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COVER
This month's cover features a watch made by Ron DeCorte, CMW.



President's Message

By David A. Christianson

Each new year brings a chance for a fresh start with new opportunities, new chances and new hopes: a clean sheet upon which to write a new chapter in our lives and our work.

At the end of this month a number of our committees will have a chance to write a new chapter for AWI when they gather together at Headquarters to meet face to face with each other to work on their various committee assignments and objectives for the new year. Last year we tried this physical gathering of selected committees during the Mid-year Board of Directors Meeting and the results were impressive. Most noteworthy was the Strategic Planning Committee which was locked together in one room all day long to contemplate AWI: its makeup, its past and its future potential. From this very active meeting and subsequent long-distance work came the Report of The Strategic Planning Committee which you have read about in the last three issues of *Horological Times*.

The other committees that met were equally successful in their endeavors. So this year more committees will gather in one place at one time. Since June the committees have been actively working via long distance ... when brought together we hope for great things to come from their collective efforts as they concentrate together for the benefit of all the members of AWI.

To you and yours, here's wishing you a happy, healthy and successful New Year.



Executive Director's Message

By William J. Ewbank

Once again we have turned the calendar on a new year. It's 1999. I first learned how to address letters with a date back in the glorious 50s. Quite frankly, I find it hard to imagine that we are on the cusp of not only a new century, but a millennium! I suppose it will be a big deal for apocalyptic worriers and non-Y2K compliant computer owners. I rather suspect that once all the overwrought hoorah is over that things will seem pretty much the same as they were before.

Millennium or no, we still have pretty much the same concerns and same procedures. It is annual survey time. This year, we are requesting your feedback on how we are doing with the magazine. Please take the time to clip out pages 55-56 and complete the survey form. As in past years, all you need to do is to fold the survey so that the postage paid permit on the reverse side is visible and return it to AWI Headquarters. We really pay attention to your opinions and advice.

I would like to make a strong reminder to the membership that the AWI Academy is now taking applications for enrollment for the 1999-2000 school year. It is a big commitment for a young person to spend a year learning a new trade; but, consider the potential rewards. In the first two years of the Academy, AWI had graduation and placement rates of over ninety-two percent. This is a remarkable success story. One thing that is becoming very apparent is that there is a growing shortage of skilled watchmakers. Every member who I discuss the issue with is busy. Some members have even told me of their regrets when they turn away work because of their current backlogs. This is a good career that needs good new professionals. There is room in the AWI Academy or in the thirteen member schools of the Research and Education Council for far more students than we presently train. Formal education and graduation from a recognized school of horology is one of the keys to a successful career. For further information, visit the AWI website at awi-net.org or contact the education department at AWI Headquarters.

Happy New Year to all.

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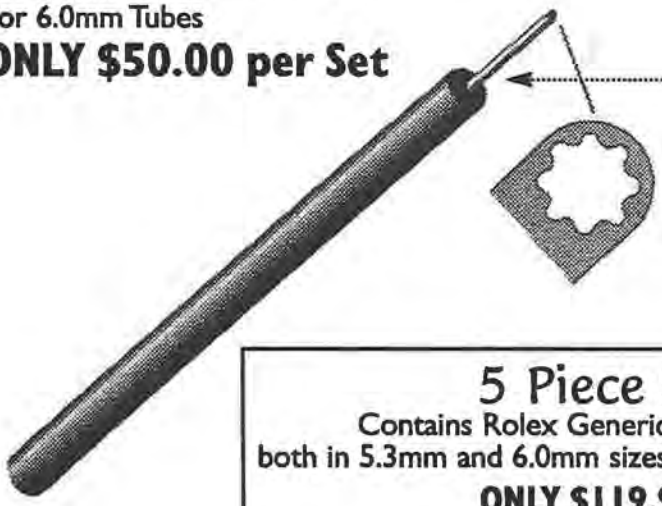
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Questions & Answers

Question

It is my hope to obtain some information regarding one of the old beauties I have received for repairs. It is an 8-day tall clock. There are no marks whatsoever to aid identification.

Its plate dimensions are H = 122 mm x W = 90 mm (4.80" x 3.54"). In addition to time, it strikes on the hour and half-hour. It also has ladder chains.

Other information:
61.73 beats/min.,
calculated from tooth count
0.972 sec./beat
37 inches P.L.

Any information you may supply will be appreciated. Is this piece from the United States or foreign? who might have been the manufacturer? Approximate date of manufacture? Approximately when did ladder chains cease to be used?

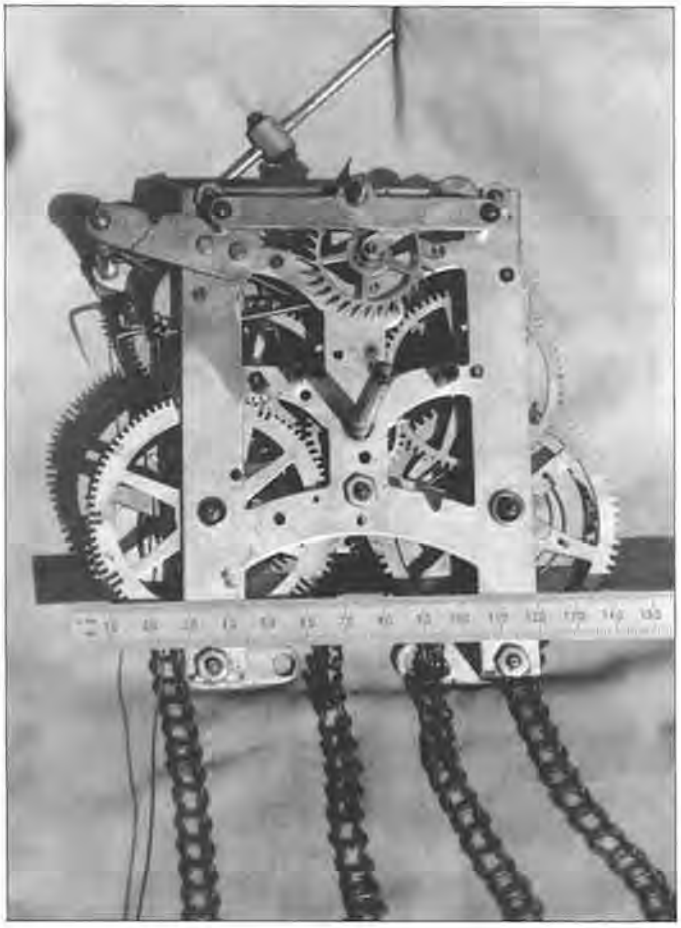
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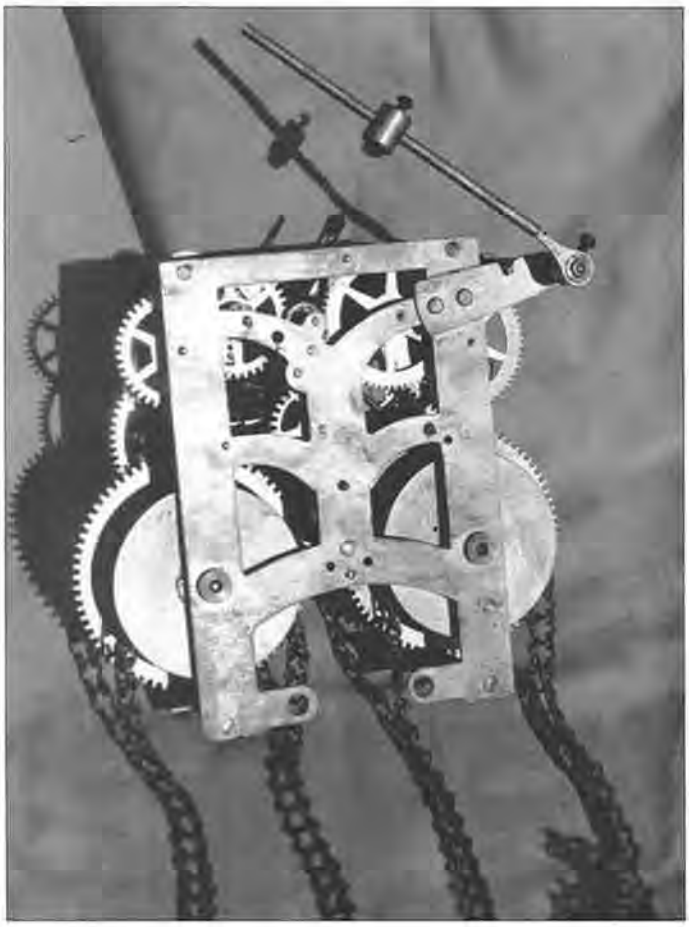
Answer

Your 8-day time and strike movement was made by the New Haven Clock Co. of New Haven, Connecticut, probably between 1900 and 1915. They made this movement as a weight-driven model like yours for floor clock cases, and a spring-driven model for mantle and table clock cases.

