

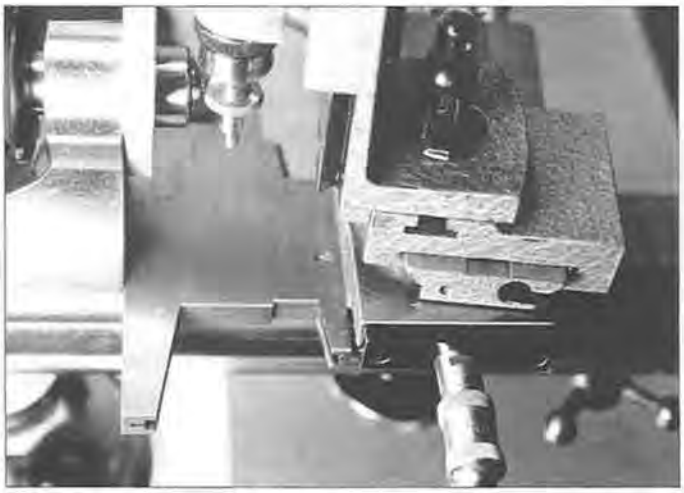


Figure 58.



Figure 59.

Key Test for Quartz Watches

The *Key Test for Quartz Watches* by Ewell Hartman, CMW, FAWI, is a quick and simple method of locating the problem in a quartz analog movement. The only tool required is a meter.

Material and instructions for learning this test are supplied by the AWI-ELM Trust as part of their educational work. There is no charge to any group wishing to learn this test. There are great benefits to learning this in a group setting. However, for individuals who may not be able to participate in a group, it is available to them also.

Contact AWI Headquarters, 701 Enterprise Dr., Harrison, OH 45030; Phone (513) 367-9800 for an information sheet and application form.

SEEKING PROSPECTIVE CANDIDATES FOR THE AWI BOARD OF DIRECTORS

The committee involved with securing candidates to run for the AWI Board of Directors is seeking recommendations from the membership. If you plan to suggest a possible candidate, please send that individual's name and background to: Chairman, Nominations for Board of Directors Committee, AWI Headquarters, 701 Enterprise Drive, Harrison, Ohio 45030.

Each recommendation will be carefully considered by the committee. Candidates will be selected on the basis of their past local association or AWI experience, geographical location, present job status, horological experience, and willingness to serve.

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Pocket Watches and Their Maintenance
Part 6
Length of Run and the Power Transmission Unit

Archie B. Perkins,
CMW, FAWI,
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The length of run of a watch or clock is influenced by the number of turns of the mainspring barrel on a complete winding of the mainspring. The length of run on one complete winding of the mainspring is also influenced by the gear ratio between the mainspring barrel and the center wheel pinion.

One-Day Power System

Figure 1 shows an example of a one-day watch power system. The number of teeth in the mainspring barrel divided by the leaves in the center pinion will determine how many hours the watch will run for each turn of the barrel. For example, if the barrel has 72 teeth and the center pinion has 12 leaves, we would have $\frac{72}{12}$ = 6 hours run for each turn of the mainspring barrel. If the barrel has 6 turns of winding, then the watch would run 6 times 6 equals 36 hours run on a complete winding.

We can increase the running time on a complete winding by having more teeth in the barrel and less leaves in the center pinion. For example, if we increase the barrel teeth to 90 and reduce the center pinion leaves to 10, then we would have $\frac{90}{10}$ = 9 hours run for each turn of the barrel X 6 turns of winding would give 54 hours run on one complete winding instead of the 36 hours in the first example.

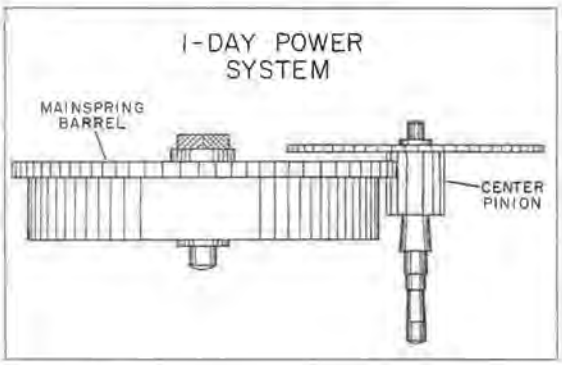


Figure 1.

The total hours run on a complete winding can be increased further by using a longer thinner mainspring.

The Illinois Watch Company made a railroad watch called the "60 hour Bunn special" which used a longer mainspring to power the watch for the 60 hours.

An 8-Day Power System

Figure 2 shows the arrangement used to power a timepiece for eight days. This system uses an intermediate wheel and pinion between the barrel and center pinion. This increases the ratio between the barrel and the center wheel pinion. If the barrel has 80 teeth, the intermediate pinion has 10 leaves, the intermediate wheel has 60 teeth, and the center pinion has 12 leaves, then we would have:

$$\frac{80 \text{ X } 60}{10 \text{ X } 12} = \frac{4{,}800}{120} = 40 \text{ hours}$$

40 hours X 6 turns = 240 hours run

$$\frac{240 \text{ hours}}{24 \text{ hours}} = 10 \text{ days run}$$

This allows 3 days of reserve power in case one forgets to wind the timepiece in exactly seven days.

A 400-Day Clock Power System

The best example of a long-term power system for a timekeeping mechanism is the four-hundred-day clock power system that is shown in Figure 3. This power system has three intermediate wheels and pinions between the barrel and center wheel pinion. This increases the ratio between the barrel and the center pinion to the maximum allowable for intermediate wheels

and pinions. This system makes it necessary to use a much stronger mainspring to overcome the extra friction of the three extra intermediate gears. The stronger mainspring also increases the friction since it increases the pressure against the gears. If we have a barrel with 80 teeth, 1st intermediate pinion with 10 leaves and its wheel of 60 teeth, 2nd intermediate pinion with 10 leaves and its wheel of 60 teeth, a 3rd intermediate pinion with 10 leaves and its wheel of 60 teeth, and a center pinion of 12 leaves, then we would have:

$$\frac{80 \text{ X } 60 \text{ X } 60 \text{ X } 60}{10 \text{ X } 10 \text{ X } 10 \text{ X } 12} = 1{,}440 \text{ hours on one turn of the barrel}$$

1,440 X 7 turns = 10,080 hours total run

$$\frac{10{,}080}{24} = 420 \text{ days run on a complete winding}$$

This would give 55 days reserve power over the 365 days or 1-year run.

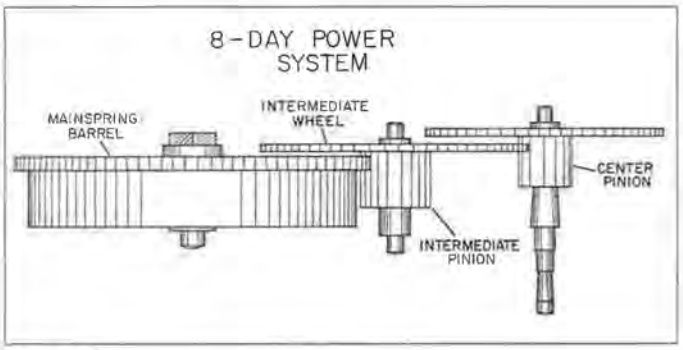


Figure 2.

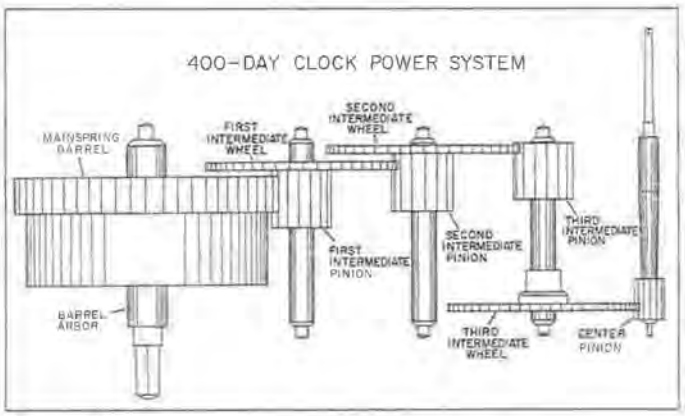


Figure 3.

Power Transmission Unit

Figure 4 shows the power transmission unit. This unit is made up of the center wheel, third wheel and pinion, and fourth wheel and pinion. If the watch has an off-center second hand, the fourth pinion will have a long pivot for carrying the second hand. In this case, the fourth wheel

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with pinion needs to make one revolution each minute. When the center wheel makes one revolution, the fourth wheel and pinion should make 60 revolutions. If the center wheel has 64 teeth, 3rd pinion has 8 leaves, 3rd wheel has 75 teeth, and the 4th pinion has 10 leaves, then we would have:

$$\frac{64 \text{ X } 75}{8 \text{ X } 10} = 60 \text{ revolutions of the 4th wheel}$$

If we add the escape wheel and pinion to the transmission wheels and pinions, then we can calculate the number of vibrations the balance wheel must make to cause the watch to keep correct time. Following is an example of how to calculate the vibrations for the balance wheel. See Figure 5 for this calculation.

If the center wheel has 64 teeth, the 3rd pinion has 8 leaves, the 3rd wheel has 75 teeth, the 4th pinion has 10 leaves, the 4th wheel has 60 teeth, the escape pinion has 6 leaves, and the escape wheel has 15 teeth, then we would have:

$$\text{Vibrations per hour} = \frac{64 \text{ X } 75 \text{ X } 60 \text{ X } (15 \text{ X } 2)}{8 \text{ X } 10 \text{ X } 6} = 18{,}000$$

Note: When calculating the vibrations per hour of a watch with a pallet fork, each escape wheel tooth receives two impulses; therefore, we need to double the number of escape wheel teeth in the calculation.

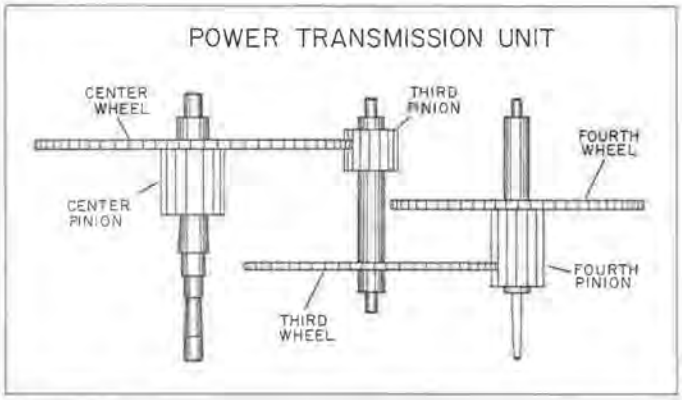


Figure 4.

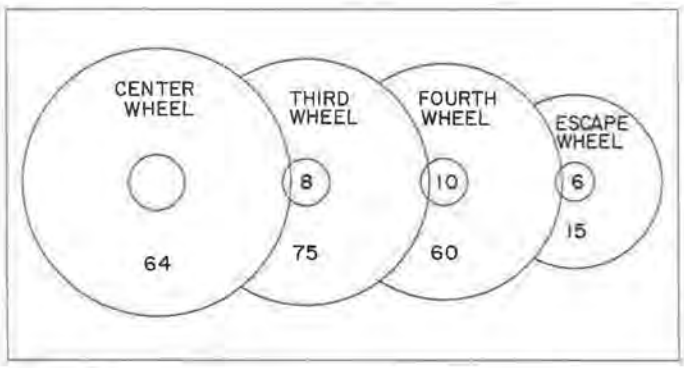


Figure 5.

Calculating for Missing Wheels and Pinions

Suppose we have a watch with a missing fourth wheel pinion. This is shown in Figure 6:

$$18{,}000 = \frac{64 \text{ X } 75 \text{ X } 60 \text{ X } (15 \text{ X } 2)}{8 \text{ X } x \text{ X } 6} = \frac{180{,}000}{x}$$

$$18{,}000x = 180{,}000$$

$$\frac{180{,}000}{18{,}000} = x$$

$$x = 10 \text{ leaves}$$

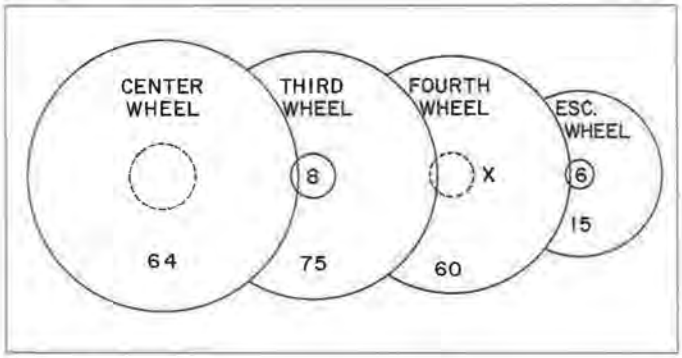


Figure 6.

Next, suppose we have a watch with a missing fourth wheel only. This is shown in Figure 7.

$$18{,}000 = \frac{64 \text{ X } 75 \text{ X } x \text{ X } (15 \text{ X } 2)}{8 \text{ X } 10 \text{ X } 6} = 300x$$

$$18{,}000 = 300x$$

$$\frac{18{,}000}{300} = x$$

$$x = 60 \text{ teeth}$$

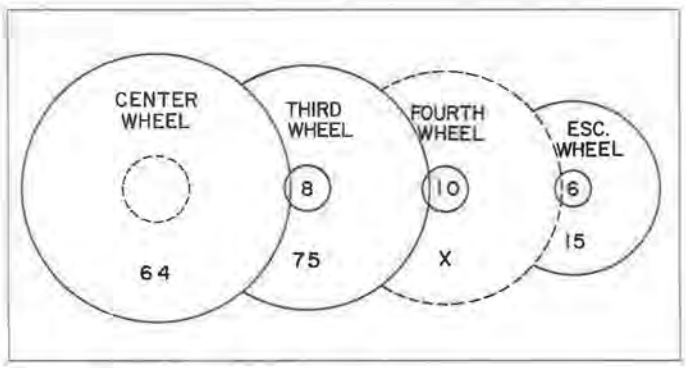


Figure 7.

If we have a watch with a center wheel and third pinion both missing, the following method would be used to determine the numbers of each. (See Figure 8.)

$$18{,}000 = \frac{x \text{ X } 75 \text{ X } 60 \text{ X } (15 \text{ X } 2)}{y \text{ X } 10 \text{ X } 6} = \frac{2{,}250x}{y}$$

$$18{,}000 = \frac{2{,}250x}{y}$$

$$\frac{18{,}000}{2{,}250} = \frac{x}{y}$$

$$\frac{x}{y} = 8.\ (8 \text{ is a ratio})$$

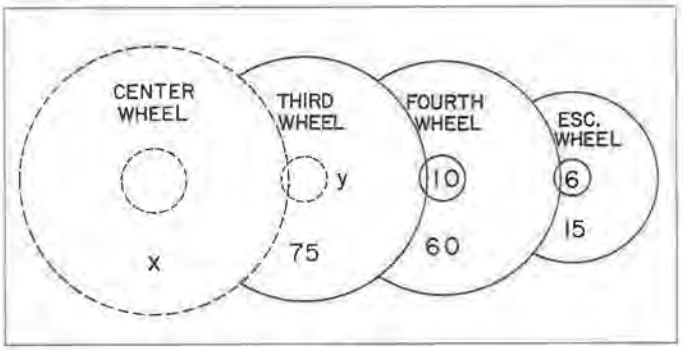


Figure 8.

When we multiply this number by other numbers, we find different combinations of center wheels and third pinions that would be usable with the other wheels and pinions to cause the watch to keep correct time. For example:

Pinions		Wheels
6 X 8	=	48
7 X 8	=	56
8 X 8	=	64
9 X 8	=	72
10 X 8	=	80
11 X 8	=	88
12 X 8	=	96

The following method is used to find the numbers for a missing third wheel and pinion. (See Figure 9.)

$$18{,}000 = \frac{64 \text{ X } x \text{ X } 60 \text{ X } (15 \text{ X } 2)}{y \text{ X } 10 \text{ X } 6} = \frac{1{,}920x}{y}$$

$$18{,}000 = \frac{1{,}920x}{y}$$

$$\frac{18{,}000}{1{,}920} = \frac{x}{y}$$

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1.50 MM	17.0 - 35.0mm IN 0.2mm INCREMENTS PLUS 0.5	**# MGA-1.5/109** 17.0 - 35.0mm 109 PCS	**$160.00 Refills $2.00 ea**
1.85 MM	17.0 - 35.0mm IN 0.2mm INCREMENTS PLUS 0.5	**# MGA-1.85/109** 17.0 - 35.0mm 109 PCS	**$160.00 Refills $2.00 ea**
2.00 MM	17.0 - 35.0mm IN 0.2mm INCREMENTS PLUS 0.5	**# MGA-2.0/109** 17.0 - 35.0mm 109 PCS	**$190.00 Refills $2.25 ea**
2.25 MM	17.0 - 35.0mm IN 0.2mm INCREMENTS PLUS 0.5	**# MGA-2.25/109** 17.0 - 35.0mm 109 PCS	**$190.00 Refills $2.25 ea**
2.50 MM	17.0 - 35.0mm IN 0.2mm INCREMENTS PLUS 0.5	**# MGA-2.5/109** 17.0 - 35.0mm 109 PCS	**$218.00 Refills $2.50 ea**

By reducing these two figures to their lowest terms, we would have:

$\frac{75}{8}$ = 75 teeth for the missing third wheel and 8 leaves for the missing third pinion

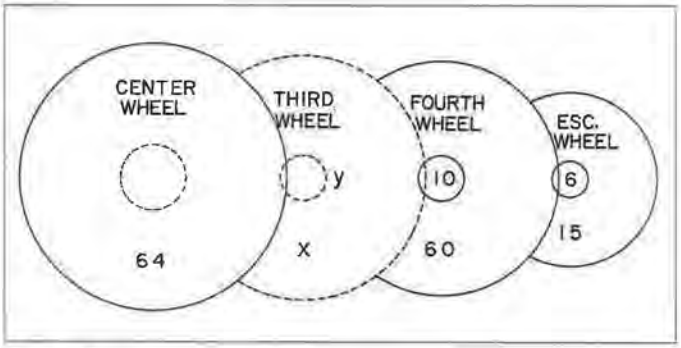


Figure 9.