Interestingly enough, this movement was also used in conjunction with a separate chiming movement to create a Westminster chime clock. This separate movement, called a Wilcock Chimer, was patented by Stephen Wilcock of Toronto, Ontario, and manufactured by New Haven. The only connections between the two movements are the hour strike warning/release lever and the strike hammer which acts as the chime release lever.

David A. Christianson







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Ewell D. Hartman, CMW, FAWI

Battery of Information

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Is watch battery replacement all that important to your business? When I consider that over 11,000 customers came through the doors of our three stores in a year's time for watch batteries, the answer is obvious. These *paying* service department customers were also potential merchandise customers. *Batteries are big business* in more ways than one!

How can we give our battery customers better service than our competition does? How can we become known as *the* best place for watch battery replacement? Our reputation will be enhanced over a period of time when it becomes known that we have a *complete inventory*, we have the *proper equipment* to test and install batteries, and that our "*batteries last longer.*"

A major factor in how long a battery will last is the design and efficiency of the watch movement. All of us have had a customer ask that we put a "five-year battery" in their watch (because they have been confused by the advertising of some watch companies). My answer to this request is to use an analogy. "As you well know, we can't purchase 'fifty-miles-per-gallon' gasoline; primarily, it is the efficiency of the car that makes the difference. The same is true of watch batteries; the length of time the battery will last is normally dependent on the efficiency of the watch."

The *size* (dimensions) of the battery determines how much total energy it can supply; in this way it is similar to a reservoir. The *chemistry* of the battery determines the "energy density" (the amount of energy it will produce, relative to its volume). The *quality* of the battery seals and internal separator also contribute to the length of time that the battery will be serviceable. All of these factors are predetermined by the design of the watch or of the battery.

The single factor that *we* can help control is the "freshness" of the batteries that we supply our customers. All batteries will self-discharge to a greater or lesser degree, over a period of time. It is therefore important to understand the four factors that will help determine the battery's condition when we install it.

Purchasing proven *quality* batteries assures us that the internal separator and the seals will keep the amount of self-discharge to a minimum. The *chemistry* of the battery is the second factor; high-drain batteries generally self-discharge at a more rapid rate so they should be stocked *only* for watches that have a light or alarm. Lithium batteries have the best "shelf-life" of any type, and can be stocked for a long period of time.

The *dimensions* of the battery are a factor that is rarely considered with regard to shelf-life. The diameter and thickness of a battery have an important effect on self-discharge. Many years ago, the Longines Watch Company produced an excellent booklet on watch batteries in which they dealt with this extensively. I quote, "The loss of capacity in silver-oxide batteries through natural self-discharging is directly proportional to the surface area of the separator; that is to say, the larger the diameter of the battery, the greater the loss of capacity." They also point out that "The loss of capacity—will be in inverse proportion to (the) thickness of the battery." In other words, the shelf-life of a small diameter silver-oxide battery will be greater than that of a large diameter of the same thickness; the shelf-life on a thick battery will be greater than that of a thin one, if they are the same diameter. As an example, a 9.5 x 1.2 mm battery should not be kept in stock as long as a 7.9 x 5.4 mm battery.

The fourth factor is the *dating* of your battery stock. It would be most helpful if manufacturers would publish their date-of-manufacture codes, but most of them prefer not to do so. The best hedge we have against installing a "too old" battery is to buy from a source that has a known high turnover of batteries. We then should mark a "use by" date on our new purchases. As a general guideline, high-drain batteries (AWI odd numbers) should be used within two years; low-drain batteries (AWI even numbers) should be used within three years. Lithium batteries (AWI numbers with an "L") can be stored for at least five years. When dating your stock, subtract a year for *silver-oxide* (not lithium) batteries that are very thin; do so especially for those that are of a larger diameter *and* very thin.

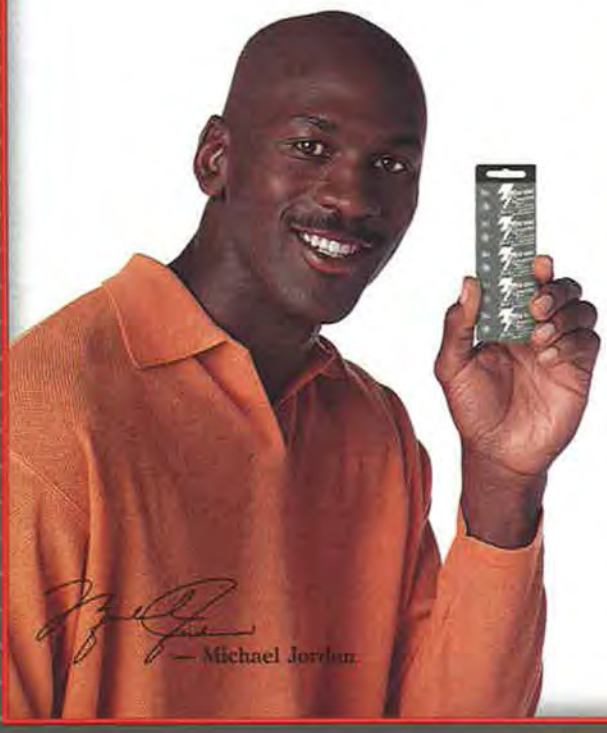
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Ask Huck

J.M. Huckabee,
CMC, FAWI, FBHI

Bad Screw Holes in Old Clocks

Question

What can be done about wood screw holes in an antique clock? These are unsightly, and often in functional areas of the case.

Answer

I don't know how to treat your problem, but will give a personal view. Possibly an advanced clock collector could give a better opinion.

I have an old English Grandfather clock that is about 200 years old. It's screwed to the wall for stability and hasn't been moved for the past 22 years. There must be at least a dozen holes in its back from previous owners. Every time I wind the clock these holes catch my eye. Oh how I wish those holes could talk. I wouldn't even consider an attempt to fill, or obscure those holes. They are a part of "the way it is."

Let's talk about functional holes; for instance, where the dial screws are in a Kitchen clock. We need to use the holes, and I object to making new holes in the wood or metal parts.

I frequently take a little piece of soft wood cut to approximately fill the hole, stain it with coffee, tea, or whatever, and slip it into the hole; a touch of white glue will make it secure. This can be done at the time the screw is inserted. A drop of oil on the screw helps prevent the glue from binding to the screw. This job turns out reasonably well and its acceptability is certainly subject to the viewer's opinion.

Appearance of a flat-head brass screw can often be improved by touching its head to a sanding disc. Likewise, for steel screws which can be flame-blued.

Adjusting a Strip-Type Escapement Anchor

Question

Many clocks with strip-type escapement anchors need to be refurbished. How do you do this? Most are too hard to permit reforming.

Answer

These anchors are often so hard that any shape adjustment is apt to break the piece. They often are rusty, badly worn, and need help.

I don't take a chance on breakage. Touch the strap in its backbone area with a fine file. If it appears hard, anneal the piece just beyond the point where it makes its bend. I hold an active area with a pair of smooth-jaw pliers and heat the backbone area quickly with a small torch. Bring the heat approximately to a dull red. When cool, do the same thing to the opposite end.

Grind and polish the active area and make the necessary shape adjustment. In that this device is in a low-stress part of the clock, I leave the anchor in the annealed state. The functional area of our anchor remains hard, which can be verified with a small file.

A good understanding of the escapement is needed prior to any attempt at adjustment. One text that comes to mind is *The Modern Clock*, by Ward Goodrich. This book is available from many material suppliers.

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Ron DeCorte, CMW

A Watch Story

So, you ask, how did I end up making watches? Well I ask myself this question almost everyday and the answer is never easy to explain. Actually, I'm not sure myself.

Let's start at the beginning. All my life I have been making things, first as a tool maker, then as an instrument maker (scientific instruments), and now as a watch*maker*. Making things, and making things happen, seem to be the key.

I'll skip over the details of my earlier careers other than to say that they gave me the foundation required to make watches and do restoration. In 1990 I decided to make a career change and wanted something challenging but that also involved mechanical devices. I'd always been interested in clocks and was known as a Sunday afternoon kitchen table "clock fixer." But deep inside I really didn't want to work on clocks, I wanted to "make" watches. This seemed like a suitable trade and would challenge my abilities as a mechanic.