Suppose we have a missing escape wheel and pinion. The following method is used to determine these numbers: (See Figure 10.)

$$18{,}000 = \frac{64 \text{ X } 75 \text{ X } 60 \text{ X } x \text{ X } 2}{8 \text{ X } 10 \text{ X } y} = \frac{7{,}200x}{y}$$

$$18{,}000 = \frac{7{,}200x}{y}$$

$$\frac{18{,}000}{7{,}200} = \frac{x}{y}$$

When we reduce these two numbers to their lowest terms, we would have:

$$\frac{x}{y} = \frac{5}{2}$$

By multiplying these two numbers by the same number, we find the teeth and leaves.

5 X 3 = 15 teeth for the escape wheel

2 X 3 = 6 leaves for the escape pinion

Pocket watches and their maintenance will continue.

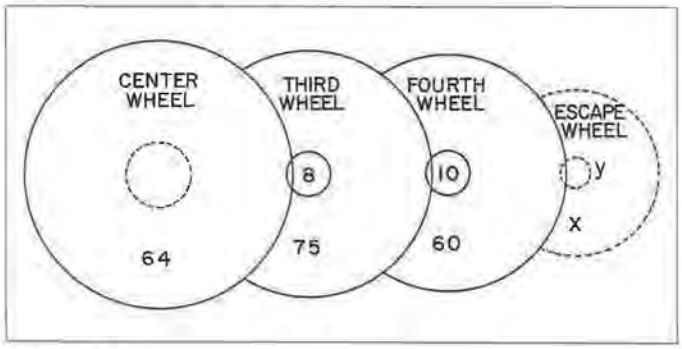


Figure 10.

BULLETIN BOARD

At press time, no new requests or responses were received for publication.

ITEMS STILL NEEDED

ETIC Quartz Watch
Testing Equipment

Donald Yax, Howell, MI, is seeking an operator's manual or instructions for operating an ETIC Model 340.525 662 Stabilwatch, an ETIC Model 340-610 or 644 Speedy Trim MK1, an ETIC Switch Box 340-612, and an ETIC Microphone 340-608 32 KH.

DYNA MYTE 2200
Milling Machine

Charles Mazzone, Sandwich, MA, is looking for a source for parts and repairs for a DYNA MYTE 2200 three- axis CNC milling machine. The machine was manufactured by Dyna Electronics, Inc., formerly of Sunnyvale, CA. He is also seeking a copy of the operating and programming manual for this machine.

Bulova Shelf Clock

Gaetan Demers, Lawrence, MA, needs to know the beat rate of a Bulova shelf clock. The clock is battery operated with a mechanical Japanese movement. This clock has Westminster chimes.

C & E Marshall Material
Cabinet Charts

Michael Okagaki, San Francisco, CA, is looking for two material charts for a C & E Marshall Material Cabinet. The wooden cabinet has 10 drawers, circa 1920s. The Marco System Number is not known, but the rest of the system covers older Swiss material, 4 to 10½ ligne.

He needs a material chart for Setting Levers and Screws, Drawer #4, 160 clear top boxes in a wooden drawer. This drawer appears to contain an assortment of 160 types of setting levers and screws for Swiss watches, roughly 4 to 10½ ligne.

The other chart is for the Setting Bridges, Drawer #7, 160 clear top boxes in a wooden drawer. This drawer appears to contain an assortment of 160 types of setting bridges for Swiss watches, roughly 4 to 10½ ligne.

AWI Academy of Watchmaking Accepting Applications

The American Watchmakers-Clockmakers Institute is accepting applications for their 1999-2000 Academy of Watchmaking.

The Academy features a 45-week program in watchmaking which is designed to accept students with no experience and train them for an entry level position. The program is scheduled to start July 12, 1999 with graduation scheduled for June 9, 2000.

The cost of the program is $7,750. Scholarship monies may be available to qualified students. Successful completion of an entrance examination will be required. Individuals who are interested in attending the Academy of Watchmaking should contact AWI Headquarters for an application. Testing will be conducted between January 1 and April 1, 1999. For further information contact:

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John P. Kenyon, CMC

A Practical Course in Clock Repair

The Design of a Pendulum Clock Movement Part 1

The first thing to consider in designing a pendulum clock movement is the length of the pendulum. This will determine the number of vibrations in a given time. Next, the number of teeth in the escape wheel and the number of revolutions required of it is resolved. For example, if a pendulum length of 9.78 inches (23.84 cm) is selected, it can be calculated (or found in the literature) that this length will result in 7,200 vibrations (beats) per hour. If an escape wheel of 30 teeth is chosen, the number of teeth can be multiplied by 2 since each tooth will give two impulses to the pendulum, and divided into the hourly vibrations to determine the number of revolutions of the escape wheel per hour. This can be expressed by equation:

$$\frac{\text{hourly vibrations}}{\text{escape wheel teeth x 2}} = \text{escape wheel revolutions per hour}$$

$$\frac{7{,}200}{30 \times 2} = 120 \text{ revolutions/hour}$$

An escape wheel of more or less teeth can be selected and the number of revolutions per hour calculated in the same manner. With the revolutions of the escape wheel known, the gear ratios can be calculated so that the center wheel will make one revolution per hour.

Gearing

Figure 1 illustrates a simple gear train of four wheels geared directly to each other. For each revolution of the first wheel, there will be 1-1/5 revolutions of the second wheel, 1-1/2 revolutions of the third wheel, and 2 revolutions of the fourth wheel. These revolutions would be the same if each succeeding wheel was geared directly into the first wheel. For each tooth of the first wheel that passes point (A) there will be one tooth of the fourth wheel that will pass point (B). The end result will be a transmission of power with a 2 to 1 ratio of the revolutions between the fourth and first wheels.

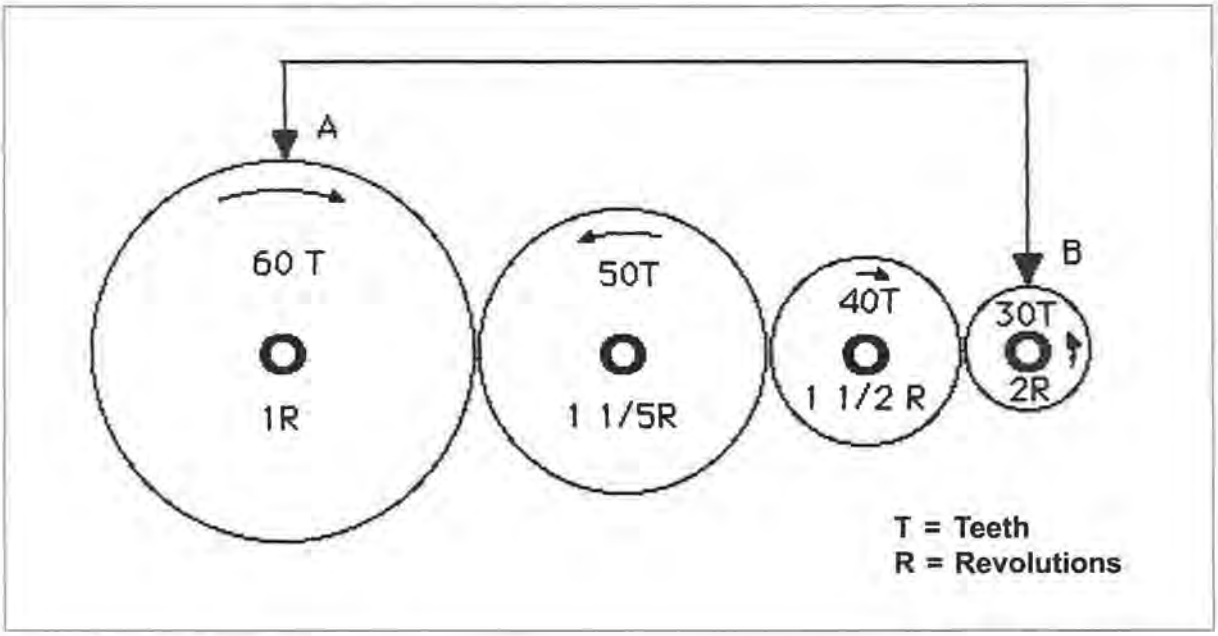


Figure 1. Simple Gear Train

Figure 2 illustrates a compound gear train of the same four wheels meshing with 10-leaf pinions on the second, third, and fourth wheel arbors. With the wheels gearing into pinions, the number of turns of subsequent wheels will increase considerably. For each revolution of the first wheel there will be 6 revolutions of the second wheel, a ratio of wheel teeth to pinion leaves of 6 to 1. For each revolution of the second wheel there will be 5 revolutions of the third wheel, a ratio of wheel teeth to pinion leaves of 5 to 1. Since the second wheel will make 6 revolutions, the third wheel will rotate 30 times (5 x 6) for each revolution of the first wheel. For each revolution of the third wheel, the fourth wheel will rotate 4 times (the ratio being 4 to 1) or 120 times (30 x 4) for each revolution of the first wheel. The product of the numbers of teeth in the first three wheels of Figure 2 can be divided by the product of the number of leaves in the three pinions to obtain the revolutions of the fourth wheel.

$$\frac{60 \times 50 \times 40}{10 \times 10 \times 10} = 120$$

This increase in number of revolutions of the last wheel of the train is the advantage of compound over simple gearing.

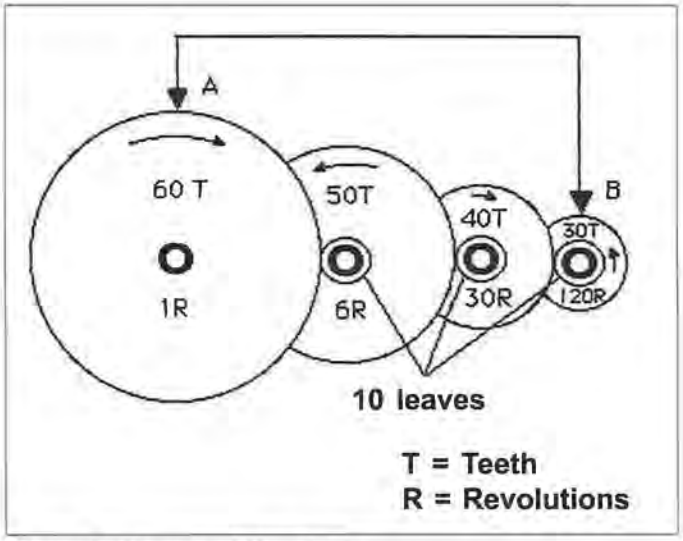


Figure 2. Compound Gear Train

For each tooth of the first wheel that passes point (A), 120 teeth of the fourth (escape) wheel will pass point (B). For each turn of the first wheel, 3,600 teeth of the escape wheel will pass point (B). If the pallets are located at this point, there will be two impulses to the pendulum from each tooth of the escape wheel, or 7,200 vibrations of the pendulum per hour (3,600 x 2). To calculate:

$$\frac{60 \times 50 \times 40 \times 30 \times 2}{10 \times 10 \times 10} = 7{,}200$$

Any combination of wheel teeth and pinion leaves that equals this result can be used.

Calculating Numbers of Gear Teeth and Pinion Leaves

The numbers of leaves used in clock pinions have been standardized as follows:

Pinion	Leaves
Escape	6, 7, 8, 10, 12
4th	8, 10, 12
3rd	8, 10, 12
2nd (center)	10, 12, 14

The number of teeth in the wheels will depend upon the number of leaves selected for the pinions. This can be calculated using the following equation:

$$\frac{B \times C \times D \times E \times 2}{b \times c \times d} = \text{vibrations/hour}$$

B = number of teeth in 2nd wheel
C = number of teeth in 3rd wheel
D = number of teeth in 4th wheel
E = number of teeth in escape wheel = 30
b = number of leaves in 2nd pinion = 10
c = number of leaves in 3rd pinion = 10
d = number of leaves in 4th pinion = 10
2 = number of vibrations produced by each tooth vibrations/hour = 7,200

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Substituting known values:

$$\frac{B \times C \times D \times 30 \times 2}{10 \times 10 \times 10} = 7{,}200$$

$$BCD = \frac{7{,}200{,}000}{60} = 120{,}000$$

Any number of teeth for (B) (C) and (D) can be selected as long as the product is 120,000.

Factors to consider:

a). Wheels must decrease in diameter in progression so that each will clear the arbor of the one proceeding it.

b). There are limits in the size of clock plates.

c). Wheel tooth numbers must be equally divisible by the number of teeth in the pinion with which it gears.

To determine the number of teeth for (B) (C) and (D), 120,000 must be resolved into prime factors. It can be divided by 2 six times, by 3 one time, and by 5 four times.

Set up in an equation:

$$BCD = 2^6 \times 3 \times 5^4$$

Using these figures, the numbers of teeth desired can be selected from the following groups:

Group A

$B = 2^3 \times 3 \times 5 = 120$
$C = 2 \times 5^2 = 50$
$D = 2^2 \times 5 = 20$
$BCD = 2^6 \times 3 \times 5^4 = 120{,}000$

Group B

$B = 2^2 \times 5^2 = 100$
$C = 2^2 \times 3 \times 5 = 60$
$D = 2^2 \times 5 = 20$
$BCD = 2^6 \times 3 \times 5^4 = 120{,}000$

Group C

$B = 2^4 \times 5 = 80$
$C = 2 \times 5^2 = 50$
$D = 2 \times 3 \times 5 = 30$
$BCD = 2^6 \times 3 \times 5^4 = 120{,}000$

Group D

$B = 2^2 \times 3 \times 5 = 60$
$C = 2 \times 5^2 = 50$
$D = 2^3 \times 5 = 40$
$BCD = 2^6 \times 3 \times 5^4 = 120{,}000$

Substituting the values from Group D:

$$\frac{60 \times 50 \times 40 \times 30 \times 2}{10 \times 10 \times 10} = 7{,}200$$

Calculating Numbers of Main Wheel Teeth and Center Pinion Leaves

After calculating the number of teeth in the wheels and pinions from the center wheel to the escapement, and determining the hourly vibrations of the pendulum, the number of main wheel teeth and center pinion leaves are calculated. From this information the number of coils required by the mainspring can be resolved, which will determine its length.

A one-day clock should run for 32 hours on one winding. This means that there should be 32 turns of the center arbor in that time period. The number of teeth in the mainwheel can be calculated using the following equation:

$$\frac{M}{p} = T$$

M = number of teeth in the mainwheel
p = number of leaves in the mainwheel pinion = 10
T = number of turns of the center wheel = 32

$$\frac{M}{10} = 32$$

$$M = 320$$

A mainwheel with this number of teeth would be out of proportion to the rest of the wheels, but it can be reduced in size by increasing the number of turns. A wheel tooth to pinion leaf ratio of 5 to 1 (or more) is an adequate selection for a spring clock. Using this ratio, a mainwheel of 50 teeth will make 6-2/5 turns in 32 hours.

$$\frac{320}{50} = 6.4 = 6\text{-}2/5 \text{ turns}$$

The mainspring selected must be long enough to insure a difference of at least 6-2/5 coils between its wound and relaxed positions.

Calculating the Dial Train

Figure 3 illustrates a dial train, where step-down gearing is used to turn the hour hand 1/12th of a revolution for each revolution of the minute hand. The cannon pinion (W) is fixed rigidly on the center arbor and turns with it. The minute pinion (Y) is fixed on the minute wheel (X) which meshes with the cannon pinion. The hour wheel (Z) on which the hour tube is fixed meshes with the minute pinion. The socket of the hour hand is friction-fitted to the hour wheel pipe. The minute hand is installed on the end of the center arbor.

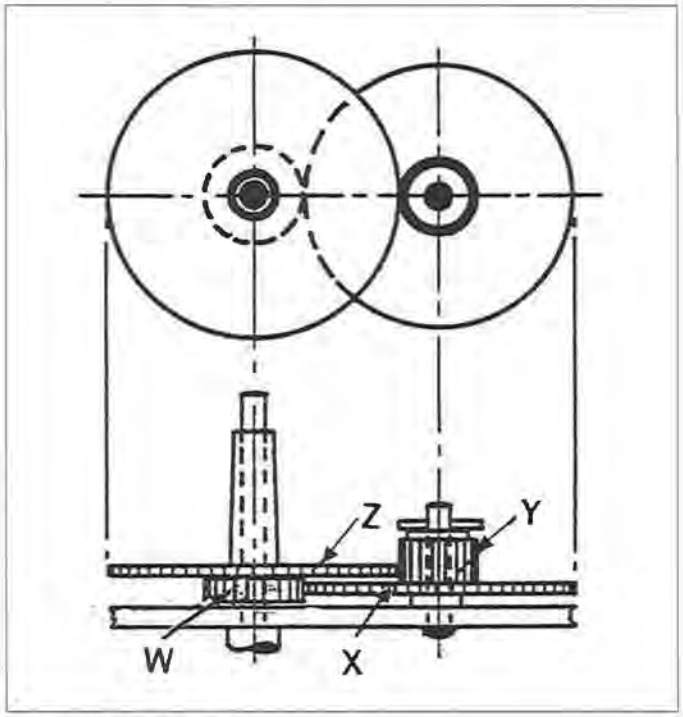


Figure 3. Dial Train

To calculate the numbers for wheel teeth and pinion leaves, the product of the wheel teeth must equal 12 times the product of the pinion leaves.

$$\frac{X \times Z}{W \times Y} = 12$$

There are many combinations that will produce a ratio of 12 to 1. A few are listed below:

Cannon Pinion	Minute Wheel	Minute Pinion	Hour Wheel
12	36	10	40
14	40	10	42
16	40	10	48

Next time, I will discuss a method to calculate the diameters of wheels and pinions.