So the journey begins. The first stop was working with a retired watchmaker in the





Toledo, Ohio area, Herman Brandt, who taught me the basics of watch repair and watch mechanics in general. One thing became very clear to me during this time, I wanted to make things, not exchange parts. So finally the opportunity came around for me to start making watch parts when a customer of Herman's dropped off an old pocket watch with a broken staff. The staff that was needed was not available through the material house so I volunteered to make one. Needless to say I had never made a staff before and the only reference I had was my *Joseph Bulova School of Watchmaking Training Manual*. Several days later, after countless broken pivots and a whole lot of cussing, I finally made a staff and put things together. Much to my amazement the watch was alive again; I was hooked! I continued working with Herman for about 6 months and then we decided it was time for me to go off on my own.

Working on my own was great. My shop was at home and most of my work was simple staffing, making new staffs, repivoting, cleaning and oiling, etc. Word of mouth was my best advertisement and the word spread fast that I could make parts when they were not available. This was a very important time in my career since I would take just about anything that needed a part made and tackle the job head on. Slowly the watches and the work became more complicated—chronographs, calendars, repeaters, and so on. At the same time that I was learning a lot about "repair" work, I also wanted to make my own watch. This seems to be a common dream for many watchmakers but few ever have the opportunity and/or time to make this dream become a reality.

In 1991, I met Tony Simonin from the WOSTEP watchmaking school in Switzerland. This was a real turning point in terms of making "my" dream come true. Mr. Simonin showed me pictures of a Grand and Petite Minute Repeating Sonnerie that was made by Philippe Dufour. Wow! This was real watchmaking and it was now impossible for me to not follow my dream further. So after about a year of drooling on the picture of Philippe Dufour's watch, that was "nailed" onto the concrete wall above my bench, I decided it was time to go to Europe and meet some real watch*makers*, Philippe Dufour, Richard Miklosh, Derek Pratt, George Daniels.

In early 1992 I was off on my "pilgrimage" to the holy land of watchmaking. First I met with Philippe Dufour

in Switzerland. This was an experience that I will never forget, seeing first hand what it took to produce an extremely complicated watch from the ground up, design to final assembly. But I think the most important lesson I learned from Philippe was that without the proper attitude, my dream would only be a dream and never a reality. Practice, more practice, study and most important, "just do it". As Philippe told me straight away, "there have been a hundred young people who have visited me and they always say the same thing, they want to make a watch. But as of yet not one of them has ever showed me a finished watch, so don't talk BS to me, just go home and make your watch." (Thanks Philippe, that was the best kick in the pants that anyone ever gave me.)

Making a long story short, I eventually visited Richard Miklosh and Derek Pratt, both master watch*makers* who took the time to visit with me and plant more seeds in my mind.

Now the garden was planted and it was my job to make it grow. Once again, making a long story short, I took some jobs that no one thought feasible or practical, like making a minute and quarter snail assembly for a watch that had them missing. This job started a long string of trips to Switzerland, visiting with Philippe and Derek in order to get ideas and even more inspiration.

In the spring of 1994 I decided that I had waited long enough and it was time to "make my watch." The design was in my head and I started out by putting everything on paper. This took more than a month, drawing and checking to be sure that everything would be workable in the end. Taking the summer away from my restoration and repair work, I started the fabrication process. Besides my watchmaker's lathes and the usual assortment of hand tools and files, I had purchased a Swiss 102-mm lathe a few years earlier. A milling attachment and dividing attachment made this the tool that would allow me to make my watch. Not to say that it isn't possible to make a watch with more compact and/or simple tools. Richard Miklosh had shown me that he was able to make beautiful tourbillion watches with an 8-mm watchmaker's lathe, a drill press and a rounding up tool, nothing more. But I had a thing for big heavy machine tools since that is what I had learned my trade on earlier, so this was my weapon of choice.

The fabrication took about 4 months. Plates, bridges, screws, wheels, pinions, and a lot of special tools and cutters that could not be bought. Finally, in late August 1994, the moment of truth came around. Place the balance into place and tighten the screws, give it a slight push... and... TICK, tick, tick... WOW, what a feeling! Almost as good as sex, almost I said.

OK, I have a naked watch sitting on my bench but no case. So I call my friend, Jean Wuischpard in Florida. Jean is a master case maker who came to the U.S. from Switzerland in the late 1920s. After many years of making custom cases at the Hamilton factory in Lancaster, PA, he retired to Florida and was doing case repair of the highest quality. Jean was also excited that I had finished my watch and we discussed a proper case for the movement. It was my wish that it be made of sterling silver and I left the design to Jean. After the case was complete it was sent for engraving, as was the movement, to Steve Lindsay in Nebraska. Steve's reputation as a master engraver is world renowned and I felt very comfortable giving him the artistic freedom to express himself and his art on my work. A hard porcelain dial had been designed earlier and ordered from Mr. Donze in Switzerland, another master at his art, probably the only person left on earth who still makes real porcelain dials.

This was my first watch and it resides in my pocket most of the time these days. It wasn't made with the intention of being sold and I hope the day will come when I can pass it on to my children. But there were other people who wished to have a unique watch for themselves. So in early 1996 I started a series of 5 more pieces of this model, the first of these five watches is featured on this month's cover.

There were some minor changes from my first watch and on the series of five that I am working on now, very minor. Also, the job of making the 18K gold hunting case that is pictured in this article fell to a master case maker from England, Mr. Gideon Levingston.

It was my intention by writing this story to hopefully inspire some others to follow their dream, and make it a reality. "Just Do It."

In the near future I will be writing some articles about some of the people who are mentioned in this article. Many of these people have talents that are almost extinct in the world today and their arts are very interesting.

Bringing this watch story to an end, I would like to thank a number of people who have helped me accomplish my "dream": Herman Brandt for giving me a chance to get started. Philippe Dufour for "kicking me in the pants," his friendship and his willingness to share his expertise. Derek Pratt for his expertise and warm personal friendship. Jean Wuischpard for his willingness to "clothe" my first watch with his work. Steve Lindsay for his art that adds so much detail to everything he touches. Gideon Levingston for his case making skills. And also a person who has not been mentioned yet, but who actually made this whole dream possible, Heinz Nikles of Chicago, Illinois. Heinz has been in the background of my dream since it was conceived. Quietly lending me his advice and help in any way possible, as a mentor, a motivator, sometimes a father figure, and most importantly a great friend. Thanks Heinz! This is your dream as much as my own.

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Letters to the Editor

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Dear Editor:

I thoroughly enjoyed your treatment of the Smithsonian in your November issue. "The Brief History of the Quartz Watch" was excellent and "The Smithsonian Horological Exhibits: Present and Future" was informative. Nevertheless, I do take issue with some details. (After all, I ain't Adjunct Historian, Special Project Smithsonian for nuttin').

A) On the "Brief History":

1) Hamilton Pulsar is referred to as an LCD. This is an error. It is an LED.

2) The article records the evolution of liquid crystal display (LCD) but does not mention light-emittng diodes (LED) which preceded it. This is an error of omission.

B) On the "Smithsonian Exhibits":

In my view, the permanent exhibit "On Time" scheduled for 1999 is a real exhibit—you can see actual watches. I believe that referring to Smithsonian's 1997 website as an "exhibit" is misleading.

In conclusion, I repeat, the treatment of the Smithsonian in the November issue was excellent. I hope that my comments will be accepted as constructive criticism.

Ben Matz
Boca Raton, Florida

OOPS! The reference to the Hamilton Pulsar is an error. Thank you for pointing it out. The development of the LED was omitted from the story. Quite frankly, the Quartz Watch website exhibit has so much information that there was just not enough space allocated to this article to do justice to it all. Sometimes Ben, editors have to edit.

Promotional material distributed by the National Museum of American History refers to the Quartz Watch display as an exhibit. That's good enough for us. We were also trying to make a little point about the march, or gallop, of technology from the first quartz electronic watches to a museum exhibit in cyberspace in little more than a generation.

William J. Ewbank
Editor-in-Chief

Dear Editor:

My greatest disappointment with the *Horological Times* is the elimination of the "Rock Quarry" by Mr. Fred Burckhardt. His stories brought back many a memory of my fifty years at the bench. Oh, how humorous! It made my day.

Quentin Klaus
Perryville, Missouri

Not to worry. "Rock Quarry" resurfaced in our December issue. Its absence is due to the exceedingly busy schedule maintained by Fred Burckhardt. There are times when we believe that no group of people is more in need of periodic injections of humor than our membership. Fred, your fans are calling!