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Jack Kurdzionak

From the Workshop

Clock Tips and Techniques

Bob Macomber of Washington state has made an AWI video called *Clock Tips and Techniques*. Its 46-minute length is full of valuable suggestions for both experienced and novice clockmakers. Anyone in the business of repairing clocks will benefit from the helpful hints found in Bob's presentation.

Selling the Job to the Customer

The program begins by meeting with the most important person in the transaction, the customer. She approaches Bob the clockmaker with the concept that the clock merely needs cleaning. He examines her clock and ascertains that the clock is not only dirty, but is badly worn from many years of use. He explains that her clock needs an overhaul and not a dip, dry, and oil type of cleaning. His overhaul consists of taking the movement completely apart, washing all of the parts in the appropriate solvent, and examining all parts for damage and wear. He then repairs or replaces all worn parts, cleans parts he has worked on, and reassembles the clock movement. He lubricates the clock and makes all necessary adjustments to the escapement and striking mechanism. This procedure is quite a bit more involved and costly than simply putting the entire movement in a cleaning solvent, drying the movement, and oiling the pivots. The customer will feel confident that the clock has been evaluated for repair by a competent clockmaker.

Take-In Procedure for Clocks and Almost Anything Else

The recommended procedure is to fill out a claim check in triplicate: customer's copy, one for the shop records, and one to stay with the clock. The clock is carefully examined for any possible damage or missing parts at this time. Some points to be noted are: Is there a winding key? Any broken glass? Bezel hinge OK? Dial damage? Case parts broken or chipped? Finials missing or not matching? Hands appropriate for the clock and a matching set? The list could go on for a paragraph or two, but the experienced person will be able to check all pertinent items in a minute or so. It is better to note all such missing or damaged items before the clock is left rather that argue with the customer when it is picked up.

Bob recommends a fixed cost estimate to perform clock repairs. It is not good to surprise a customer with charges higher than the fixed cost previously agreed upon.

He does, however, leave himself an escape route for charges substantially higher than the written estimate. In these cases, he calls the customer with a request to perform additional work to the clock after explaining that the clock needs more work than he initially believed. If the extra work and charges are declined, Bob can return the unrepaired clock at no charge. Although Bob gave his customer an immediate estimate of the repair costs, my own experience in these matters demonstrates that I am better able to estimate repair charges on items that I can examine at a time when I do estimating only. Personally, I make less errors when I can examine repairs at my leisure rather than come up with an instant estimate with a customer standing at the counter.

Finally, before any item is left in a shop, the customer must declare a value on each item for insurance purposes. Once the item is in your shop, it is your responsibility to protect it from damage due to negligence, fire, and theft. If the item is damaged, lost in a fire, or is taken during a robbery, the owner will be seeking damages from you. The declared value is a starting point for your insurance company to pay a claim. If no value is declared when the item was whole and in your presence, how can a value be determined after it is gone? The item's value should be declared by the owner. In the case of a very expensive item, the owner should be able to provide an up-to-date appraisal from a person certified to appraise the item. If you take the

responsibility of determining the value of an item left for repair, you should be certified as an appraiser. If you are not certified to do appraisals, you may have some problems regarding the value placed on the clock in case it is lost or damaged.

Records of all work done to each clock are a must. Bob makes a written record of each clock he has repaired including such details as work performed, time required, material expenses, and income derived from the job. He also logs each incoming clock into a notebook. The records indicate the type of clock, its value, its promised date, and of course the owner's name, address, and phone number. These written records are kept away from the clocks themselves so that in case of a disaster the records will not be destroyed along with the clocks.

Returning the Clock

The owner of the clock or any repaired item sees this as the most important part of the job. She is getting her valued possession back and in much better condition than it was when she left it for repair. The case and glass should be clean. A few minutes spent talking to the customer about her clock is time well spent. She should receive instructions for winding, setting, and adjusting the timekeeping of her clock. She might need a few hints regarding the care of her repaired clock. She might not realize that a polished brass, French clock case should not be cleaned with an abrasive cleaner such as Noxon. Her four-hundred-day clock must have the torsion pendulum secured before the clock is moved. The hour hand on clocks must not be moved independently of the minute hand. These are just a few examples of things that should be brought to the customer's attention before the clock leaves the shop. It never hurts your business to offer to carry the clock out to the customer's car.

Clock Repair Tips

The viewer of the video will receive various hints for doing clock repair better and faster. Bob goes through a complete repair sequence by dismantling an American time and strike clock, cleaning it, polishing pivots, putting in bushings, winding and unwinding mainsprings, and putting the clock back together. His tips about cleaning and repairing are invaluable to the clockmaker, both experienced and novice. Chiming clocks, along with their history, are discussed with musical notes being played in the background. Bob finishes the technical portion of the video with suggestions for adjusting the repaired clock and testing it before presentation to the owner.

This valuable presentation is available for purchase or loan from AWI. The three quarters of an hour needed to watch it will be time well spent.

Jack Kurdzionak



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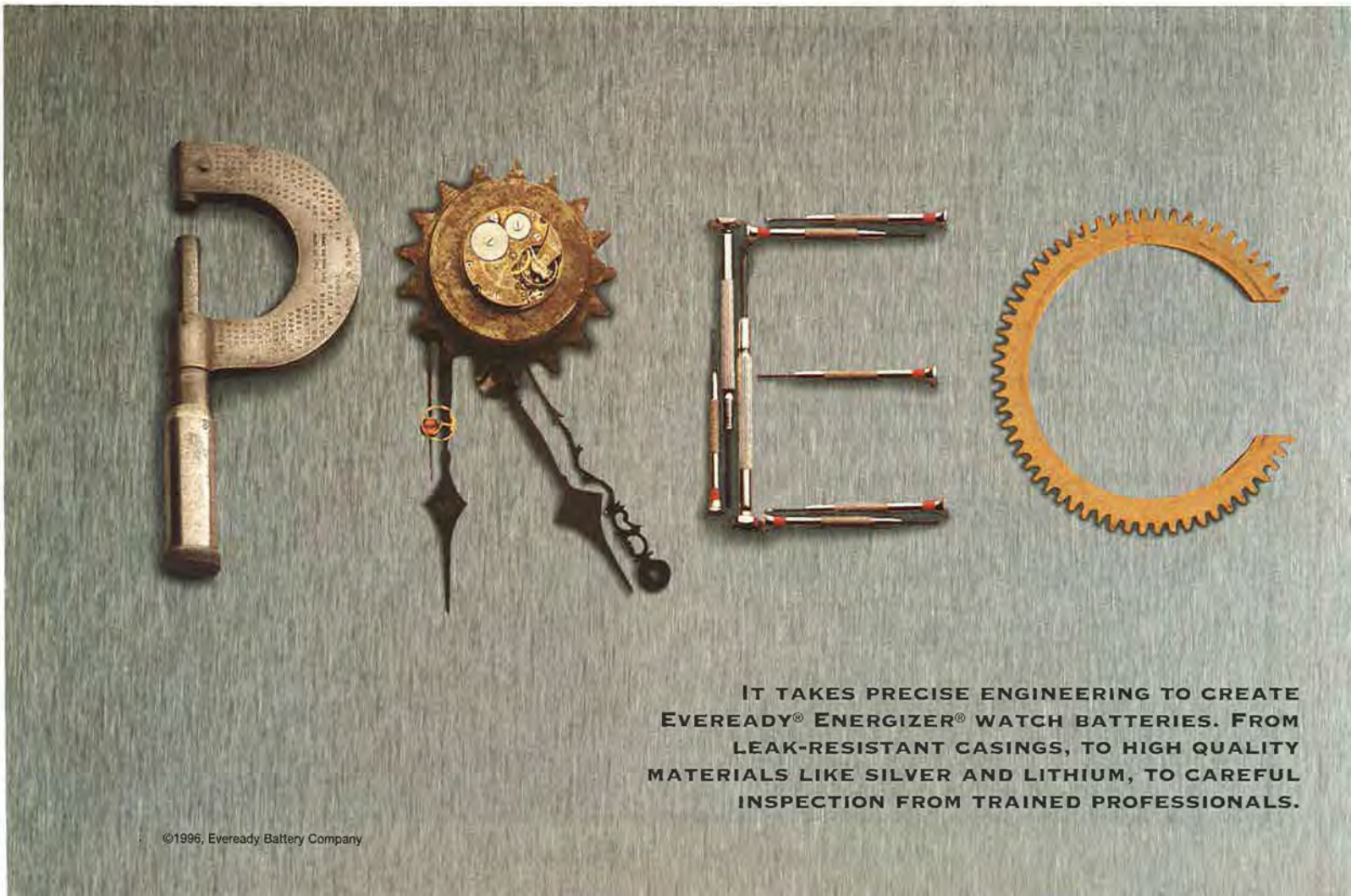
James E. Lubic, CMW

Education Update

I have just returned from the Mid-Atlantic Horological Symposium. It was very refreshing to see approximately 150 enthusiastic horologists gathered in one spot. The MITAGS facilities were fantastic. All who were involved in making the Symposium a success are to be congratulated. My only wish is to find similar facilities in other parts of the country for future endeavors.

The students of the Academy of Watchmaking have been very busy working hard at their new trade. Last week was the completion of hairspring vibrating. Anyone interested in hiring a graduate of the Academy should contact AWI Headquarters. I will be happy to speak with you. We are also accepting applications for the 1999-2000 Academy of Watchmaking. Contact AWI for an application.

Affiliate Chapters and AWI members wishing to schedule Bench Courses or speakers in their region need send their requests to me at AWI Headquarters as soon as possible. We hope to have a new schedule completed in time for publication in the December issue. For a list of available courses, consult your April 1998 issue of *Horological Times*, page 28.









Above: Angela Kunze drawing the lever escapement.

Top Right: Students of the Drawing the Lever Escapement course. (L to R) Greg Tanielian, Jerry Watson, Stan McMahan, Angela Kunze, and Hans Schroeder.

Bottom Right: Students of the Friction Jeweling course. (L to R) Jerry Watson, Mike Gray, Angela Kunze, Mike Doyle, and Hans Schroeder.





Dennis Warner

Affiliate Chapter Report

Several years after AWI was established it found a need for representation of the chapters affiliated with it. For years now the Affiliate Chapters of AWI have held a yearly meeting just prior to the Annual Board Meeting of AWI. Many topics are discussed, friendships established, and decisions reached.

In the past the Board of Directors, affiliate representatives, and those who requested minutes were able to read them. For the first time the minutes of an Affiliate Chapter Meeting are being published in *Horological Times* for all to read. Members' awareness of all aspects of AWI is crucial to the future of our organization.

Affiliate Chapter Meeting
June 19, 1998
Cincinnati, OH

The meeting was called to order at 10:00 a.m. by Affiliate Chapter Director, Dennis Warner.

The delegate from the Massachusetts Watchmakers Association, Terry Kurdzionak, gave the invocation, recognizing Buddy Carpenter. Following the invocation was the pledge to the flag led by Debbie Varjabedian of Florida.

Introductions were given by each delegate, alternate, guests, and soundman, Tony DePrato of AWI Central.

Chairman Warner then made various meeting announcements. Fred Burckhardt made comments about the battery contest.

The chairman then went over regulations governing the Affiliate Chapter meeting and voting procedures. He then appointed Paul Wadsworth as the parliamentarian.

The appointment of the Nominating Committee (John Nunmaker, Scott Lemons, Jerry Kincaid) was then proclaimed. The appointment of the Awards Committee (Dale Huntington, Mark Baker, Brent Glommen) was announced. After these announcements Dewey Clark of the Strategic Planning Committee informed us of a meeting by the Strategic Planning Committee with anyone interested in discussing their report.

Jerry Kincaid then announced the nominees for the vice-chairman of the Affiliate Chapters. Stanley McMahan and Gene Bertram were announced as nominees. Paul Wadsworth explained the absence of John Sokol (voted for this position in 1997) and the necessity of replacement so that the minutes would get recorded for 1998.

A secret ballot vote was then taken and counted. During the counting process, David Christianson spoke on behalf of AWI President Charles Cleves (absent). He welcomed the delegates, alternates, and guests to the meeting.

The result of the vote was then presented. Stanley McMahan was elected to fill the vice-chairman position for 1998.

Dan Fenwick was then introduced as the keynote speaker. He gave an interesting, and at times humorous, speech about his company, Swiss Watch Technical Center, and the Swiss watch industry.

Chairman Warner stated that committee forms in the delegate packets should be filled out and turned in for committee appointments. Then he commented that motions had to be submitted in writing.

Break at 11:00. Resumed at 11:25.

The meeting resumed with discussion concerning the minutes of the 1997 meeting. The minutes were challenged as to voting figures and as to the spelling of names in the minutes. These were changed and the minutes approved unanimously.

Chairman Warner then thanked the office staff of the AWI for the fine job they did putting together the information packets for the meeting.

The next order of business was the annual report from each of the chapters by their delegate in order as follows:

Wisconsin Horological Society
Allan Smiles
Washington State Watchmakers-Clockmakers
John Nunmaker
Horological Association of Virginia
Mark Pellmann
Texas Watchmakers and Clockmakers Association
Curtis Anderson
Metroplex Watchmakers and Clockmakers Guild
Marybess Grisham
Western Pennsylvania Watch/Clockmakers Assoc.
Joseph Jakim
Watchmakers-Clockmakers Association of Ohio
Mark Baker
North Carolina Watchmakers Association
Scott Lemons
South Carolina Watchmakers Association
Stanley McMahan
New York State Watchmakers Association
Paul Wadsworth
Horological Society of New York
Keith Lovett

Break for Lunch at 12:00 p.m. Resumed at 1:36 p.m. and continued with introductions in order as follows:

Watchmakers Association of New Jersey
Richard Luts
AWI/NAWCC Chapter 102
Jack Kurdzionak
Ozarks Area Timekeepers Guild
Dennis Warner
Metro St. Louis Watchmakers Association
Gene Bertram
Minnesota Watch & Clockmakers Association
Janet Larson
Minnesota Clockmakers Guild
Brent Glommen
Massachusetts Watchmakers Association
Terry Kurdzionak
Horological Association of Maryland
Gerald Kincaid
Central Illinois Watchmakers Association
James Dowell
Indianapolis Horological Association
Bill Moore
Horological Association of Indiana
Dale Huntington
Florida Watch & Clockmakers
Aaron Rennert

Introductions and guild reports finished at 2:08 p.m.

Chairman Warner then opened discussion for Old Business. There was no old business to discuss.

New business was next on the agenda. Mark Pellmann then discussed Milt Stevens' election platform wording and contended inaccuracies concerning traveling workshops were allowed to be included in the platform statement. Milt Stevens then responded to the criticism by noting the difference between the traveling workshops and bench courses. Bill Ewbank then discussed the fact that Platform Statements are not edited in any way except for the 300-word limit.

Jack Kurdzionak asked Bill Ewbank whether or not a candidate can take out an ad in the *Horological Times* magazine for election advertising. Milt Stevens responded that it has been the policy to not allow this type of campaigning.

Mark Pellmann then brought up the Marshall Richmond letter that questioned the honor and integrity of four directors and that had suggested the recipients of the letter not vote for these four directors of the AWI. He suggested the letter broke the spirit and letter of the AWI Code of Conduct.

Marshall Richmond provided a rebuttal concerning the intent of the letter and provided no defense of the action. No further response ensued.

New business was ended at 2:19 and proposals from the affiliate chapters were then presented.

Terry Kurdzionak from the Massachusetts Watchmakers Association proposed:

That the AWI allow each affiliate chapter up to $400 reimbursement to delegates attending the annual convention regardless (sic) of percentage of AWI members to non-members within the chapter.

The motion was seconded for discussion. Terry Kurdzionak suggested that more affiliate chapters would send delegates if this percentage rule were relaxed. No discussion ensued.

Proposal passed: 18 for, 3 opposed.

Stanley McMahan from the South Carolina Watchmakers Association proposed:

South Carolina proposes that an AWI full-time student tuition fund be set up and administered by the affiliate chapters.

The motion was seconded for discussion. Stanley McMahan suggested that full-time students are the future of professionalism in our industry and that financial aid would encourage students to continue with schooling if financial problems arise that would necessitate them dropping the course.

Discussion ensued and Bill Ewbank explained the tax advantages of funneling the donations through the ELM trust. It was noted that donations to the ELM trust could be earmarked for a particular purpose.

Gene Bertram discussed the utilization of the ELM trust and the mechanism for these donations and requested information on the ELM trust.

Bill Ewbank gave more details covering the ELM trust and the total in the ELM trust fund.

Jim Dowell rebutted the need for the affiliate chapters to fund a student.

Ken Pell brought up the point about REC funding by individual guilds and that this funding should not interfere with guild funding to the REC schools.

Proposal failed: 9 for, 12 opposed.

Scott Lemons from the North Carolina Watchmakers Association proposed:

When less than the minimum number of students have been scheduled for a course, let a contact person know and give us the opportunity to pay the difference to have the course without the minimum number of students.

The motion was seconded and Scott Lemons stated North Carolina's position. Keith Lovett from the Horological Society of New York further stated that their guild was faced with this same problem of not having enough participants but that the members that were interested in the program would have been willing to pay the additional amount necessary to fund the program.

Proposal passed: 20 for, 0 opposed.

John Nunmaker from Washington State Watchmakers-Clockmakers proposed:

Currently the chairman shall also serve in the capacity of affiliate chapter representative to the American

1998 Affiliate Chapter Annual Meeting Minutes
Affiliate Chapter Delegate Voting Results

I approve the minutes of the 1998 Affiliate Chapter Meeting.
I disapprove the minutes of the 1998 Affiliate Chapter Meeting.

Delegate	Approve	Disapprove	Ballot Not Received
Allan Smiles, Wisconsin Horological Society	✓		
John Nunmaker, Washington State Watchmakers-Clockmakers			✓
Mark Pellmann, Horological Association of Virginia	✓		
Curtis Anderson, Texas Watchmakers and Clockmakers Association			✓
Marybess Grisham, Metroplex Watchmakers and Clockmakers Guild	✓		
Joseph Jakim, Western Pennsylvania Watch/Clockmakers Assoc.			✓
Mark Baker, Watchmakers-Clockmakers Association of Ohio			✓
Scott Lemons, North Carolina Watchmakers Association	✓		
Stanley McMahan, South Carolina Watchmakers Association			✓
Paul Wadsworth, New York State Watchmakers Association	✓		
Keith Lovett, Horological Society of New York			✓
Richard Luts, Watchmakers Association of New Jersey			✓
Jack Kurdzionak, AWI/NAWCC Chapter 102	✓		
Dennis Warner, Ozarks Area Timekeepers Guild	✓		
Gene Bertram, Metro St. Louis Watchmakers Association	✓		
Janet Larson, Minnesota Watch & Clockmakers Association	✓		
Tamara Pinsel, Minnesota Clockmakers Guild	✓		
Terry Kurdzionak, Massachusetts Watchmakers Association	✓		
Gerald Kincaid, Horological Association of Maryland	✓		
James Dowell, Central Illinois Watchmakers Association	✓		
Bill Moore, Indianapolis Horological Association	✓		
Dale Huntington, Horological Association of Indiana			✓
Aaron Rennert, Florida Watch & Clockmakers	✓		
23 Ballots Sent, 15 Ballots Returned TOTAL	**15**		**8**
MINUTES OF THE 1998 AFFILIATE CHAPTER ANNUAL MEETING ARE APPROVED.			

Watchmakers-Clockmakers Institute Board of Directors. Our proposal is to add: If the chairman or vice-chairman is unable to fulfill this duty, they may select another to fill this duty. This election must be made from those who have served as a delegate at the most recent annual meeting.

Chairman Warner then asked for clarification from the parliamentarian, Paul Wadsworth, concerning whether or not this proposal would need to be submitted to AWI since this proposal requires a change to the Affiliate Chapter Bylaws.

Paul Wadsworth clarified that the issue would not need to be submitted to the Board of Directors but that, in fact, their Bylaws would have to change concerning acceptance of a substitute.

A two-thirds majority would be needed to change the Bylaws. Mr. Bob Bishop spoke regarding the Board of Directors Bylaws does not require any particular person to be the affiliate chapter representative. Any delegate from the affiliate chapters would be eligible for the position as a representative of the affiliate chapters.

Gene Bertram brought up a constitutional problem with this proposal. Chairman Warner asked for clarification again from the parliamentarian. The proposal was reread and seconded for discussion. No discussion ensued.

Proposal failed: 2 yes, 20 no

Proposals over at 2:55 p.m.

Chairman Warner then called for a report from the nominating committee. Gerald Kincaid reported Dennis Warner as the only candidate for chairman of the affiliate chapters. Motion to close nomination passed unanimously. A secret ballot vote was taken and Dennis Warner was elected as the chairman of the affiliate chapters for a second term for 1998-1999.

Nominations for the vice-chairman of the affiliate chapters were presented as Gene Bertram and Stanley McMahan.

Break at 3:00 p.m. Resumed at 3:23.

Gene Bertram presented his case for winning the election. Then Stanley McMahan presented his case. A secret ballot election was taken. During the vote counting, Stanley McMahan reread the motions that passed.

Stanley McMahan was elected as vice-chairman of the affiliate chapters for 1998/1999.

Alice Carpenter was then asked to swear in the new officers. (Stanley and Dennis).

Meeting adjourned at 3:30 p.m.

Minutes prepared by Stanley McMahan from written notes and audio tape of the meeting. Thursday, July 23, 1998.

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Repeater, Petite and Grande Sonnerie Clocks

Carriage Clocks, Part 37

Leo A. Jaroslaw

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Introduction

In this series we will cover in detail the description and operation of carriage clock control systems. These include: normal strike, petite sonnerie and grande sonnerie strike. Also covered will be repeat and alarm controls.

The clock we will concentrate on is a complicated carriage clock by J.M. BADOLETTE & Cie. GENEVA. (Figure 37.1). This clock has both petite and grande sonnerie strikes as well as strike/silent. It also has a repeat control which repeats the last hour in addition to the quarter for the first three quarters. The hour is struck by itself, without the four quarter strikes. The three quarters are ting-tang or bim-bam with two separate and different pitched gongs. The deeper pitch alone is used for the hour strike. This clock's alarm system is fairly standard, similar to many other carriage clocks. The alarm sounds on its own gong.

The Badolette family were clockmakers and watchmakers from 1600 to the 1920s according to Bailie's listing. Almost all were listed as working in Geneva. Several were listed as having worked in London. Loomes list a J.J. Badolette & Cie. working in Geneva in 1882. I could find no listing for J.M. Badolette & Cie. Geneva. Possibly the initials in the listing are a typo. J.M. Badolette & Cie. is engraved or stamped on the plates of this clock.

We will also do some comparisons with a French carriage clock by DROCOURT, of approximately the same period. This clock has standard hour strike, half-hour strike, repeat, and alarm. We may at times also include some photos and descriptions of other clocks for comparison and to show differences. Some of these may be used for showing details which are clearer in a less complicated and crowded photo.

I regret to say that when I did the notes and photos for this clock, I did not plan to go into reassembly details. My intention was to just cover description and operation of the control systems. This was done in 1989. The clock hasn't been back to the shop. The owner died five years ago and the clock went to some relative in another part of the country. Nor has another as complicated carriage clock come across my bench. In my descriptions I will cover some critical adjustments.

1. Removing movement from the case. (Figures 37.2 - 37.3)

1.1. Lay case front down, with the door open on a soft mat/carpet or other material you use for case work.

Note: (Figure 37.2) The Badolette clock has only a baseplate (2). Most clocks with normal strike (Figure 37.3) have a false bottom (8) (View A) which is removed to gain access to the main baseplate (2) (View B). The clock in these photos was French with no maker



Figure 37.1. J.M. BADOLETTE & Cie. Geneva Carriage Clock



1 Case Base
2 Baseplate
3 Mode Shift Lever
4 Sound Holes
5 Baseplate Screws (4)
6 Movement Mount Screws
7 Threaded Holes for Baseplate Screws

Figure 37.2. Removing Movement From Case

1.2.1. Upright the case to stand.

Note: As the four attaching screws have been removed, the movement will now slide down.

1.2.1.1. Steady the movement with your finger through the open rear door.

1.2.2. Lift the case off the movement.

Note: Again steady the movement as you lift the case (Figure 37.2). View B shows the separation of the two parts. View C shows the construction of the base with movement removed.

1.2.3. Remove baseplate from the movement.

Note: Watch out for the mode shift lever (3) when the movement is removed, as it extends below the movement (Figure 37.2).

2. Removing movement from a typical case.

2.1. Lay case face down on soft material (rug, towel, or whatever you use for casework) with rear door open.

identified. There are four screws (6) mounting the movement to the baseplate. Many clocks have only two.

The baseplate on the Badolette is mounted by four corner screws (5) to the base (1) of the case. The two larger centered screws (6) are the movement mount screws. A series of holes are drilled in the rear of the plate (4). These are sound holes. They are an outlet for the gong sound to be heard better with the case door closed.

Also on the front of the bottom plate are the slot and position cut-outs for positioning the mode shift lever (3): Silent, Petite Sonnerie, and Grande Sonnerie.

1.2. Remove four corner screws (5).

CAUTION: AT THIS TIME DO NOT TOUCH THE CENTERED MOVEMENT MOUNT SCREWS (6). THEY ARE REMOVED AFTER THE MOVEMENT IS REMOVED FROM THE CASE.

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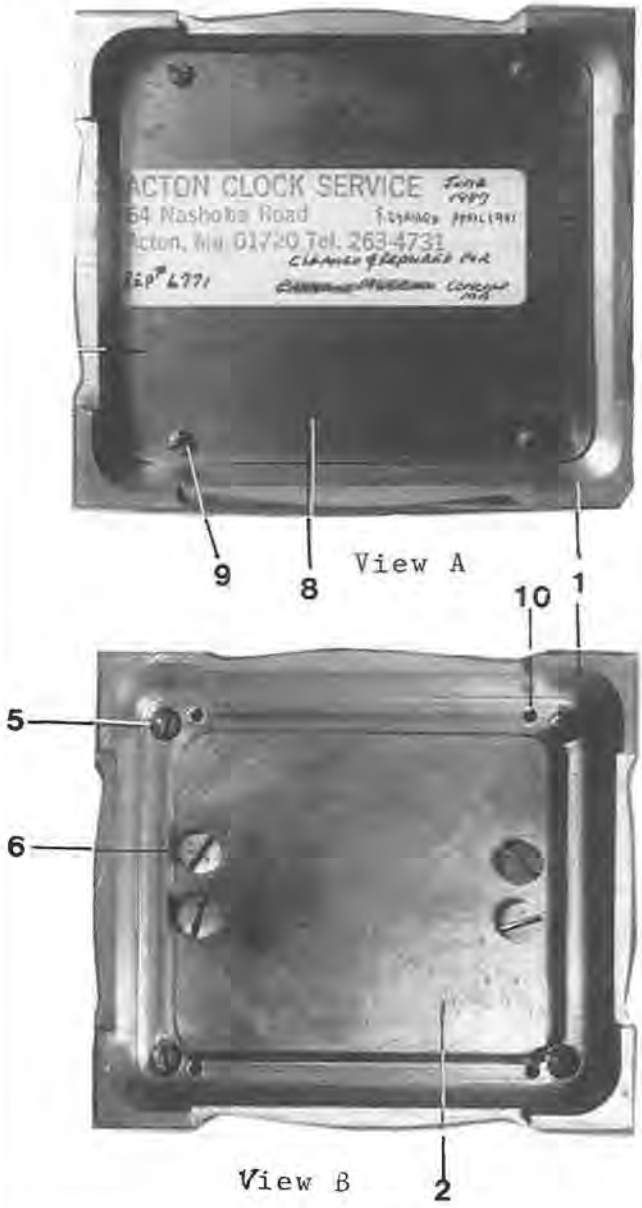
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1 Case Base
2 Baseplate
5 Case Baseplate Screws (4)
6 Movement Mount Screws (4)
8 False Bottom Plate
9 False Bottom Plate Screws (4)
10 Threaded Holes for False Bottom Screws (4)

Figure 37.3. Typical Bottom Details

2.2. Remove four screws (9) attaching false bottom plate (8) to the case base (1), (View A).

2.2.1. Remove false bottom plate.

Note: This allows access to the main attaching screws, (View B).

CAUTION: THERE ARE TWO, AND SOMETIMES FOUR, LARGER CENTERED SCREWS (6). THESE ATTACH THE MOVEMENT TO THE BASEPLATE (2) AND MUST NOT BE REMOVED UNTIL AFTER THE MOVEMENT IS REMOVED FROM THE CASE.

2.3. Loosen the four corner screws (5) in recessed holes in the case base.

CAUTION: THESE SCREWS ATTACH THE CASE BASE, THROUGH THE BASEPLATE TO THE CORNER POSTS OF THE CASE. WHEN LOOSENED, THE REAR DOOR WILL BE LOOSE AND CAN BE REMOVED.

2.3.1. Remove rear door.

2.3.1.1. Place two heavy rubber bands on the case.

Note: One near the top of the case, the other near the bottom. This will hold the case and the three glass panels together when baseplate screws (5) are removed.

2.3.2. Remove the four baseplate screws (5).

2.3.2.1. Pull base away from case and movement.

Note: Case and movement will tend to drop to the mat/towel, etc. Hold the case to minimize this drop.

2.3.2.2. Upright the case and movement.

Note: Steady the movement through the rear door opening.

2.3.3. Lift case away from the movement.

CAUTION: THE GLASS PANELS ARE LOOSE IN THE CASE FRAME, HELD ONLY BY THE RUBBER BANDS. TRY TO SURROUND THE WHOLE CASE WITH YOUR HAND WHEN LIFTING, TO PREVENT THEM FROM FALLING OUT.

2.3.4. Remove baseplate from the movement.

This ends Part 37. In Part 38 we will show the back and front components on both the Badolette and the Drocourt clocks. This will compare the complexity of the Petite/Grande Sonnerie with the normal strike mechanism. We will then discuss the strike controls and operation.

AWI Material Search

EDITOR'S NOTE: This column is designed to work in conjunction with the AWI Movement Bank. If you can supply any of the items listed here, please send details to the Material Search Network. **Do not send the items to AWI.** Members requesting these items will be advised of their availability and will contact you directly.

1O1 Hamilton 6/0 men's wristwatch bezel, elliptic shape, white gold.

1O4 Howard pocket watch hairspring with collet and stud attached, 16's open face series 2, 17J, 5 positions adjustable.

1O6 Illinois pocket watch hairspring, 16's, model #706, serial #3101177, adjusts to 4 positions, double roller.

1O10 Mercer ship's chronometer English style detent, serial #13888.

If you can supply any of these items, please contact: AWI Material Search Network, AWI Headquarters, 701 Enterprise Drive, Harrison, OH 45030; Phone (513) 367-9800; Fax (513) 367-1414.

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As a Clockmaker Turns

Your Fourth Day with the Clockmakers Lathe

J.M. Huckabee,
CMC, FAWI, FBHI

Making Pivot Bushings with "Old Huck"

This is the fourth and concluding article of simple steps to lathe work as applicable to the clockmaker. It has been my aim to teach a series of examples to encourage the newcomer to lathe work. Also, I trust that those more experienced with the clockmakers lathe can find, and adapt, some ideas to their skills.

Objective

This work will relate problems and solutions to restoration of clocks that have badly worn pivot holes in the movement plates. Bushing tools are extensively used for this purpose. This work will use two of the most used power tools in a clock service center. Namely, a small benchtop drill press and the most basically appointed watchmakers lathe. I suggest that each reader study the methods and illustrations carefully. They are both time and cost efficient. The example is an Old American clock; the type so often needing this work.

The Process

Just as with commercial bushing tools, the process is to enlarge the pivot hole area, and insert a friction-fit bushing.

Here are some guidelines for any method of the process. The bushing must be on the exact location of the original pivot hole. It must equal movement plate thickness in length. The piece must be secure in the clock plate. It must have a suitable oil sink, hole diameter to its pivot size, and be perfectly aligned to the opposite plate of the clock.

I do not attempt to obscure the fact that the bushing has been installed. However, I do require the workmanship be such that it will be admired by those who are skilled clockmakers.

How to Begin

We may begin with various parts of the work. My suggestion is that the respective pivot be refurbished first. Then the bushing hole is finished to that size.

Open up the plate hole to receive the bushing. Some use precision reamers and bushings of a precise outside diameter. I approach the job differently. I open the hole with a very short drill bit and a small press. Look over Figure 1. A smooth wood block on the press table reduces backside bur on the plate. I hand-hold the plate. I suggest the inexperienced worker hold the plate with C-clamps. The illustration is approximately actual size. Run the bit about 3,000 RPM and feed the bit slowly. This is about a 30-second task.

Some locations are more difficult to drill. Figure 2 is the escape wheel bridge of a kitchen clock. It is drilled from the plate inside, therefore not a problem.

Clean up the hole edge bur with a ball bur. Rotate the bur by hand from both sides of the plate (see Figure 3).

The Lathe Work

Select the raw material. I use 1/8" brass rod from a local hobby store. A one-foot length



Figure 1. For shop-made bushings a benchtop drill press is ideal to prepare the bushing pocket. A 1/8" stubby drill bit is suitable. The plate is backed up by a smooth pine block of wood.



Figure 2. The less accessible escape wheel bridge is worked from the plate inside. Use a new place on the block each time to reduce exit bur on the lower side.



Figure 3. A ball-shaped bur is used to cut away the sharp edges of the drilled hole. It is held in a large pin vise. Do not use a power tool.



Figure 4. Select the material for the bushing. This is a 1/8" brass rod. It should just slip into the drilled hole.

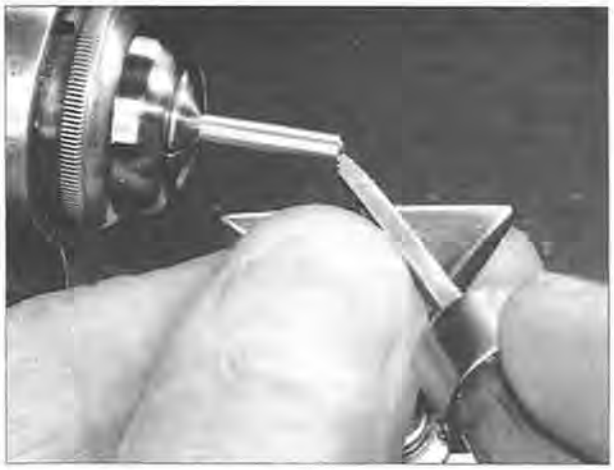


Figure 5. Chuck the bushing material to run true. If that is a problem, use a larger piece and make a surface cut to reduce it to size. Face the end; chamfer the edge.

will make 50 or more bushings for the American-type clock. The raw material should just slip into the drilled hole (see Figure 4). Your bit and raw material may not be perfectly sized; if so, the material may not enter the hole. If so, hold it in the lathe and pinch a piece of scour pad on the running stock for a very few seconds.

Chuck with about 1/2" overhang, face the end and chamfer the edge. Figure 5 has about 3/4" overhang for a better view. Keep the overhang to a minimum value for convenient work.

Locate exact center with a pointed graver. Just a small dimple to start your drill bit. Figure 6 shows the magic center finder in use. A future article will relate construction of that tool.

Study Figure 7, and its caption. This bit is in the range of 0.050" in diameter. These are very easy to break. Rest the bit on your fingertip for support. The pin vise here is round, aluminum, and lightweight. It is a modified hobby knife handle. The cut-off tool of Figure 8 is also a modified hobby knife. Study the caption of the same figure. It tells how I handle the small piece. Remember, the bushing has a hole size slightly smaller than the respective pivot. It will just slip through the enlarged hole in the plate, and has no oil sink.