William J. Ewbank
Editor-in-Chief

Dear Editor:

Did the "Pickle Barrel" get pickled?

Lou Roza
Halifax, Nova Scotia

Yup.

William J. Ewbank
Editor-in-Chief

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How to Make a Winding Pinion and Clutch

Part 11

How to Make a Square Hole

Robert D. Porter, CMW

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Machining on our clutch pinion is complete except for making a square hole through the pinion. The square of the winding stem measures 1.28 mm. We want our clutch pinion to slide freely on the stem so we will make the square through the clutch .05 mm larger than the stem, or 1.33 mm.

We will make a broach to cut the square through the pinion; so, to determine the diameter of a circle that will enclose a 1.33 mm square, we multiply 1.4142 times 1.33 which gives us a diameter of 1.88 mm. Our safety glasses are on as we turn a pilot diameter of 1.31 mm, about half as long as our pinion, on the end of a 4" length of 3/16" (.1875") drill rod. Immediately behind the pilot, we turn a 1.88 mm diameter slightly longer than the pinion. Figure 66 pictures a square being ground on the broach, using the pilot diameter as a reference to control the depth of grind.

We have used our 70-degree cutter in Figure 67 to put a series of cutting edges on the broach, and to provide chip traps for the corner material being removed. The first cutting edge is slightly smaller than the following edges so the material is removed gradually instead of all at once, producing a cleaner square hole. The broaching end of our tool was coated with soap, heated to a cherry red, and quickly quenched end first in oil to harden.

Figure 68 shows the clutch pinion resting on a soft piece of

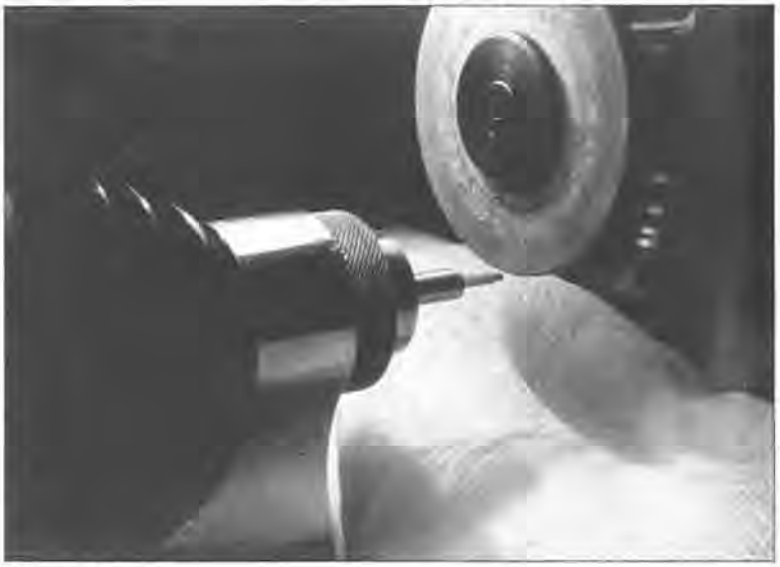


Figure 66.

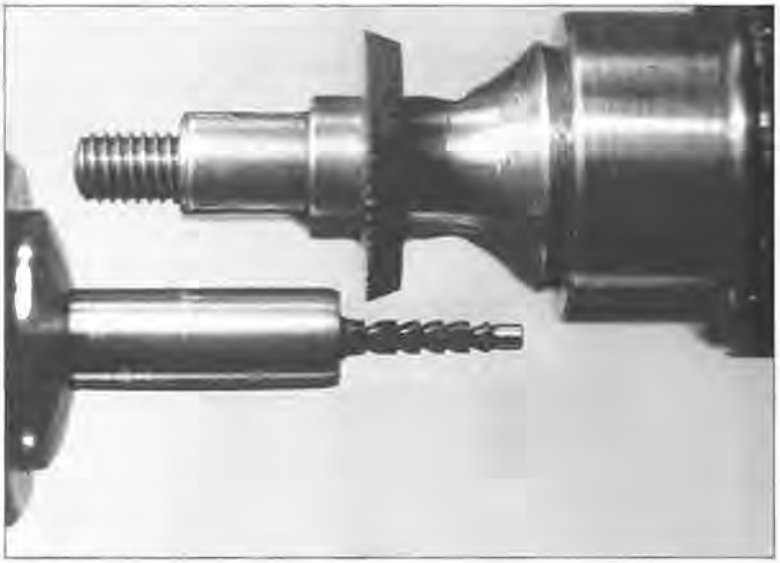


Figure 67.

CORRECTION

Two errors appeared in this series in the December issue. On page 14 you are referred to page 17 for a chart. It should have read **page 15**. In the chart on page 15 the first numbers in column two should read **m x 1.118** and in column three **9.9**. We apologize to Mr. Porter and *HT* readers for these errors.



Figure 68.



Figure 69.

aluminum with a hole through it, and that the broach has been lubricated with oil and given a sharp tap with a brass-headed hammer to cut the square through the pinion. It probably would have been better to put the square through the blank before cutting any of the clutch or pinion teeth.

The pinion and clutch are being tried on the winding stem in Figure 69. It is a lot of fun to see parts you have made, fit and work as they should. All that remains is to deburr our parts with a brass brush, clean ultrasonically, harden, and temper to a dark blue.

This concludes the series on "How to Make a Winding Pinion and Clutch."

Many years ago, while taking a course at the National Bureau of Standards in Gaithersburg, Maryland, I saw a sign on an office wall that read something like this:

"Whatever your mind can conceive,
and your heart can believe,
you can achieve."
Author unknown

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Technically Watches

Pocket Watches and Their Maintenance
Part 8
The Watch Regulating Unit

Archie B. Perkins,
CMW, FAWI,
FNAWCC, FBHI

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The watch regulating unit is considered the heart of the watch. This unit consists of the balance wheel, the hairspring with its collet and stud, the regulator, the balance staff, and the roller table with its roller jewel.

The purpose of the regulating unit is to allow a timed constant release of the mainspring power through the escapement which causes the hands of the watch to indicate the correct time.

Figure 1 shows the regulating unit of a watch. This illustration shows the balance wheel being suspended by the hairspring which is attached to the balance cock. The balance cock is being held on a balance tack. The regulator is shown in place on the balance cock. The balance wheel is suspended by the hairspring with tweezers in this manner when a hairspring is being vibrated or timed to the balance wheel. Note: The hairspring must be matched to the balance wheel and be of such a strength that it will cause the balance wheel to give the proper number of vibrations per hour to make the watch keep correct time. The most common number of vibrations per hour for a modern pocket watch is 18,000.

Figure 2 shows an exploded view of the balance wheel unit which is made up of the balance wheel, the hairspring with its stud and collet, the balance staff, and the roller table with its roller jewel.

Materials Used for Balance Wheels and Hairsprings

Over the years, the balance wheel and hairspring have had changes in their design and material content. Early balance wheels were made of steel or brass and early hairsprings were made of a straight pig bristle or hair, thus the name hairspring. Later hairsprings were made of steel and in the form of a spiral.

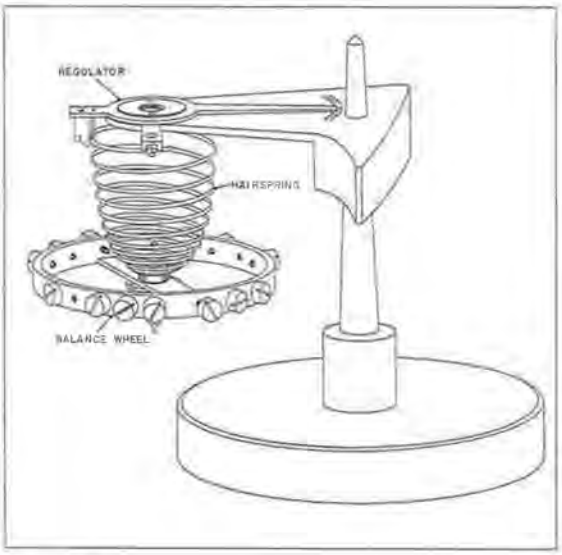


Figure 1.