Swage-Fit the Bushing in Place

A swage is used to expand the bushing. The one in Figure 9 was made from 3/16" diameter steel rod (mild steel from the hardware store). About 2-1/2" long, and with an included angle of about 110-120 degrees. This angle is important. Do not attempt to use a punch with a more acute angle

I selected the escape wheel bridge as the example in Figure 9. A stump in the bench block can be used, but must be larger than the bushing outside diameter. That is

what I normally use. Wanting to simplify the method, I slipped a small parallel jaw clamp between the bridge and plate; it just fit the job.

A couple of sharp strokes with a two-ounce steel hammer does the job. The bushing is expanded, locking it in place. The oil sink is formed, and the material is work hardened. It is now harder than the original plate. Broach the hole to size and debur the pivot hole edges.

Broaching the New Pivot Hole

Regardless of your bushing method, the pivot holes in both plates must be on exact location and in perfect alignment. As you broach the swage-fit bushing, you will detect that it is harder than the original clock plate holes. I work from both sides of the plate to give a slight hourglass-shaped hole. Then debur the hole mouth at each end. Study the broaching operation in Figure 10. View your work from several angles.

Again, regardless of your bushing method, carefully test each wheel to see that it runs free. You should be able to shake the movement and lash each arbor in its endshake.

Test Your Work

Our specimen in Figure 11 has bushings in several locations on each side of the movement. It is assembled (time train only) without the mainspring. It should spin easily with just a little pressure on the 2nd wheel. Try this in dial-up, dial-down and various other positions. This is your guard against latent stoppers, need for long test runs, and misdiagnosed problems. The most common of these problems are: weak mainspring, improper type of lubricant, or



Figure 6. Use the center finder to spot exact center for your drill bit. The bit chosen should be slightly smaller than the respective pivot size.



Figure 8. Use the cut-off tool. Cut almost into the drilled hole. Exchange ends, hold the bushing and break away the parent material. Face the end to plate thickness length.



Figure 7. Drill about two-plate thickness deep. Use a round pin vise to hold the bit. In event of a hang-up, let the vise spin until the motor can be turned off. Support the bit on your fingertip.



Figure 9. Back up the bridge with a suitable stump. Here a parallel jaw clamp is of suitable thickness. Place on a heavy bench block and expand and form the oil sink with a swage.

improper application of the lubricant. I do the work and spin-test before the movement is cleaned or lubricated. My mentor taught me to make repairs, clean the pieces, assemble and lubricate, in that order. On occasion, one is so dirty that it gets a little rinse before it is disassembled.

Evaluation of the Work

Study Figures 12 and 13. The pivots you see are all the workmanship described here. The pivots were all polished (refurbished) prior to broaching their respective pivot holes. It is obvious that the bushing job was done. The method used has no compromise in functional quality, cost efficiency or efficiency of time consumed. The job is one that will stand before the hardest taskmaster. Study the entire group, so that various light reflections will aid your judgment.



Figure 12. This is one of the new bushings, as are the other two. Light reflections may cause them to appear somewhat different. The respective pivots were refurbished.

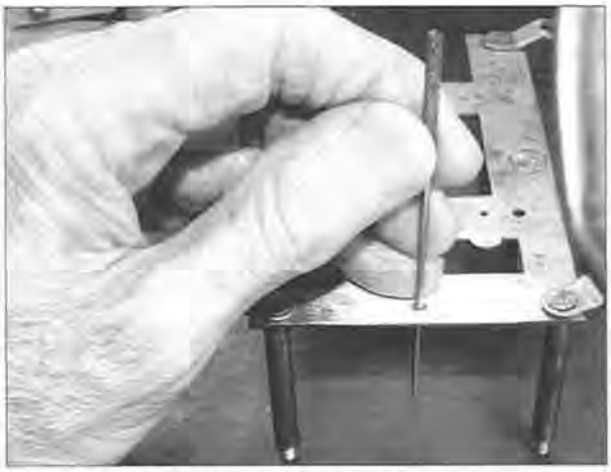


Figure 10. The bushing was locked in place by a sharp stroke of a two-ounce steel hammer and swage punch. The swage is larger than the bushing and has an included angle of about 110-120 degrees. It also forms the oil sink. Broach the hole to size.

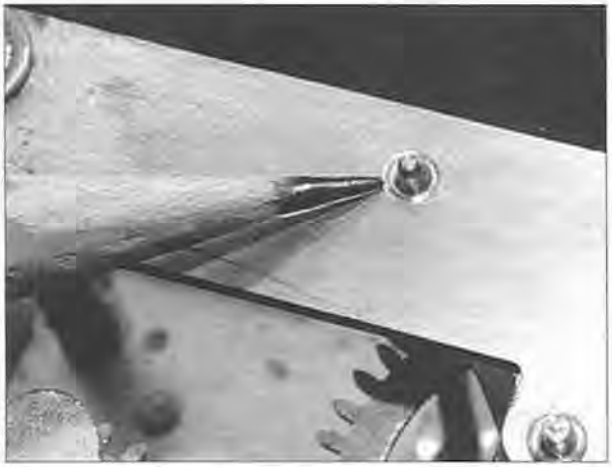


Figure 13. These two bushings were also installed. A job that will function for many, many years. The movement is now ready to be cleaned, assembled, and cased.

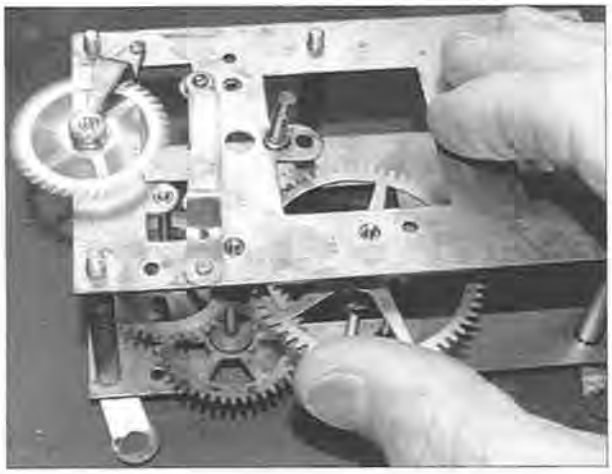


Figure 11. With no mainspring, spin-test the gear train. Hold the movement in various positions to assure there is no abnormal friction. This movement received several bushings.

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Servicing the Thirty-One-Day Clock Movement

By David J. Carlson

The heart of the thirty-one-day clock is a time and strike movement whose proportions are similar to those found in early American clocks. Servicing these movements can prove more labor intensive than their antique counterparts primarily due to the mainspring configuration required for the extended running time. Dealing efficiently with mainspring problems will enable a more favorable repair cost to the customer and less frustration at the workbench.

The thirty-one-day movement shown in Figure 1 was removed from a shelf clock. The clock was brought into the shop with the complaint that it had stopped running and the time side arbor could not be wound. When the back was removed, the time side spring was completely extended and pressing against the side of the case. Removal of a movement under these conditions must be done carefully to prevent damage to the case or the movement itself. The rather generous interior space allowed the movement to be removed without any problems. Under less favorable conditions, a useful technique is to cut the spring loops with a pair of double-action tin snips to relieve the pressure on the side of the case before removing the movement.

The thirty-one-day mainspring is quite different from its seven-day counterpart in both cross section and length. A typical seven-day loop-end spring for an early American clock is made from flat spring stock and measures ¾" x .018" x 96". The thirty-one-day mainspring is made from specially rolled stock as shown in Figure 2. The ridge-like shape increases the effective stiffness (power) of the spring without the need to increase its thickness. A flat spring of the same stiffness would require more space in the movement. The typical thirty-one-day spring measures ¾" x 0.0155" x 150".

An important feature of the thirty-one-day movement is a "pressure clip" which is used with each mainspring to force the mainspring outward from the movement as it unwinds. The top of the clips can be seen on each of the lower corners of the front plate in Figure 1. Without the clip, the mainspring would crowd the 2nd wheel pinion as it unwinds, thereby causing premature stopping.

The four-part procedure listed below proved effective in the shop. Remember when working with any mainspring, be sure to wear eye protection and where possible keep out of the expansion zone of the spring.

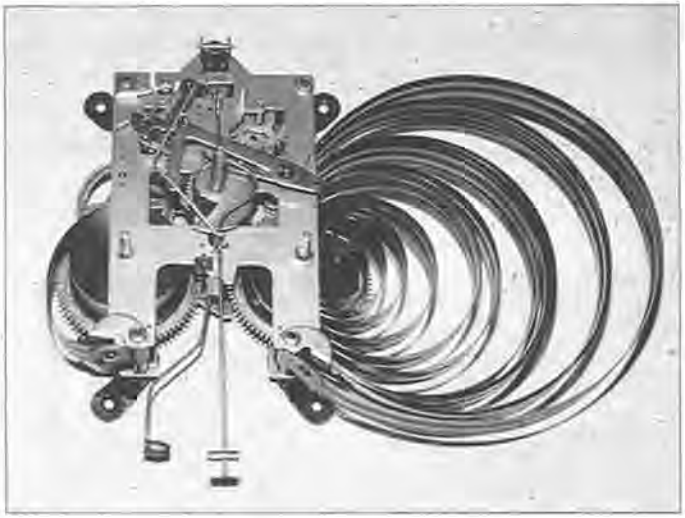


Figure 1. Thirty-One-Day Movement

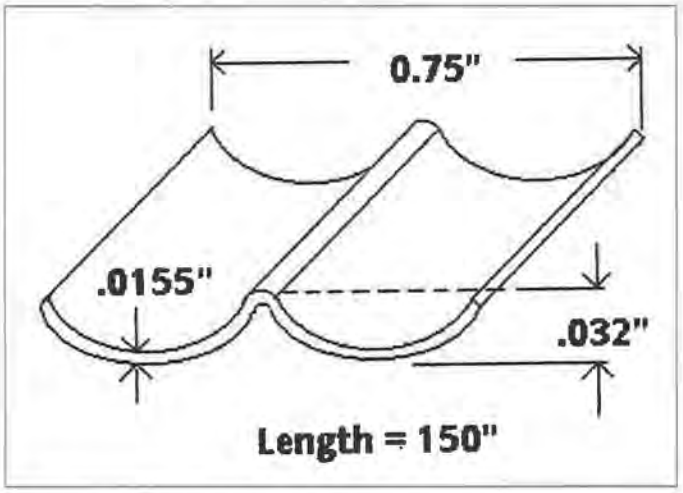


Figure 2. Section of Thirty-One-Day Mainspring

Clamp the Mainsprings before Disassembly

- Remove the pressure clips. Preparation for removal of the pressure clip on the strike side is shown in Figure 3. Pressure on the last turn is relieved with the spreading tool (piston ring pliers) and the clip is lifted out with a screwdriver. Alternatively, the mainspring can be let down halfway and the clip removed.



Figure 3. Ready to Remove the Pressure Clip

- Wind the spring to take up the slack due to the removal of the pressure clip.
- Thread a hose clamp behind the spring and tighten the clamp to secure the spring as shown in Figure 4.* Note the pressure clip in the foreground.
- Let the power down to relieve any reserve power which was released when the clip was removed.
- Proceed with disassembly.

* The use of metal retaining rings or binding wire is not recommended. The raised center of the spring and the flat loop-end piece make it difficult to find a stable clamping position.

Clean and Lubricate the Mainsprings

It is ***essential*** to unwind and then thoroughly clean and lubricate thirty-one-day mainsprings. Failure to do so can cause serious hang-ups during winding or unwinding, resulting in a loss of running time or a sudden release of power that can damage the gear train. The steps are:
- Remove the clamped spring from the great wheel arbor.
- Lightly hold the clamped spring in a bench vise as shown in Figure 5.

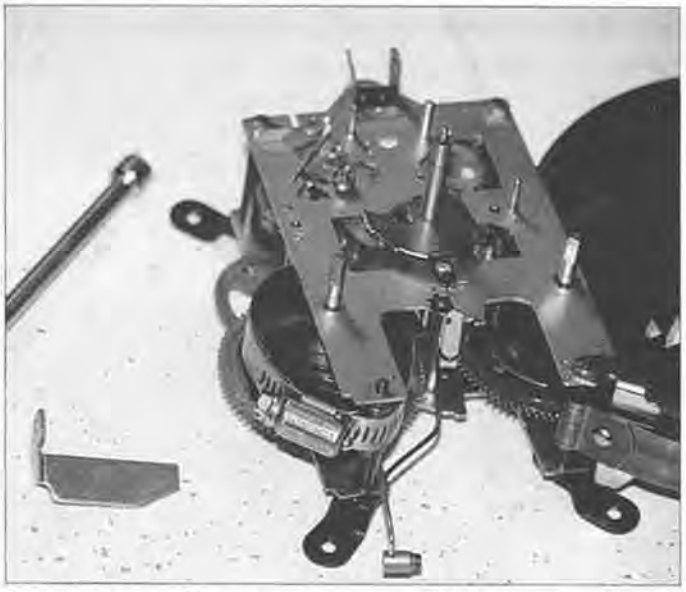


Figure 4. Hose Clamp in Position on the Mainspring

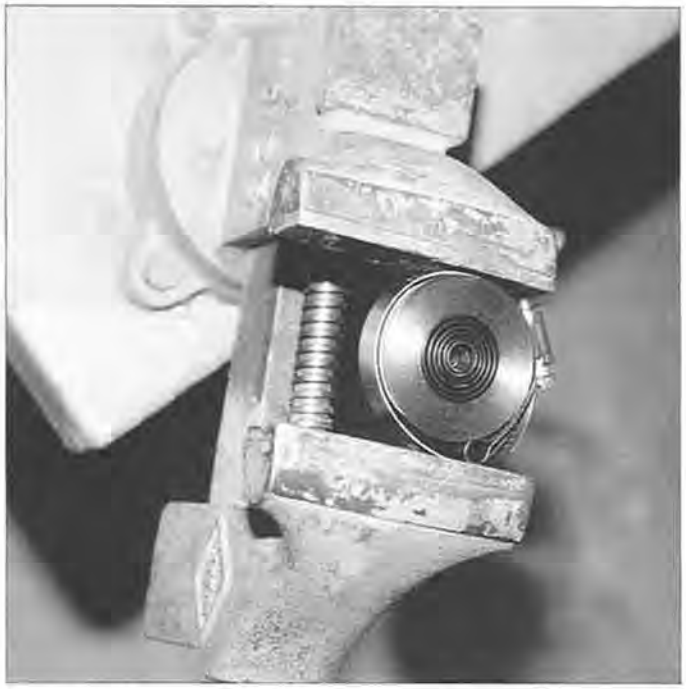


Figure 5. Mainspring & Hose Clamp in Vise

- Gradually release the pressure on the hose clamp while loosening the vise until the hose clamp is completely open (Figure 6).
- The remaining spring pressure at this point is low enough so that the spring can be removed from the vise manually. In your first attempt with this method, a glove or a stout cloth should be used to remove the spring until you get a feel for the technique.
- Wipe the unwound spring with 4-0 steel wool saturated in WD-40. For more difficult cases, presoak the spring in carburetor cleaner. Wipe the spring dry.
- Lubricate with a good grade of wheel bearing grease.

Wheel bearing grease is preferred because it will resist being squeezed out under pressure. The grease is applied by the "bicycle chain method," (i.e., rub the grease into the spring with the thumb and forefinger). A side benefit of this procedure is that any faults in the spring can be more easily picked up with "feel" than visually.



Figure 6. Ready to be Removed from the Vise

Rewind the Spring

My favorite spring winder for barrel-type springs proved to be unsatisfactory for thirty-one-day mainsprings because the spring would spill out from either side during the winding process. A simpler way by far is to use the clock plates as follows:

- Replace the spring on the great wheel.
- Put the loop end of the spring on its arbor and put it and the 2nd wheel in place on the lower plate as shown in Figure 7.
- Put on the top plate, replace the pressure clip and secure the plates. A word of caution: Be sure to use the pressure clip. Without the clip, the spring will bind the 2nd wheel. It can be a real mess.
- Trap the 2nd wheel with a piece of dowel so that it cannot rotate (Figure 8). Wind the spring. Clamp the spring with the hose clamp.
- Remove the pressure clip. (Same process as Figure 3.)
- Let down the spring to relieve any residual power. The top plate may now be removed as shown in Figure 9 and the process repeated for the strike side.

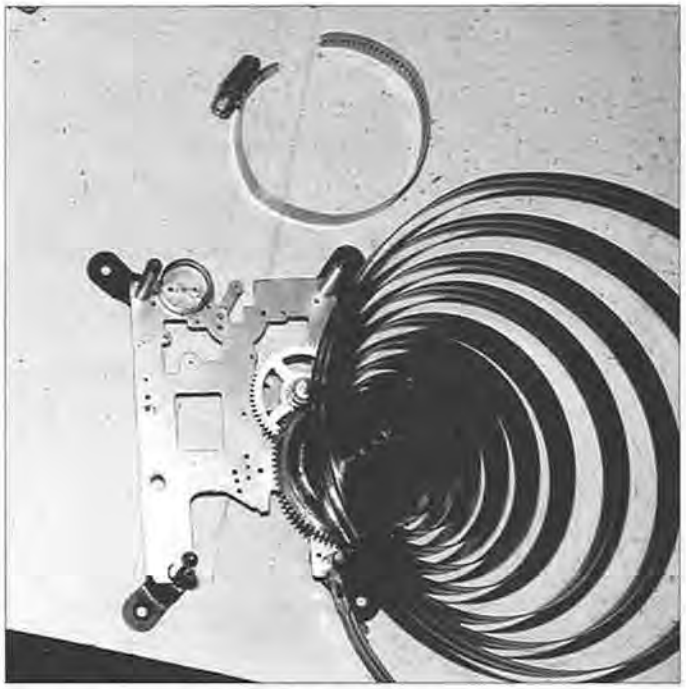


Figure 7. Spring and 2nd Wheel on Bottom Plate

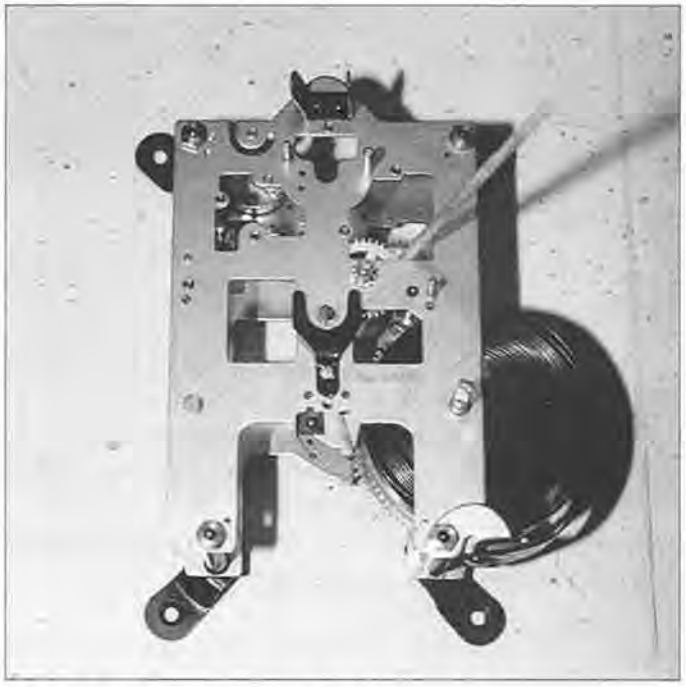


Figure 8. Spring Partially Wound

Assemble the Movement

After cleaning, checking for bushings, pivots polishing, etc., assemble the movement. The clamps on each mainspring are removed by alternately winding the arbor and gradually releasing the hose clamp tension until the hose clamp is loose and can be removed safely. Next, the pressure clips are installed by letting the mainspring down halfway, spreading the last turn, inserting the pressure clip, and replacing the nut to hold the clip in place. An

alternative method to install the clip is to slightly reduce the hose clamp pressure, spread the end turn as in Figure 3 (page 47), and insert the clip.