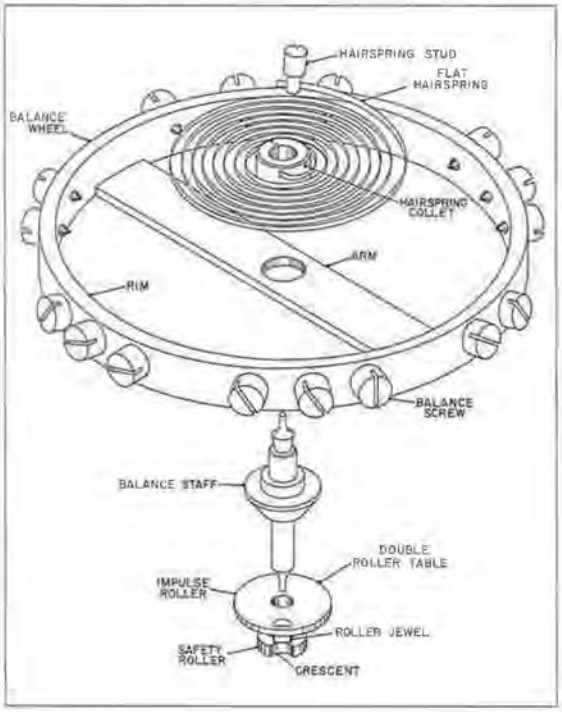


Figure 2.

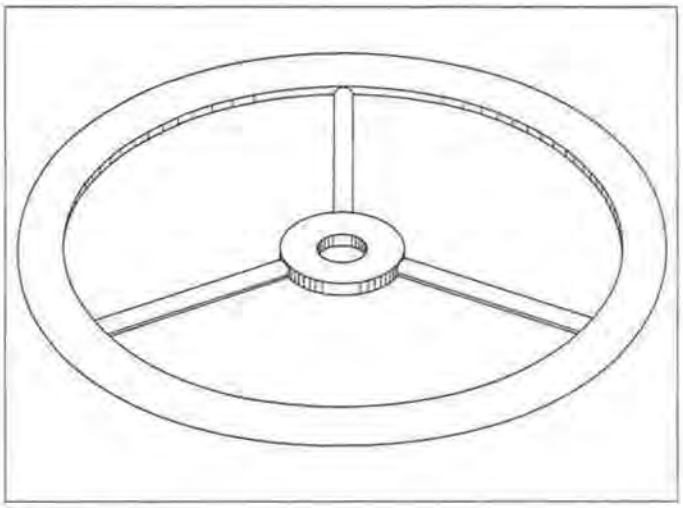


Figure 3.

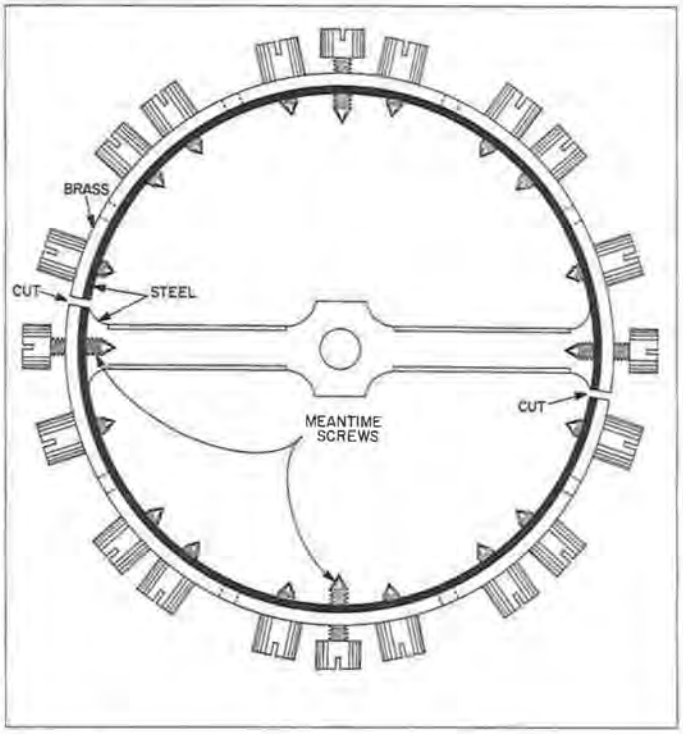


Figure 4.

After this, when closer timing was needed, changes were made to improve on materials used and the design of both the balance wheel and hairspring.

It was found that changes in temperature affected the steel hairspring. In cold conditions, the steel would shorten and become stiffer and stronger causing the watch to run faster. In heat, the steel hairspring would become longer and more flexible and weaker, causing the watch to run slower. The balance wheel used was like the one shown in Figure 3 which was made from brass or steel with a solid rim.

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The Bi-Metallic Balance Wheel and Steel Hairspring

To compensate for the changes in the hairspring due to temperature changes, the bi-metal balance wheel like the one shown in Figure 4 was developed. This wheel is constructed of a brass outer rim and a steel inner rim. The brass outer rim is fused to the steel rim and arm. The width of the rim is usually made of 3/5 brass and 2/5 steel in order to obtain the proper compensation abilities to compensate for the changes in the hairspring during temperature changes.

The bi-metallic balance wheel has its rim divided near the ends of the arm at two opposite points. This allows freedom of movement at these points of the rim.

Brass expands and contracts more than does steel in temperature changes; therefore, in heat, the hairspring becomes weaker and slower and the brass in the wheel's rim expands and pushes the rim inward to make the watch faster to compensate for the slowness of the hairspring.

In coldness, the hairspring becomes stiffer and faster. The brass in the wheel's rim shortens and pulls the rim outward to slow down the watch to compensate for the effect of the coldness on the action of the hairspring. The effectiveness of the temperature compensation of the bi-metallic split balance wheel can be changed by moving balance screws in pairs toward or away from the cut ends of the rim. Moving screws toward the free ends of the rim increases the effectiveness and moving screws away from the free ends decreases the effectiveness.

The Mono-Metallic Balance Wheel and Elinvar Hairspring

One of the most important advancements in balance wheels and hairsprings came about 1940 when the Hamilton Watch Company did research on Elinvar and developed a solid mono-metallic balance wheel to be used with an Elinvar hairspring. The word *Elinvar* means ELasticity INVARiable.

Figure 5 shows one of these mono-metallic balance wheels. The hairspring used with this balance wheel is made of Elinvar "Extra" that Hamilton developed. When a watch equipped with the mono-metallic balance wheel and the Elinvar Extra hairspring was subjected to temperatures of between 40° F and 90° F, there was almost no error in the time keeping of the watch. This means that the length and elasticity of the Elinvar hairspring had very little change between the two extremes of temperature.

The Ovalizing Balance Wheel

Another improvement in balance wheels was the balance wheel that Hamilton developed for its marine chronometer during World War II. This balance wheel is shown in Figure 6. The balance wheel has an Invar arm that is silver soldered to the stainless steel rim of the wheel. The

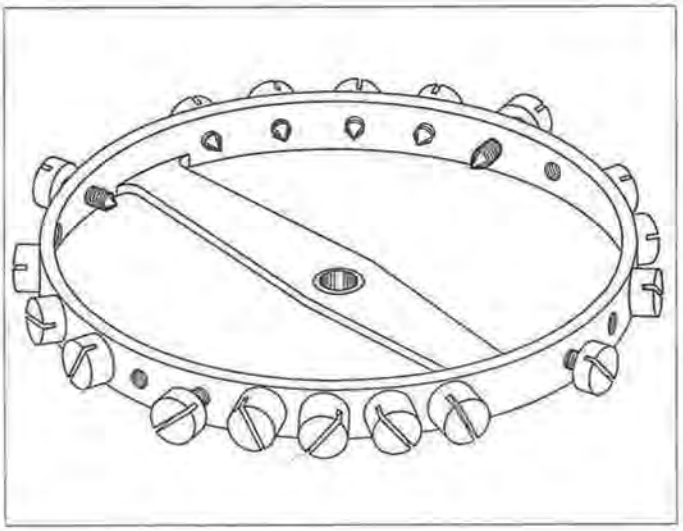


Figure 5.

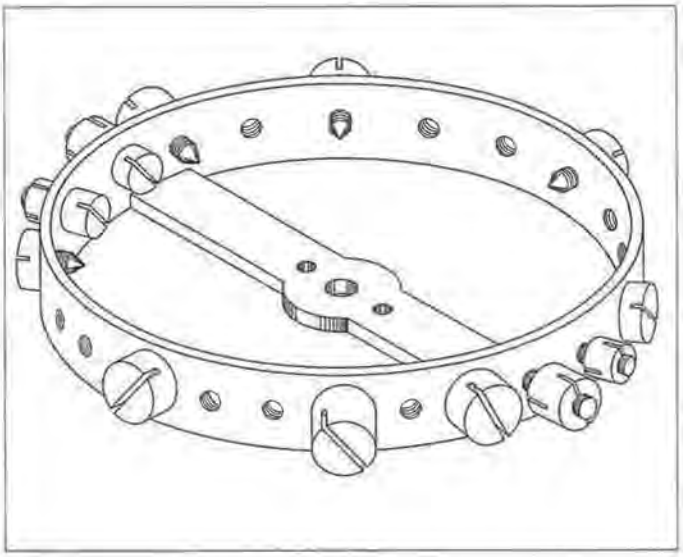


Figure 6.

arm remains stable in heat and cold, but the stainless steel rim expands in heat and contracts in cold. In both heat and cold, the rim becomes ovalized. The effect is greatest 90° from the ends of the arm. In heat, the rim moves outward and in cold, the rim moves inward. The wheel is called an ovalizing balance wheel. Any temperature adjusting is done by moving the screws to and from a point on the rim which is 90° from the ends of the arm. This same balance wheel construction was used by Hamilton for the balance wheel in its 35-size navigation watch.

The Flat and Overcoiled Hairsprings

The characteristic of a flat hairspring is that its center of gravity is continually shifting during its breathing action. This prevents the hairspring from being isochronal. When a hairspring is isochronal, the long and short

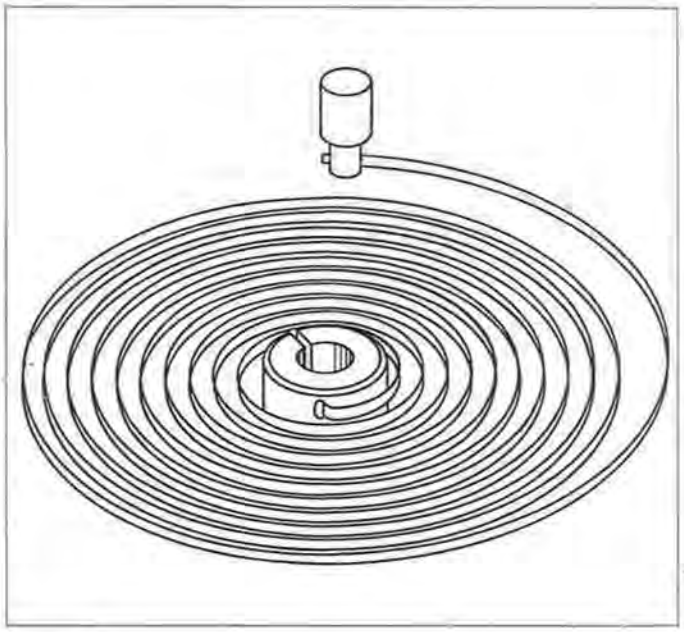


Figure 7.

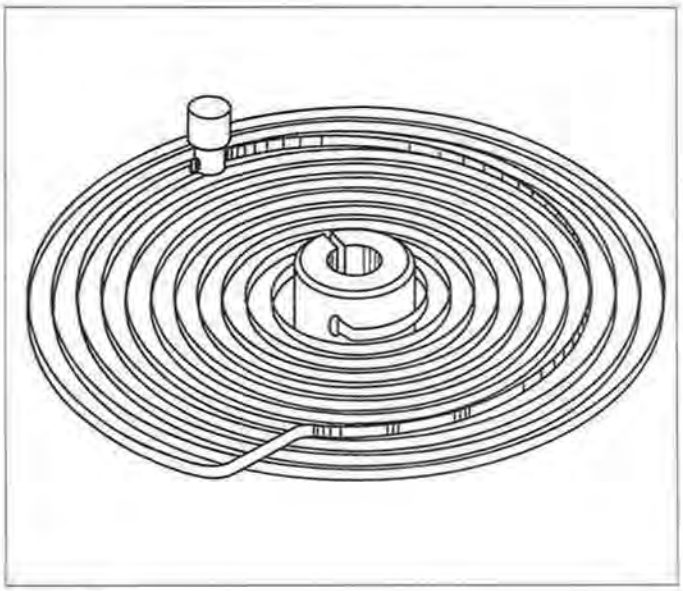


Figure 8.

arcs of the balance wheel will be made in equal time. The coils of a flat hairspring breathe toward the regulator pins when the coils are contracted and away from the regulator pins when expanded. It is difficult to get close timing with a flat hairspring. A flat hairspring is usually used in watches where very close timing is not expected. Figure 7 shows a flat hairspring.

In 1779, John Arnold patented an overcoiled hairspring and Abraham Louis Breguet used an overcoiled hairspring and noted that the watch kept closer time than with a flat hairspring. The overcoiled hairspring is sometimes referred to as a Breguet hairspring.

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gravity of the hairspring can be placed on the axis of the balance wheel when the overcoil is shaped correctly. The hairspring will breathe evenly in all directions when the center of gravity is on the center of the balance wheel. The watch will then have a close isochronal rate. An overcoiled hairspring is shown in Figure 8.

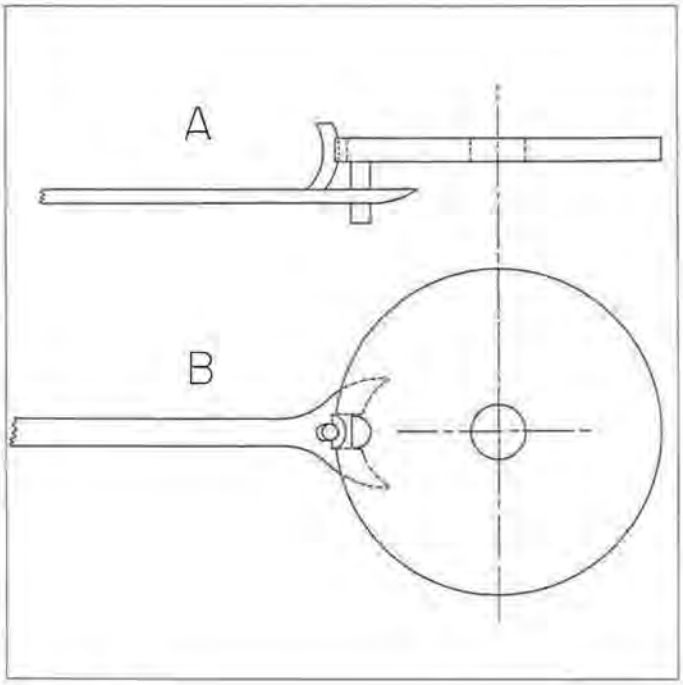


Figure 9.

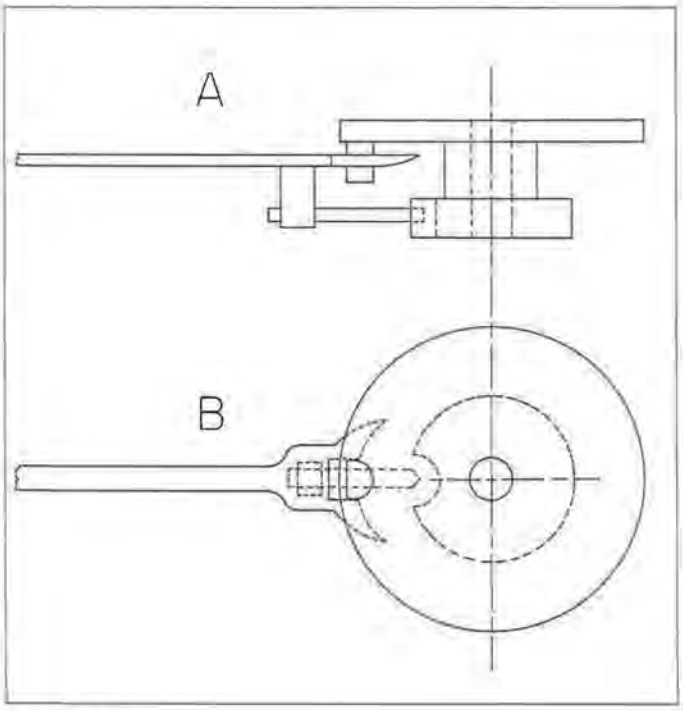


Figure 10.

The Single Roller Table

Figure 9 shows a single roller table. View A shows an edge view of the roller table and View B shows a top view of the table. When a single roller table is used, the crescent for the guard pin is cut in the edge of the table just in front of the hole for the roller jewel. The guard pin is frictioned into a hole in the fork just back of the slot for the roller jewel. The guard pin stands vertically from the top of the fork. When the roller table has a straight outside edge, the guard pin is usually given a slightly curved shape as shown in View A, Figure 9. If the roller table has a rounded edge, the guard pin is usually left straight and perpendicular to the top of the fork.