Bench Testing

To prevent comebacks, it is important to be sure that the movement will be fully functional at the end of the thirty-one-day cycle. Rather than leave the movement under test for such a long period of time, it is more efficient to set up the end of cycle conditions as part of the initial inspection. To accomplish this, the mainspring can be let down manually by the same amount that it would run down in thirty-one days.

To find the number of turns to let the spring down, the time train schematic and data in Figure 10 is most useful. (The teeth and leaves in the time train gears and pinions were counted while the movement was apart for cleaning). The portion of the time train that drives the center wheel is referred to as the power train. The action of the power train may be described as follows.

The mainspring drives the great wheel W_1. (In the time train, the wheels are numbered in ascending order starting with great wheel W_1 and ending with the escape wheel W_5. A pinion sharing an arbor with a wheel carries the same number as the wheel, (i.e., the center wheel is W_3 and its pinion is P_3). W_1 drives the 2nd pinion P_2. W_2 drives the center wheel pinion P_3. In 31 days the center wheel (minute hand) will rotate 744 times (24 rotations per day x 31 days).

If "T" equals the turns of the mainspring, then

T x W_1/P_2 x W_2/P_3 = Turns of the center wheel, substituting,

T x 80/10 x 60/12 = 744

Solve for T,

T = 18.6 Turns

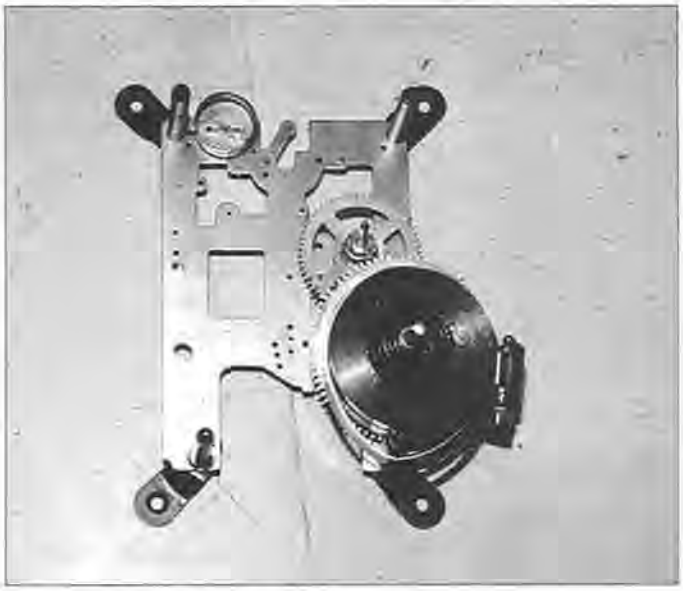


Figure 9. Spring Ready to be Removed

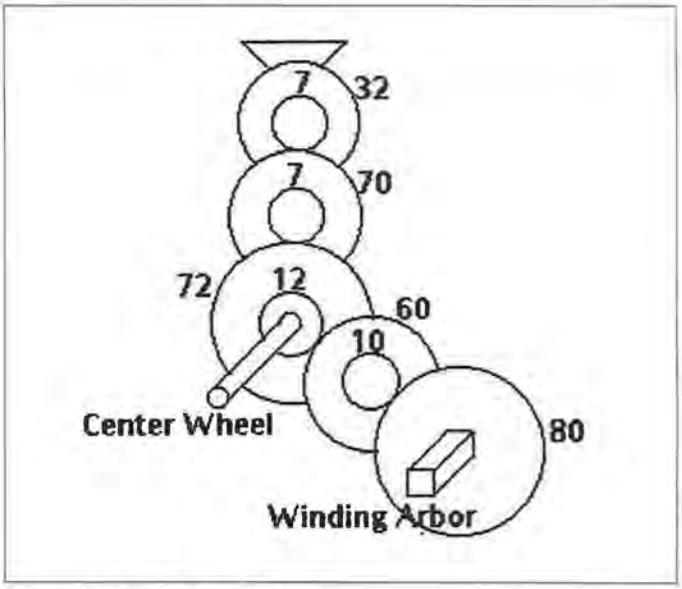


Figure 10. Time Train Schematic

Setting the Clock to Rate

In the shop, an electronic counter is recommended to set the clock to rate. For the clockmaker, the electronic timer is the modern day equivalent of the timing machine which has been used by watchmakers for years. The electronic timer currently in use is a Timetrax® that comes with an extensive listing of clock rates in beats per hour. If the clock is not listed, as in this case, the BPH can be readily determined.

Starting with the center wheel in Figure 10, W_3 drives the 4th wheel pinion P_4, W_4 drives the escape wheel pinion P_5, and the escape wheel drives the escapement 2 x W_5.

BPH = W_3/P_4 x W_4/P_5 x (2 x W_5) = 72/7 x 70/7 x (2 x 32) = 6583

Strike Regulator

The only other major difference noted in this movement was the strike side governor. In place of the typical fan used in American movements, a slotted neoprene disk was used to control the speed. The slotted portion of the neoprene disk used friction as the means of regulation as it expanded and rubbed the sides of a brass cup. The brass cup is visible in the upper left hand of the bottom plate in Figure 7.

Thirty-one-day movements still pose a challenge when received in the shop for repair. The customer needs and deserves our best efforts. I would welcome any comments, suggestions, or alternatives. Contact me through AWI Central.

Report of the AWI Strategic Planning Committee

Part 2

Editors Note: This is the second of three installments of the Strategic Planning Committee Report. The final installment, containing the committee's recommendations and a proposed mission statement for AWI will appear in the December issue of HT.

What is the Environment in which AWI Operates?

The environment in which AWI exists is fairly supportive to AWI. There are many factors, which tend to support the need for the services provided by AWI while there really is only one organization that is AWI's competitor.

AWI is the only U.S. horological craft organization dedicated solely to the development of the horological crafts. It represents the traditions of the horological trade; and it is the only organization in the U.S. that represents the continuum of the horological business. AWI attempts to represent the interests of the individual craftsperson, business owners, material suppliers, timepiece manufacturers, equipment manufacturers and full-time horological schools. *Only* AWI is in the position to bring these parties to the table when the interests of one segment conflict with the interests of another segment.

State of the Horological Trades: The state of the trade would also indicate support for AWI as an organization. Increasingly, craftspersons are faced with complex regulator issues related to disposal of hazardous materials from exhausted watch batteries to spent cleaning solutions. There has been an increasing trend by some manufacturers to decrease their reliance on independent craftspersons. In some cases, this has gone as far as illegally restricting access to repair material. AWI is uniquely positioned to represent the craftspersons in these matters.

At the same time, demographics and economics indicate that AWI's position as a trainer of horological craftspersons can also be sustained. Aside from a strong demand for working collectible timepieces, there is increased interest in, and output of, mechanical timepieces. This is at a time when there has been very little interest in pursuing a career in full-time horology. At the same time, there seems to be little difficulty for skilled horologists to achieve an annual income in excess of $40,000. Hence, there would seem to be a need for AWI's educational programs.

Demographics would suggest an increased pool of those interested in AWI who are over the age of 40 years; which neatly fits in with the traditional pool of AWI members. The number of individuals who are seeking second careers as a result of retirement, early retirement or dissatisfaction with their first career is increasing. This pool also includes military retirees who are eligible for retirement after 20 years service.

Personal maturity, patience, and financial stability characterize this pool of "retreads." They are generally motivated and independent learners inclined to perform high-quality work. These are perfect candidates for the horological trades and the adult oriented education offerings of AWI.

The existing pool of horologists would seem to be dominated (numerically) by clockmakers. Further, there is a very broad range of competence that includes many full-time and part-time professionals whose work, most would agree, is substandard.

Very generally, those currently working in the horological trades are resistant to technological innovation and are known to resist spending the money required to obtain the equipment needed to properly perform their jobs. This probably indicates weak business skills.

Many in the trade have observed that independent horologists tend to undercharge for their work. The combination of limited competence, lack of equipment, and weak business skills is probably linked to lack of confidence that leads independent horologists to undercharge for their work.

The Competition: There is only one organization within the United States that can be viewed as competition for AWI, the NAWCC. Very recently, the NAWCC has offered a formal education program in the horological crafts. While these programs were initially characterized as somewhat amateurish; and they are, in fact, currently directed to nonprofessionals and collectors, it would be a mistake to assume the NAWCC is not committed to establishing world-class horological educational offerings. This organization has the financial resources to build such a program.

Also, while AWI has only recently (begrudgingly) welcomed clockmakers into the organization, that group has been the strongest draw of the NAWCC. It is probably no accident that the strongest efforts in improving their educational program is directed at courses of interest to clockmakers.

However, this concern must be tempered by the recognition that AWI offers the *only* recognized certification program; and that the NAWCC Director of Education; and the museum Conservator were both chosen because of their AWI certifications. In addition, AWI is the place where full-time horological schools meet.

Having said all that, it must be recognized that the NAWCC is a formidable and serious potential competitor. While there is nothing that precludes membership in both organizations, AWI must establish why membership is relevant to nonprofessional craftspersons, and AWI must not lose ground in its educational and certification offerings.

Resources Available to AWI

Financial. AWI can derive financial support from at least three sources: organizational income-producing activities, donations from individuals, and donations from industry.

The income-producing activities include: a) dues, b) book sales, c) advertising, d) accessory sales (memorabilia), e) courses, f) certifications, g) videotape sales and the ELM Trust. In addition, AWI could possibly make various facilities available to outside groups as an income-producing activity.

AWI does not actively seek monetary donations from individuals and industry. Yet, as an educational not-for-profit organization, donations to the AWI-ELM Trust can carry tax benefits to the donor. This should be explored.

Communications. In addition to the *Horological Times*, Seminars and Bench Courses, AWI has the Internet available as a communications device. While the traditional communication routes are important (in fact, to some members the *Horological Times* is the AWI), the use of the Internet offers important advantages that are not easily achieved by the traditional routes.

The most obvious is that a professional Internet Web Page, announced to the myriad of search engines employed by Internet users, is an extremely cost-effective way to let the world know what AWI is. It should be a primary point for attracting new members.

Beyond that, course announcements and registration could easily be accomplished via a Web page. While every service organization fantasizes about allowing members to access library and reference material via a web page, copyright issues and transcription costs usually limit a Web page's usefulness to administrative functions. *But*, that is a very powerful function.

In addition, the Internet could provide a low-cost, highly effective way to provide long distance learning and technical support. At very little cost, mail lists (small groups of people who discuss things on the Internet) could be established for specific kinds of instruction. In addition, anything that can be photographed can be loaded almost instantaneously to the Web Page for access by those in "class" mail lists. Further, the instructors can work from their home. All they need is permission to send things to the Web Page.

Physical Plant. AWI has a modern, well-equipped physical plant. While staff knowledge in their use is limited, AWI does have nine Pentium computers. Thus, AWI is well-positioned to take advantage of the Internet and to create data systems that support management decision making.

It should be noted that the current use of the computers at AWI for record storage and retrieval is appalling. This goes hand in hand with the lack of a data system that supports management decision making. In crass terms, AWI currently owns a very expensive mail label maker. The computer systems are currently useless for tracking individual participation in AWI courses, certification or anything else. It is also impossible to use the computers to determine how many members have attended any given course. ***This must be rectified.***

AWI has two up-to-date classrooms well equipped for the horological education. AWI has purchased excellent equipment that clearly demonstrates to students the need for good equipment. However, only one classroom is used to its capacity. Attempts should be made to increase the use of the second classroom.

The video studio built by AWI, while not state of the art, is adequate for the production of the learning materials needed by AWI. It has been suggested that an attempt be made to find ways to generate income from this studio. That suggestion should be explored; but AWI's use of the studio should not be compromised.

Office Staff. The staff of AWI is among its most prized assets. As noted elsewhere, the office staff are extremely service oriented, and their long tenure make them knowledgeable of the needs and concerns of the membership. However, they are not very skilled at using computers to their full advantage, and they may lack the desire to learn about computers beyond the knowledge required to perform their routine tasks.

AWI has the benefit of an Executive Director who is knowledgeable and skillful in the operation of a member-oriented association. He has already installed financial controls and has worked with the Board of Directors to improve the management of AWI. However, he is not a craftsperson and cannot be looked upon as a technical resource.

Fortunately, AWI has a WOSTEP-trained Education and Technical Director. He is responsible for the coordination of AWI educational activities. He is also the primary instructor of the AWI Academy. The amount of time he has available to provide

Continued on page 59.



Oro Logics II: The Aurum Perspectives

Ring Size Tables of the U.S. Standard

Peter J. Kinberger,
Goldsmith

As mentioned in the previous installment of Oro Logics II, ring size tables are important to the work of jewelry makers and repair technicians.

It would be helpful to consider that the tables and accompanying information relevant to their calculation are very real tools. Accurate tables are as much of a necessity as mandrels, gauges, etc., used in bench operations the world over.

When rolling or ordering shank stock, information from ring size tables are used to secure an appropriate amount of materiel for ring construction and/or shank replacements.

Ring size tables are also used to check the calibration of sizing tools as a means of assuring accuracy.

Finally, the means by which a ring measurement can be calculated is important to remember in the potential event that the tables are misplaced or lost.

In this installment, the U.S. Standard tables will be presented. The next installment will concentrate on the Euro-American Standard. It is important to remember that the E.A. or Euro-American Standard is a term created by this goldsmith to delineate the metric interpretation of the U.S. Standard from the actual inch fraction rule that the standard is based on.

Due to the relevance of the metric system in American metalsmith work, the inch fraction of the U.S. Standard will be converted into millimeters. There is a significant difference between the U.S. and the E.A. Standards as expressed in millimeters. This will become obvious when the E.A. Standard tables are published in the next Oro Logics II installment, then compared.

The Exhaustive Ring Size Tables of the U.S. Standard

Inside Diameters

The inside diameter of a circle is measured by using a line to divide a circle into two equal halves. The length of this dividing line is measured, end to end, where each end touches the inside of the circle.

The inch fraction calculations of the U.S. Standard begin from the initial measurement of .010". The consecutive addition of .032" begins at this point and continues to size 0. At size 0 eighth size measurements begin and are represented by adding .004" consecutively, throughout the table.

Quarter size measurements are calculated at .008" increments and half sizes are calculated at .016". These increments reflect a calculable equidistance of a specific whole size and are consistent throughout the entire table, unlike many extant tables.

Moving laterally across the table to the next column, inch fractions are converted into millimeters to arrive at the metric inside diameter equivalents. This process begins by dividing each and every inch fraction number by .03937, the conversion factor, for translation into millimeters.

Incidentally, though impossible to publish with the tables, the outside diameter of a circle is calculated by dividing a circle of a specific thickness and measuring the dividing line, end to end, from outer wall to outer wall - not the inside walls. Another means by which this can be accomplished is to measure the wall thickness and multiply by

2, then add the length of the inner diameter line to it. This is an important factor when, for instance, one chooses to make a bi-color or bi-metal wedding band where a thinner band of one color is to be place on the outside of a much wider band as a design feature.

Multiplying the outer diameter by 3.14159 (Pi) will establish the outer circumference of a ring. If the inner diameter of another ring is calculated by 3.14159, without the thickness times 2 the inside of such ring will match the outside of the other. Light filing or sanding will refine the fit for easier placement of one ring atop another.

Inner Circumference

Moving laterally across to the next column, to the inner circumference, the measurement of the inside circle of a ring can be found to correspond to a specific ring size measurement.

To arrive at the inner circumference of a ring, the inside diameter is multiplied by 3.14159, the product will be the length of a circle from beginning to end.

Incidentally, a short cut going directly from the inch fraction diameter column to the inside circumference can be had by multiplying the inch fraction number by 79.797 to establish the inside circumference in millimeters. To reverse the process, one can convert the metric inner circumference back to inch fraction diameter by dividing the inner circumference by 79.797. This can also serve as a check in calculation.

Ring Blank Sizes

The length of a ring blank is calculated according to the measurement of inner circumferences plus the addition of a given factor corresponding to a certain gauge of shank material.

Simply adding 1.57 to 39.10 will provide the length needed for 24-gauge shank stock to be made into a size one band. Adding 1.88 to 39.10 will provide the necessary length of 22-gauge material needed and so on.