The Double Roller Table

Figure 10 shows the double roller table. View A shows an edge view of the double roller table. This roller table has an impulse roller and a safety roller which can be made in one piece or two pieces. The guard pin is mounted in a block on the pallet fork and works with the safety roller as shown in Views A and B, Figure 10.

The guard pin is used to prevent the balance wheel from going out of action when the roller jewel is outside the fork horns. The fork horns serve as a safety device when the guard pin is still in the crescent of the safety roller. After the guard pin leaves the crescent of the safety roller, the guard pin takes over as the safety device.

The safety action is more positive with the double roller than it is with the single roller. This is because of the smaller diameter of the safety roller used for the double roller compared to the larger diameter roller used for the crescent of the single roller. The smaller the diameter of the safety roller, the more positive the safety action.

The Regulator

The regulator is used in a watch to change the timing of the watch by shortening or lengthening the active length of the hairspring. When we move the regulator toward the F on the regulator scale, the active length of the hairspring is shortened making the watch faster. When we move the regulator toward the S on the scale, the active length of the hairspring is increased making the watch slower.

Some special watches do not have regulators. These watches are called free sprung watches. To change the time, the weight of the balance wheel is changed or the weight is moved inward or outward on the balance wheel. When the weight is moved outward, the watch will be made slower and when the weight is moved inward, the watch will be made faster.

"Pocket Watches and Their Maintenance" will continue.

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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From the Workshop

Jack Kurdzionak

Dial Screws

How much can be said about those little screws? You know the ones. Those screws that go through the edge of the plate and secure the dial legs to the plate. Most watches have two of them, some have three, and a few even have four. They seem to cause more problems than any other screws in a watch.

The first and easiest problem to solve is missing dial screws. These are often lost during servicing of the movement and the loss prevention is easy. Train yourself to tighten dial screws as soon as you remove the dial. The screws remain in place while the movement is serviced and they are ready to secure the dial when it is replaced. Missing screws should be replaced with original ones, if possible, or use substitutes with the same length, head size, and most important, the same threads.

The more difficult problems include: dial screws broken and/or rusted in the plate, and oversized screws forced into the plate. These are not easily removable, they must be chemically removed. Bill Schroeder of Illinois suggests using salt water. All you have to do is mix up a solution with regular table salt. Remove all steel parts from the plate and place it in the salt water solution. Let it sit for 4 or 5 days and all that is left is a small amount of rust in the hole which is easily cleaned. It also does not damage or etch the plate at all.

A Novel Solution to an Unusual Problem

Dave Carlson of Indiana wrote about the following problem and how he solved it. A customer brought in a fairly new eight-day, three-weight cuckoo clock. The weights powered the time, strike, and music box trains. The clock worked fine except it failed to cuckoo and play the music box on the half hour.

"I suspected that there was insufficient lift on the half-hour position to enable the rack to be in the single strike position. To gain access to the strike adjustment, I removed the hands and wooden dial of the clock and put it on a test rack. (Almost all wooden cuckoo clock dials are generally held in place with small nails. By gently lifting the dial on the edges it can be removed. This enables easy access to the strike adjustments while still maintaining normal operation.)

"I adjusted the lift lever to make the half-hour strike work but found the hour lift was much too high which jammed the hour strike. There was no way to find a suitable compromise. I removed the movement from the case and inspected the double snail on the minute arbor which provides the lift for the half-hour and hour strike. Examination of the snail revealed a suspect part (too large a difference in the snails). Fortunately, the same double snail and gear combination is used on the older two-weight, 30-hour Regula movements. I took one off a spare parts movement from the junk box and installed it on the new movement. The replacement snail allowed a normal adjustment of the half-hour and hour strike.

"To save time in the shop, the double snail can be removed from the minute arbor of the eight-day movement without disassembly. Clamp the movement with the front face up. Cover the front of the movement with a piece of paper with a hole in it to allow access to the double snail on the minute arbor. Use a cut-off disk in a Dremel or similar tool to slot the gear which loosens the snug fit on the minute arbor and the gear can be pried off easily with a screwdriver. The paper protects the movement from the cut-off wheel grit."

Move the Dial, Not the Movement

Many clockmakers repair cuckoo clocks by replacing the entire movement with a new, factory fresh one. Sometimes it is difficult to get the center shaft of the new movement,

especially if it is not an exact replacement, centered in the dial of the clock. Instead of bending the movement legs and going through a lot of contortions to center the movement in the dial, there is a very simple solution. Carefully remove the dial from the case. It is usually held in with three small brads near its edge. Occasionally it is held on with hot melt glue and it can be carefully lifted off the case. After the dial is removed and glue, if any, removed, simply replace the dial on the case with the center shaft concentric with the hole in the dial. Nail or glue the dial in its new position and the centering is complete.

Jack Kurdzionak

Play it Again, but Make it a New Tune

Some years ago the majority of cuckoo clocks were time strike models, either one-day or eight-day, with no complications. These can be simply repaired and restored to like-new working condition by replacing the movements and the bellows. That repair works fine for the older style clocks but the majority of the clocks being sold today and those coming to the repair bench today have complications including music, dancing figures, and animation. The music mechanism must be replaced just as surely as the clock movement. Until recently, the clockmaker could purchase replacement fan assemblies for almost all music mechanisms. The number of available fan assemblies is now drastically reduced and the clockmaker is forced to seek an alternative. One alternative some are using is to replace the entire music mechanism with a new one. It may require a bit of fitting and adjusting, but the results are worth the effort. The clock will have a flawless music movement and a new time and strike mechanism to give years of additional service.

There is one caveat. The replacement music movement may not have the same tune as the one being replaced. The customer may have to accept a different tune for his cuckoo clock in order to have a functioning musical cuckoo.

Jack Kurdzionak

The Finishing Touch

Stan McMahan, watchmaker and horological writer from South Carolina, has a suggestion for polishing watch cases, watch bracelets, and jewelry. Superior polishing results can be obtained by the proper application of polishing compound to the polishing wheel. Most workers apply tripoli, rouge, etc. to the entire face of the buff wheel. A much higher polish will result by applying the compound to the left 1/3 of the buff wheel face and subsequently moving the object to be polished from left to right over the face of the wheel. Essentially, the watch case, ring, etc. should be introduced on the "compounded" side of the wheel and moved across the face of the wheel to the "clean" side. The beauty of this technique is that it works in all polishing situations and with any compounds or wheels. Even previously used wheels react favorably to this application technique. The results are immediately noticeable.

Rotate Your Bezel

Stan McMahan suggests the following technique for removing rotating bezels. They can be frustrating to remove. Heuer bezels are an example of this type of arrangement. Bergeon has a tool made specifically for this project. However, in absence of this bezel remover, another method that works most of the time is to rotate the bezel counterclockwise while lifting on the point of the bezel where the opening in the spring is located. Many times this can be done with your thumb while using your opposing fingers to rotate the bezel. Of course you can't see where the opening in the spring is located so if the bezel refuses to come off, rotate your thumb position 30 degrees and try again until you are successful.

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A Practical Course in Clock Repair

The Design of a Regulator Clock Movement

John P. Kenyon, CMC

A regulator clock is a high-quality timepiece that is made with a movement capable of precise timekeeping. Figure 1 illustrates the design of a common weight-driven regulator movement with a dead-beat escapement, and a seconds pendulum. The components can be identified as follows: (A) main wheel, (B) back-stop ratchet wheel, (C) barrel, (D) center pinion, (E) center wheel, (F) third pinion, (G) third wheel, (H) fourth pinion, (I) escape wheel, (J) lever, and (K) the hour wheel, which is geared directly into the main wheel.

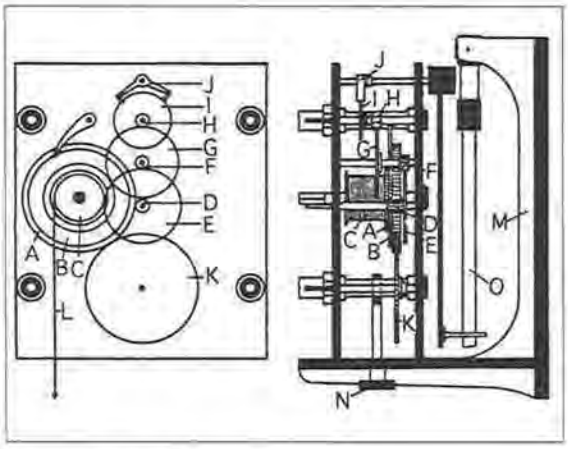


Figure 1. Regulator Movement

Main wheel (A) has 144 teeth and gears with center pinion (D) having 12 leaves. Center wheel (E) has 96 teeth and gears with third pinion (F) having 12 leaves. Third wheel (G) has 90 teeth and gears with fourth (escape) pinion (H) having 12 leaves. Escape wheel (I) has 30 teeth. The vibrations per hour of the pendulum can be calculated as follows:

$$\frac{96 \times 90 \times 30 \times 2}{12 \times 12} = 3600 \text{ vibrations/hour (seconds beat)}$$

In this movement, the center arbor (to which the minute hand is attached) makes 192 revolutions during an 8-day period (16 x 12). The ratio of the main wheel (144 teeth) to the center pinion (12 leaves) is 12 to 1. Since the center arbor makes 24 revolutions per day, the main wheel will make 2 revolutions in 24 hours or 16 revolutions in an 8-day period.