Columns are provided all the way to 12-gauge material with the add-on factor of 6.60.

To these add-on factors .5 mm is added for rings larger than 4 mm in width. This helps control stretch and shrink factors when bending blanks round. This goldsmith usually adds a little extra anyway, adding 2-4 mm depending on widths and thicknesses.

Finally, these calculations work universally for both the U.S. Standard tables and the E.A. Standard tables.

Both tables have the same format for ease of use.

For the Ring Size Table of the U.S. Standard see pages 54-58.

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Ring Size Tables of the U.S. Standard

Ring Size	Begin Calculation +.032	÷.03937	×3.14159	Add .5 mm if wider than 4 mm. +1.57	+1.88	+2.51	+3.14	+4.08	+5.03	+6.60
	.010									
	.042	1.07	3.35							
	.074	1.88	5.90							
	.106	2.69	8.46							
	.138	3.50	11.01							
	.170	4.32	13.56							
	.202	5.13	16.12							
	.234	5.94	18.67							
	.266	6.76	21.22							
	.298	7.57	23.78							
	.330	8.38	26.33							
	.362	9.19	28.89							
000	.394	10.01	31.44	33.01	33.32	33.95	34.58	35.52	36.47	38.04
00	.426	10.82	33.99	35.56	35.87	36.50	37.13	38.07	39.02	40.59
0	.458	11.63	36.55	38.12	38.43	39.06	39.69	40.63	41.58	43.15
1/8	.462	11.73	36.87	38.44	38.75	39.38	40.01	40.95	41.90	43.47
1/4	.466	11.84	37.18	38.75	39.06	39.69	40.32	41.26	42.21	43.78
3/8	.470	11.94	37.50	39.07	39.38	40.01	40.64	41.58	42.53	44.10
1/2	.474	12.04	37.82	39.39	39.70	40.33	40.96	41.90	42.85	44.42
5/8	.478	12.14	38.14	39.71	40.02	40.65	41.28	42.22	43.17	44.74
3/4	.482	12.24	38.46	40.03	40.34	40.97	41.60	42.54	43.49	45.06
7/8	.486	12.34	38.78	40.35	40.66	41.29	41.92	42.86	43.81	45.38
1	.490	12.45	39.10	40.67	40.98	41.61	42.24	43.18	44.13	45.70
1-1/8	.494	12.55	39.42	40.99	41.30	41.93	42.56	43.50	44.45	46.02
1-1/4	.498	12.65	39.74	41.31	41.62	42.25	42.88	43.82	44.77	46.34
1-3/8	.502	12.75	40.06	41.63	41.94	42.57	43.20	44.14	45.09	46.66
1-1/2	.506	12.85	40.38	41.95	42.26	42.89	43.52	44.46	45.41	46.98
1-5/8	.510	12.95	40.70	42.27	42.58	43.21	43.84	44.78	45.73	47.30
1-3/4	.514	13.06	41.01	42.58	42.89	43.52	44.15	45.09	46.04	47.61
1-7/8	.518	13.16	41.33	42.90	43.21	43.84	44.47	45.41	46.36	47.93
2	.522	13.26	41.65	43.22	43.53	44.16	44.79	45.73	46.68	48.25
2-1/8	.526	13.36	41.97	43.54	43.85	44.48	45.11	46.05	47.00	48.57
2-1/4	.530	13.46	42.29	43.86	44.17	44.80	45.43	46.37	47.32	48.89
2-3/8	.534	13.56	42.61	44.18	44.49	45.12	45.75	46.69	47.64	49.21
2-1/2	.538	13.66	42.93	44.50	44.81	45.44	46.07	47.01	47.96	49.53
2-5/8	.542	13.77	43.25	44.82	45.13	45.76	46.39	47.33	48.28	49.85
2-3/4	.546	13.87	43.57	45.14	45.45	46.08	46.71	47.65	48.60	50.17
2-7/8	.550	13.97	43.89	45.46	45.77	46.40	47.03	47.97	48.92	50.49
3	.554	14.07	44.21	45.78	46.09	46.72	47.35	48.29	49.24	50.81
3-1/8	.558	14.17	44.53	46.10	46.41	47.04	47.67	48.61	49.56	51.13
3-1/4	.562	14.27	44.84	46.41	46.72	47.35	47.98	48.92	49.87	51.44
3-3/8	.566	14.38	45.16	46.73	47.04	47.67	48.30	49.24	50.19	51.76
3-1/2	.570	14.48	45.48	47.05	47.36	47.99	48.62	49.56	50.51	52.08
3-5/8	.574	14.58	45.80	47.37	47.68	48.31	48.94	49.88	50.83	52.40
3-3/4	.578	14.68	46.12	47.69	48.00	48.63	49.26	50.20	51.15	52.72
3-7/8	.582	14.78	46.44	48.01	48.32	48.95	49.58	50.52	51.47	53.04

	Inner Diameter in Inch Fraction	Inner Diameter in mm	Inner Circumference in mm	24 0.5 mm	22 0.6 mm	20 0.8 mm	18 1 mm	16 1.3 mm	14 1.6 mm	12 2.1 mm
							Gauges			
							Ring Blank Lengths			

Ring Size Tables of the U.S. Standard

Ring Size	Begin Calculation +.032	÷.03937	×3.14159	Add .5 mm if wider than 4 mm. +1.57	+1.88	+2.51	+3.14	+4.08	+5.03	+6.60
4	.586	14.88	46.76	48.33	48.64	49.27	49.90	50.84	51.79	53.36
4-1/8	.590	14.99	47.08	48.65	48.96	49.59	50.22	51.16	52.11	53.68
4-1/4	.594	15.09	47.40	48.97	49.28	49.91	50.54	51.48	52.43	54.00
4-3/8	.598	15.19	47.72	49.29	49.60	50.23	50.86	51.80	52.75	54.32
4-1/2	.602	15.29	48.04	49.61	49.92	50.55	51.18	52.12	53.07	54.64
4-5/8	.606	15.39	48.36	49.93	50.24	50.87	51.50	52.44	53.39	54.96
4-3/4	.610	15.49	48.67	50.24	50.55	51.18	51.81	52.75	53.70	55.27
4-7/8	.614	15.59	48.99	50.56	50.87	51.50	52.13	53.07	54.02	55.59
5	.618	15.70	49.31	50.88	51.19	51.82	52.45	53.39	54.34	55.91
5-1/8	.622	15.80	49.63	51.20	51.51	52.14	52.77	53.71	54.66	56.23
5-1/4	.626	15.90	49.95	51.52	51.83	52.46	53.09	54.03	54.98	56.55
5-3/8	.630	16.00	50.27	51.84	52.15	52.78	53.41	54.35	55.30	56.87
5-1/2	.634	16.10	50.59	52.16	52.47	53.10	53.73	54.67	55.62	57.19
5-5/8	.638	16.20	50.91	52.48	52.79	53.42	54.05	54.99	55.94	57.51
5-3/4	.642	16.31	51.23	52.80	53.11	53.74	54.37	55.31	56.26	57.83
5-7/8	.646	16.41	51.55	53.12	53.43	54.06	54.69	55.63	56.58	58.15
6	.650	16.51	51.87	53.44	53.75	54.38	55.01	55.95	56.90	58.47
6-1/8	.654	16.61	52.19	53.76	54.07	54.70	55.33	56.27	57.22	58.79
6-1/4	.658	16.71	52.51	54.08	54.39	55.02	55.65	56.59	57.54	59.11
6-3/8	.662	16.81	52.82	54.39	54.70	55.33	55.96	56.90	57.85	59.42
6-1/2	.666	16.92	53.14	54.71	55.02	55.65	56.28	57.22	58.17	59.74
6-5/8	.670	17.02	53.46	55.03	55.44	55.97	56.60	57.54	58.49	60.06
6-3/4	.674	17.12	53.78	55.35	55.66	56.29	56.92	57.86	58.81	60.38
6-7/8	.678	17.22	54.10	55.67	55.98	56.61	57.24	58.18	59.13	60.70
7	.682	17.32	54.42	55.99	56.30	56.93	57.56	58.50	59.45	61.02
7-1/8	.686	17.42	54.74	56.31	56.62	57.25	57.88	58.82	59.77	61.34
7-1/4	.690	17.53	55.06	56.63	56.94	57.57	58.20	59.14	60.09	61.66
7-3/8	.694	17.63	55.38	56.95	57.26	57.89	58.52	59.46	60.41	61.98
7-1/2	.698	17.73	55.70	57.27	57.58	58.21	58.84	59.78	60.73	62.30
7-5/8	.702	17.83	56.02	57.59	57.90	58.53	59.16	60.10	61.05	62.62
7-3/4	.706	17.93	56.34	57.91	58.22	58.85	59.48	60.42	61.37	62.94
7-7/8	.710	18.03	56.65	58.22	58.33	59.16	59.79	60.73	61.68	63.25
8	.714	18.13	56.97	58.54	58.85	59.48	60.11	61.05	62.00	63.57
8-1/8	.718	18.24	57.29	58.86	59.17	59.80	60.43	61.37	62.32	63.89
8-1/4	.722	18.34	57.61	59.18	59.49	60.12	60.75	61.69	62.64	64.21
8-3/8	.726	18.44	57.93	59.50	59.81	60.44	61.07	62.01	62.96	64.53
8-1/2	.730	18.54	58.25	59.82	60.13	60.76	61.39	62.33	63.28	64.85
8-5/8	.734	18.64	58.57	60.14	60.45	61.08	61.71	62.65	63.60	65.17
8-3/4	.738	18.74	58.89	60.46	60.77	61.40	62.03	62.97	63.92	65.49
8-7/8	.742	18.85	59.21	60.78	61.09	61.72	62.35	63.29	64.24	65.81
9	.746	18.95	59.53	61.10	61.41	62.04	62.67	63.61	64.56	66.13
9-1/8	.750	19.05	59.85	61.42	61.73	62.36	62.99	63.93	64.88	66.45
9-1/4	.754	19.15	60.17	61.74	62.05	62.68	63.31	64.25	65.20	66.77
9-3/8	.758	19.25	60.48	62.05	62.36	62.99	63.62	64.56	65.51	67.08
9-1/2	.762	19.35	60.80	62.37	62.68	63.31	63.94	64.88	65.83	67.40
9-5/8	.766	19.46	61.12	62.69	63.00	63.63	64.26	65.20	66.15	67.72
	Inner Diameter in Inch Fraction	Inner Diameter in mm	Inner Circumference in mm	24 Gauges 0.5 mm Ring Blank Lengths	22 0.6 mm	20 0.8 mm	18 1 mm	16 1.3 mm	14 1.6 mm	12 2.1 mm

Ring Size Tables of the U.S. Standard

Ring Size	Begin Calculation +.032	÷.03937	×3.14159	Add .5 mm if wider than 4 mm. +1.57	+1.88	+2.51	+3.14	+4.08	+5.03	+6.60
9-3/4	.770	19.56	61.44	63.01	63.32	63.95	64.58	65.52	66.47	68.04
9-7/8	.774	19.66	61.76	63.33	63.64	64.27	64.90	65.84	66.79	68.36
10	.778	19.76	62.08	63.65	63.96	64.59	65.22	66.16	67.11	68.68
10-1/8	.782	19.86	62.40	63.97	64.28	64.91	65.54	66.48	67.43	69.00
10-1/4	.786	19.96	62.72	64.29	64.60	65.23	65.86	66.80	67.75	69.32
10-3/8	.790	20.07	63.04	64.61	64.92	65.55	66.18	67.12	68.07	69.64
10-1/2	.794	20.17	63.36	64.93	65.24	65.87	66.50	67.44	68.39	69.96
10-5/8	.798	20.27	63.68	65.25	65.56	66.19	66.82	67.76	68.71	70.28
10-3/4	.802	20.37	64.00	65.57	65.88	66.51	67.14	68.08	69.03	70.60
10-7/8	.806	20.47	64.32	65.89	66.20	66.83	67.46	68.40	69.35	70.92
11	.810	20.57	64.63	66.20	66.51	67.14	67.77	68.71	69.66	71.23
11-1/8	.814	20.67	64.95	66.52	66.83	67.46	68.09	69.03	69.98	71.55
11-1/4	.818	20.78	65.27	66.84	67.15	67.78	68.41	69.35	70.30	71.87
11-3/8	.822	20.88	65.59	67.16	67.47	68.10	68.73	69.67	70.62	72.19
11-1/2	.826	20.98	65.91	67.48	67.79	68.42	69.05	69.99	70.94	72.51
11-5/8	.830	21.08	66.23	67.80	68.11	68.74	69.37	70.31	71.26	72.83
11-3/4	.834	21.18	66.55	68.12	68.43	69.06	69.69	70.63	71.58	73.15
11-7/8	.838	21.28	66.87	68.44	68.75	69.38	70.01	70.95	71.90	73.47
12	.842	21.39	67.19	68.76	69.07	69.70	70.33	71.27	72.22	73.79
12-1/8	.846	21.49	67.51	69.08	69.39	70.02	70.65	71.59	72.54	74.11
12-1/4	.850	21.59	67.83	69.40	69.71	70.34	70.97	71.91	72.86	74.43
12-3/8	.854	21.69	68.15	69.72	70.03	70.66	71.29	72.23	73.18	74.75
12-1/2	.858	21.79	68.46	70.03	70.34	70.97	71.60	72.54	73.49	75.06
12-5/8	.862	21.89	68.78	70.35	70.66	71.29	71.92	72.86	73.81	75.38
12-3/4	.866	22.00	69.10	70.67	70.98	71.61	72.24	73.18	74.13	75.70
12-7/8	.870	22.10	69.42	70.99	71.30	71.93	72.56	73.50	74.45	76.02
13	.874	22.20	69.74	71.31	71.62	72.25	72.88	73.82	74.77	76.34
13-1/8	.878	22.30	70.06	71.63	71.94	72.57	73.20	74.14	75.09	76.66
13-1/4	.882	22.40	70.38	71.95	72.26	72.89	73.52	74.46	75.41	76.98
13-3/8	.886	22.50	70.70	72.27	72.58	73.21	73.84	74.78	75.73	77.30
13-1/2	.890	22.61	71.02	72.59	72.90	73.53	74.16	75.10	76.05	77.62
13-5/8	.894	22.71	71.34	72.91	73.22	73.85	74.48	75.42	76.37	77.94
13-3/4	.898	22.81	71.66	73.23	73.54	74.17	74.80	75.74	76.69	78.26
13-7/8	.902	22.91	71.98	73.55	73.86	74.49	75.12	76.06	77.01	78.58
14	.906	23.01	72.29	73.86	74.17	74.80	75.43	76.37	77.32	78.89
14-1/8	.910	23.11	72.61	74.18	74.49	75.12	75.75	76.69	77.64	79.21
14-1/4	.914	23.21	72.93	74.50	74.81	75.44	76.07	77.01	77.96	79.53
14-3/8	.918	23.32	73.25	74.82	75.13	75.76	76.39	77.33	78.28	79.85
14-1/2	.922	23.42	73.57	75.14	75.45	76.08	76.71	77.65	78.60	80.17
14-5/8	.926	23.52	73.89	75.46	75.77	76.40	77.03	77.97	78.92	80.49
14-3/4	.930	23.62	74.21	75.78	76.09	76.72	77.35	78.29	79.24	80.81
14-7/8	.934	23.72	74.53	76.10	76.41	77.04	77.67	78.61	79.56	81.13
15	.938	23.82	74.85	76.42	76.73	77.36	77.99	78.93	79.88	81.45
15-1/8	.942	23.93	75.17	76.74	77.05	77.68	78.31	79.25	80.20	81.77
15-1/4	.946	24.03	75.49	77.06	77.37	78.00	78.63	79.57	80.52	82.09
15-3/8	.950	24.13	75.81	77.38	77.69	78.32	78.95	79.89	80.84	82.41
	Inner Diameter in Inch Fraction	Inner Diameter in mm	Inner Circumference in mm	24 0.5 mm	22 0.6 mm	20 0.8 mm	18 1 mm	16 1.3 mm	14 1.6 mm	12 2.1 mm
							Gauges			
							Ring Blank Lengths			

Ring Size Tables of the U.S. Standard

Ring Size	Begin Calculation +.032	+.03937	×3.14159	Add .5 mm if wider than 4 mm. +1.57	+1.88	+2.51	+3.14	+4.08	+5.03	+6.60
15-1/2	.954	24.23	76.12	77.69	78.00	78.63	79.26	80.20	81.15	82.72
15-5/8	.958	24.33	76.44	78.01	78.32	78.95	79.58	80.52	81.47	83.04
15-3/4	.962	24.43	76.76	78.33	78.64	79.27	79.90	80.84	81.79	83.36
15-7/8	.966	24.54	77.08	78.65	78.96	79.59	80.22	81.16	82.11	83.68
16	.970	24.64	77.40	78.97	79.28	79.91	80.54	81.48	82.43	84.00
16-1/8	.974	24.74	77.72	79.29	79.60	80.23	80.86	81.80	82.75	84.32
16-1/4	.978	24.84	78.04	79.61	79.92	80.55	81.18	82.12	83.07	84.64
16-3/8	.982	24.94	78.36	79.93	80.24	80.87	81.50	82.44	83.39	84.96
16-1/2	.986	25.04	78.68	80.25	80.56	81.19	81.82	82.76	83.71	85.28
16-5/8	.990	25.15	79.00	80.57	80.88	81.51	82.14	83.08	84.03	85.60
16-3/4	.994	25.25	79.32	80.89	81.20	81.83	82.46	83.40	84.35	85.92
16-7/8	.998	25.35	79.64	81.21	81.52	82.15	82.78	83.72	84.67	86.24
17	1.002	25.45	79.96	81.53	81.84	82.47	83.10	84.04	84.99	86.56
17-1/8	1.006	25.55	80.27	81.84	82.15	82.78	83.41	84.35	85.30	86.87
17-1/4	1.010	25.65	80.59	82.16	82.47	83.10	83.73	84.67	85.62	87.19
17-3/8	1.014	25.75	80.91	82.48	82.79	83.42	84.05	84.99	85.94	87.51
17-1/2	1.018	25.86	81.23	82.80	83.11	83.74	84.37	85.31	86.26	87.83
17-5/8	1.022	25.96	81.55	83.12	83.43	84.06	84.69	85.63	86.58	88.15
17-3/4	1.026	26.06	81.87	83.44	83.75	84.38	85.01	85.95	86.90	88.47
17-7/8	1.030	26.16	82.19	83.76	84.07	84.70	85.33	86.27	87.22	88.79
18	1.034	26.26	82.51	84.08	84.39	85.02	85.65	86.59	87.54	89.11
18-1/8	1.038	26.36	82.83	84.40	84.71	85.34	85.97	86.91	87.86	89.43
18-1/4	1.042	26.47	83.15	84.72	85.03	85.66	86.29	87.23	88.18	89.75
18-3/8	1.046	26.57	83.47	85.04	85.35	85.98	86.61	87.55	88.50	90.07
18-1/2	1.050	26.67	83.79	85.36	85.67	86.30	86.93	87.87	88.82	90.39
18-5/8	1.054	26.77	84.10	85.67	85.98	86.61	87.24	88.18	89.13	90.70
18-3/4	1.058	26.87	84.42	85.99	86.30	86.93	87.56	88.50	89.45	91.02
18-7/8	1.062	26.97	84.74	86.31	86.62	87.25	87.88	88.82	89.77	91.34
19	1.066	27.08	85.06	86.63	86.94	87.57	88.20	89.14	90.09	91.66
19-1/8	1.070	27.18	85.38	86.95	87.26	87.89	88.52	89.46	90.41	91.98
19-1/4	1.074	27.28	85.70	87.27	87.58	88.21	88.84	89.78	90.73	92.30
19-3/8	1.078	27.38	86.02	87.59	87.90	88.53	89.16	90.10	91.05	92.62
19-1/2	1.082	27.48	86.34	87.91	88.22	88.85	89.48	90.42	91.37	92.94
19-5/8	1.086	27.58	86.66	88.23	88.54	89.17	89.80	90.74	91.69	93.26
19-3/4	1.090	27.69	86.98	88.55	88.86	89.49	90.12	91.06	92.01	93.58
19-7/8	1.094	27.79	87.30	88.87	89.18	89.81	90.44	91.38	92.33	93.90
20	1.098	27.89	87.62	89.19	89.50	90.13	90.76	91.70	92.65	94.22
20-1/8	1.102	27.99	87.93	89.50	89.81	90.44	91.07	92.01	92.96	94.53
20-1/4	1.106	28.09	88.25	89.82	90.13	90.76	91.39	92.33	93.28	94.85
20-3/8	1.110	28.19	88.57	90.14	90.45	91.08	91.71	92.65	93.60	95.17
20-1/2	1.114	28.29	88.89	90.46	90.77	91.40	92.03	92.97	93.92	95.49
20-5/8	1.118	28.40	89.21	90.78	91.09	91.72	92.35	93.29	94.24	95.81
20-3/4	1.122	28.50	89.53	91.10	91.41	92.04	92.67	93.61	94.56	96.13
20-7/8	1.126	28.60	89.85	91.42	91.73	92.36	92.99	93.93	94.88	96.45
21	1.130	28.70	90.17	91.74	92.05	92.68	93.31	94.25	95.20	96.77
21-1/8	1.134	28.80	90.49	92.06	92.37	93.00	93.63	94.57	95.52	97.09
	Inner Diameter in Inch Fraction	Inner Diameter in mm	Inner Circumference in mm	24 0.5 mm	22 0.6 mm	20 0.8 mm	18 1 mm	16 1.3 mm	14 1.6 mm	12 2.1 mm
				Gauges Ring Blank Lengths						

Ring Size Tables of the U.S. Standard

Ring Size	Begin Calculation +.032	÷.03937	×3.14159	Add .5 mm if wider than 4 mm. +1.57	+1.88	+2.51	+3.14	+4.08	+5.03	+6.60
21-1/4	1.138	28.90	90.81	92.38	92.69	93.32	93.95	94.89	95.84	97.41
21-3/8	1.142	29.01	91.13	92.70	93.01	93.64	94.27	95.21	96.16	97.73
21-1/2	1.146	29.11	91.45	93.02	93.33	93.96	94.59	95.53	96.48	98.05
21-5/8	1.150	29.21	91.77	93.34	93.65	94.28	94.91	95.85	96.80	98.37
21-3/4	1.154	29.31	92.08	93.65	93.96	94.59	95.22	96.16	97.11	98.68
21-7/8	1.158	29.41	92.40	93.97	94.28	94.91	95.54	96.48	97.43	99.00
22	1.162	29.51	92.72	94.29	94.60	95.23	95.86	96.80	97.75	99.32
22-1/8	1.166	29.62	93.04	94.61	94.92	95.55	96.18	97.12	98.07	99.64
22-1/4	1.170	29.72	93.36	94.93	95.24	95.87	96.50	97.44	98.39	99.96
22-3/8	1.174	29.82	93.68	95.25	95.56	96.19	96.82	97.76	98.71	100.28
22-1/2	1.178	29.92	94.00	95.57	95.88	96.51	97.14	98.08	99.03	100.60
22-5/8	1.182	30.02	94.32	95.89	96.20	96.83	97.46	98.40	99.35	100.92
22-3/4	1.186	30.12	94.64	96.21	96.52	97.15	97.78	98.72	99.67	101.24
22-7/8	1.190	30.23	94.96	96.53	96.84	97.47	98.10	99.04	99.99	101.56
23	1.194	30.33	95.28	96.85	97.16	97.79	98.42	99.36	100.31	101.88
23-1/8	1.198	30.43	95.60	97.17	97.48	98.11	98.74	99.68	100.63	102.20
23-1/4	1.202	30.53	95.91	97.48	97.79	98.42	99.05	99.99	100.94	102.51
23-3/8	1.206	30.63	96.23	97.80	98.11	98.74	99.37	100.31	101.26	102.83
23-1/2	1.210	30.73	96.55	98.12	98.43	99.06	99.69	100.63	101.58	103.15
23-5/8	1.214	30.83	96.87	98.44	98.75	99.38	100.01	100.95	101.90	103.47
23-3/4	1.218	30.94	97.19	98.76	99.07	99.70	100.33	101.27	102.22	103.79
23-7/8	1.222	31.04	97.51	99.08	99.39	100.02	100.65	101.59	102.54	104.11
24	1.226	31.14	97.83	99.40	99.71	100.34	100.97	101.91	102.86	104.43
24-1/8	1.230	31.24	98.15	99.72	100.03	100.66	101.29	102.23	103.18	104.75
24-1/4	1.234	31.34	98.47	100.04	100.35	100.98	101.61	102.55	103.50	105.07
24-3/8	1.238	31.44	98.79	100.36	100.67	101.30	101.93	102.87	103.82	105.39
24-1/2	1.242	31.55	99.11	100.68	100.99	101.62	102.25	103.19	104.14	105.71
24-5/8	1.246	31.65	99.43	101.00	101.31	101.94	102.57	103.51	104.46	106.08
24-3/4	1.250	31.75	99.74	101.31	101.62	102.25	102.88	103.82	104.77	106.34
24-7/8	1.254	31.85	100.06	101.63	101.94	102.57	103.20	104.14	105.09	106.66
25	1.258	31.95	100.38	101.95	102.26	102.89	103.52	104.46	105.41	106.98
25-1/8	1.262	32.05	100.70	102.27	102.58	103.21	103.84	104.78	105.73	107.30
25-1/4	1.266	32.16	101.02	102.59	102.90	103.53	104.16	105.10	106.05	107.62
25-3/8	1.270	32.26	101.34	102.91	103.22	103.85	104.48	105.42	106.37	107.94
25-1/2	1.274	32.36	101.66	103.23	103.54	104.17	104.80	105.74	106.69	108.26
25-5/8	1.278	32.46	101.98	103.55	103.86	104.49	105.12	106.06	107.01	108.58
25-3/4	1.282	32.56	102.30	103.87	104.18	104.81	105.44	106.38	107.33	108.90
25-7/8	1.286	32.66	102.62	104.19	104.50	105.13	105.76	106.70	107.65	109.22
26	1.290	32.77	102.94	104.51	104.82	105.45	106.08	107.02	107.97	109.54

	Inner Diameter in Inch Fraction	Inner Diameter in mm	Inner Circumference in mm	24 0.5 mm	22 0.6 mm	20 0.8 mm	18 1 mm	16 1.3 mm	14 1.6 mm	12 2.1 mm
							Gauges			
							Ring Blank Lengths			

Continued from page 51.

technical assistance to individual members is limited.

Members. AWI is fortunate to have a cadre of members who are committed to providing the volunteer effort required to make AWI work. The Board of Directors, committee members, and many contributors to the *Horological Times* work on a volunteer basis. While instructors receive a stipend, that stipend does not even begin to compensate for time lost from their primary business activities. Virtually every essential member service relies on these volunteer efforts. It would be interesting to determine the value of these in-kind contributions.

Although the trade was characterized as marked by "knowledge protective" behaviors, AWI does include a cadre of members who actively share their knowledge and experience. The expertise available within this cadre is nothing short of breathtaking. There are a number of individuals who provide expertise on the handling of very rare timepieces; those who share their knowledge on construction; and others who share their knowledge on the use of tools that the uninformed consider esoteric and unnecessary.

This core of volunteers can continue to be relied upon; but every effort should be made to expand that core. As noted elsewhere, a barrier to potential volunteers has been difficulty in gaining access to those who can make use of their talents.

Industry. AWI has made good use of the watch industry as a resource. AWI has been successful in gaining industry support for the Watchmaking Academy, current production movements for use by AWI students, and technical service sheets for distribution to watchmakers.

However, perhaps due to ancient biases and interests, AWI has not developed the same relationships with the clock industry. If it is true that the AWI membership consists of a substantial number of clockmakers then this is very unfortunate. Indeed, if AWI is to attract clockmakers by offering services not available elsewhere, a strong relationship with the industry would seem essential.

Threats and Opportunities

Threats. In a strategic sense, the threats to AWI are primarily internal. While the NAWCC efforts in establishing an educational program is a significant threat to the future uniqueness and relevance of AWI, it is only a threat to the extent that AWI squanders that uniqueness and relevance.

As noted earlier, the NAWCC recognizes it has long been the organization of choice for those interested in clocks. It is aggressively pursuing the establishment of a world-class clockmaking educational program. If AWI allows that challenge to go unanswered, then AWI's membership will be unnecessarily limited to professional watchmakers.

It is the internal threats that are potentially the most damaging to AWI's future. The impact of "knowledge protective" behavior and non-welcoming of open participation have already been discussed. Membership apathy is also a problem. However, recent attention to increasing communication and opening participation in AWI activities may help to improve these concerns.

Restricted income and the subsequent reliance upon income from the Perpetuation Fund are serious business concerns.

Finally, and very importantly, the lack of the development of modern office technology to provide a record system that supports rational management decision making is a crucial barrier to managed change and growth. At the moment, AWI functions through "management by opinion." That is, in the absence of trustworthy data, management decisions must be made on the basis of personal knowledge or opinion. Not only is this a bad way to do business; but, it fosters an environment where personal alliances and "back room" deals become the norm. A modern record keeping and record retrieval system would allow data to be generated which would reduce the reliance on management by opinion.

Opportunities. While the threats are important considerations that must be managed, AWI's opportunities have never looked brighter. The growing number of retreads that is a result of the baby boom provides AWI with an expanding audience from which to attract members. AWI could capitalize on this audience by establishing links with military outplacement services and the AARP to name two easily accessible channels.

In addition, while the lack of AWI services for clockmakers is a threat, that also provides AWI with a new pool of potential members. By advertising in the NAWCC publications, and conducting mailings using NAWCC mailing lists, AWI can promote its services and benefits of membership very efficiently.

The Internet provides not only a way for AWI to promote benefits of membership to a greater audience at essentially no cost, but it also provides a mechanism for conducting instructional programs in a very cost-efficient manner. While not all instruction is conducive to long distance learning, much of the instruction AWI provides can be conducted via long distance learning via the Internet.

In addition, there are ever expanding niches for certification. For example, there may well be a need for CMC and CMW who are also knowledgeable of the documentation requirement and conservation policies of museums. This could be met through a certification program jointly developed by AWI and the American Institute of Conservation.

Next month: Goals and Implementation Strategies for 1998-2000.

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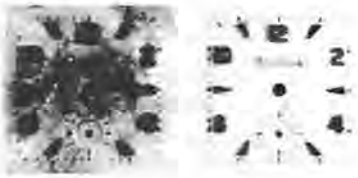
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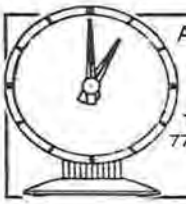
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DATE	CLASS	INSTRUCTOR	LOCATION	FEE
NOVEMBER 1998				
14-17	Phase I-Watchmakers Lathe/Clockmakers Micro Lathe	Roy Hovey	Fairfax, VA	$350.00
MARCH 1999				
19-22	Phase II - Watch/Clockmakers Lathe Program	Roy Hovey	Orange Cty.,CA	$350.00
JULY 1999				
17-20	Phase I - Watch/Clockmakers Lathe Program	Roy Hovey	Tampa, FL	$350.00

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DATE	CLASS	INSTRUCTOR	FEE
NOVEMBER 1998			
2-6	Calendar Mechanisms	Jim Lubic	$250.00
30-Dec. 4	21st Century Watchmaking	Jim Lubic	$250.00
JANUARY 1999			
19-22	Cross Slide for Watchmakers	Roy Hovey	$240.00
25-Feb.6	Lathe Operations for Watchmakers (12-day)	Roy Hovey	$780.00
FEBRUARY 1999			
8-12	Advanced Turning Between Centers	Ron DeCorte	$250.00
22-26	Chronograph Repair	Jim Lubic/Tamara Houk	$250.00
MARCH 1999			
8-12	Basic Electronics & Meter Reading	TBA	$250.00
APRIL 1999			
7-9	ETA Products	Remy Waelchli	$150.00
12-16	Advanced Quartz Watch Repair	Chip Lim	$250.00
19-23	Repair of the Bulova Accutron	Henry Frystak	$250.00
MAY 1999			
3-8	Phase IV - Wheel Cutting Operations for Watchmakers	Roy Hovey	$480.00
12-14	Shop Management	Fred Burckhardt	$150.00
JUNE 1999			
1-4	CEWT & CMEW Examinations	Jim Lubic	Exam Fee
7-11	CW & CMW Examinations	Jim Lubic	Exam Fee

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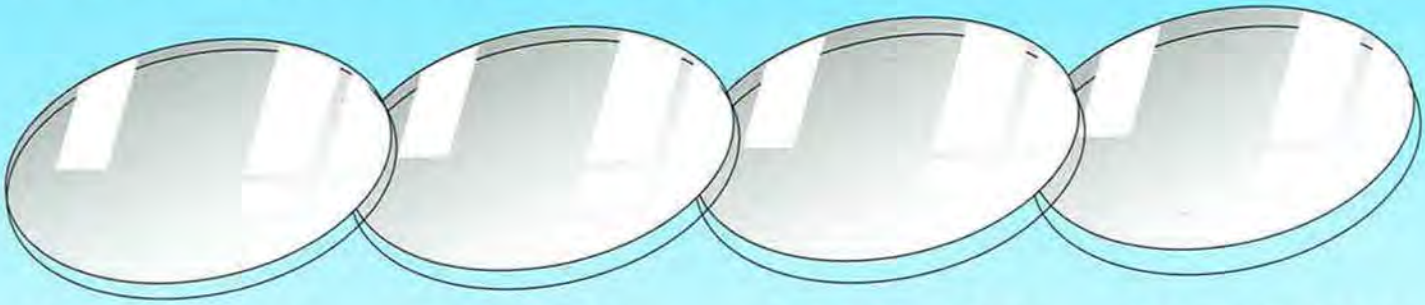
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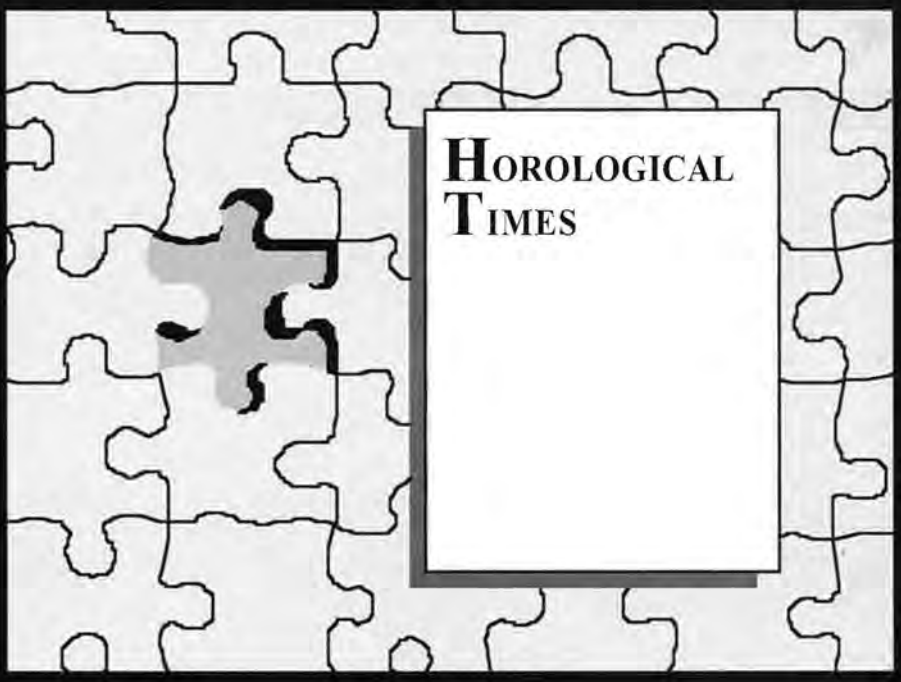
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