A descending weight is attached to a cable that is wound around the drum on the main wheel to supply motive force. Barrel (C) is designed so that the cable will wrap around it 16 times. A spiral channel is turned on the surface of the drum to guide the cable. The diameter of the barrel is 3.81 cm (1-1/2 inches) and 16 turns of the cable around the barrel requires a cable length of 191.5 cm (75.4 inches); therefore, the fall of the weight will be that same distance. A pulley can be used as illustrated in Figure 2 to cut the fall distance in half.

A regulator movement is usually attached to a heavy cast iron bracket (M) by two or more thumb screws. The bracket is fastened to the back of the clock case and supports pendulum (O), independent of the movement.

Power-Maintaining Mechanism

To prevent clock stoppage and/or damage to the escapement during winding, the main wheel (and train) is kept in motion during winding by a power-driven mechanism that compensates for the loss of impulse which would occur during this period. Figure 3 illustrates a maintaining mechanism that is fitted into the sink of a main wheel. One end of a spring is fastened to the opposite side of the wheel (underneath) at (A), while the other is attached to pin (B) which has one end extending into slot (C) and the other end fitting into a hole in back-stop ratchet (D). Click(s) (E) are fastened to the back-stop ratchet



Figure 2. Weight and Pulley

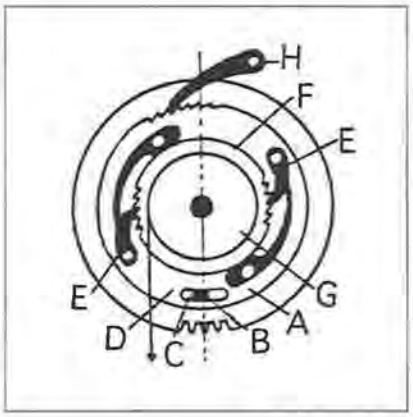


Figure 3. Power-Maintaining Mechanism

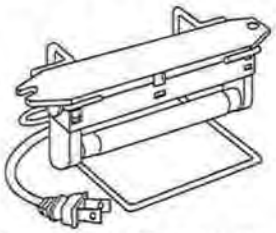
and mesh with the primary ratchet (F) which is fastened to the end of the barrel.

The action of the maintaining mechanism is as follows: When there is pressure from the weight on barrel (G), ratchet (F) forces ratchet (D) to turn with it. Click (H) which is attached to an arbor that is pivoted between the plates of the movement, advances from tooth to tooth. Power on the barrel and ratchet is transmitted to spring (A) by contact of pin (B) in the hole in the ratchet to convey power to the main wheel. Since the main wheel is in gear with the center pinion, the maintaining spring contracts until the pin in the end contacts the end of the slot in the wheel, storing up power in the spring. When the winding arbor is turned to wind up the weight, back-stop ratchet (D), which is prevented from turning by click (H), forms the opposing seat so the maintaining spring can expand and supply power to the wheel for a limited time to keep the train in motion. When the power (from the weight) is applied to the barrel, the maintaining spring will contract, and when the power is inverted (during winding), the spring will expand and supply force to the wheel.

Next time I will discuss compensated pendulums.

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As a Clockmaker Turns

The American Clock of Yesteryear

J.M. Huckabee,
CMC, FAWI, FBHI

Test Procedures to Overcome Real and Imaginary Problems as "Old Huck" Does It

Background

I once heard this: "This clock must have a demon in it. It just cannot be made to run." Old Huck says, "I can assure you that there is no demon or evil spirit in that, or any other clock. If it does not run, it has one or more valid reasons to stop.

I hear of long test runs, weak mainsprings, "tired iron," and various other imaginary reasons that a clock fails to operate. It is true, our old American clocks have gone through many trying years. However, that is no reason that they cannot be restored to the reliability and accuracy that they had when new.

Objective

This material will discuss and demonstrate a series of "pitfalls" that cause "latent stoppers," imaginary weak mainsprings, and the "tired iron" theory. Our work and inspection and adjustment process should be such that we know the clock will run when it is reassembled.

A clockmaker friend frequently quotes these words: "The ability to disassemble and reassemble a clock movement, without adding anything to its problems, is a fundamental skill that one must master early on, if he is to





Figure 1. Mainspring strength—one that looks like this is not short on power.



Figure 2. Feel the edge and surface of the spring. If it is smooth to the touch, it is not likely to break anytime soon.

succeed in this demanding work." (Nino Gonzales, Austin, Texas). The objective of this article is to dispel many of the foregoing ideas. The examples will be a simple American clock. However, they can also apply to many others of similar type.

The Tired Mainspring

A tired mainspring is usually the term used when a clock stops. Let's test the mainspring. How do we do it? Look over Figure 1. If the 8-day spring looks like this illustration, it should easily power the clock 9 or 10 days. This one is not tired, not weak, and is not the problem in its clock. Now study Figure 2. Is it about to break? Feel the edge for rough spots and small kinks. Feel the flat surface. Pull it between your fingers. If it is smooth, and the development is a continuous curve, it is not ready to break.

The simple test shown in Figures 1 and 2 is all the test you need to qualify a questionable mainspring.



Power Robbers

This is a catch-all term I use for anything that causes abnormal friction in the movement. The feet of the plate in Figure 3 do not sit flat on the workbench. If the mounting surface of the case is flat, the movement will be twisted when the case screws are tightened. That twist is a power robber to your gear train. Wheel arbors are no longer upright in the plates. Close-fitted pivots are the first ones to go into a semi-bind.

Look over Figure 4. We find the plate is warped. These plates are not very strong when compared to the powerful mainspring. Straighten the plates, adjust the feet to touch down on the case surface, and check each pivot for excess friction.

In Figure 5, we find yet another problem with the back plate. The pillars do not mate with the front plate. This movement has several high-stress problems.

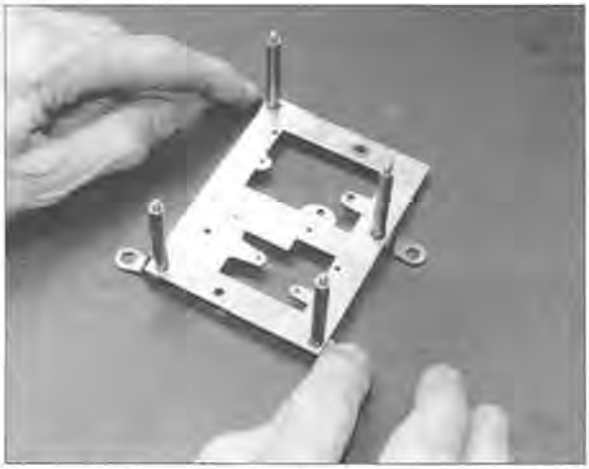


Figure 3. Determine that the plates are flat, and that foot height will not cause movement stress when fitted to the case.

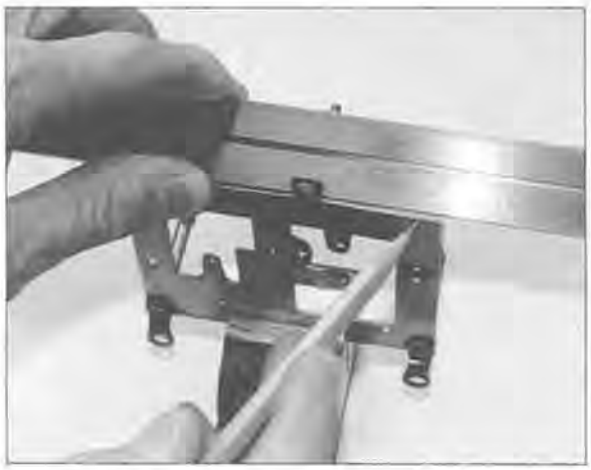


Figure 4. Check plate surface to a true straight edge tool. This plate is warped.

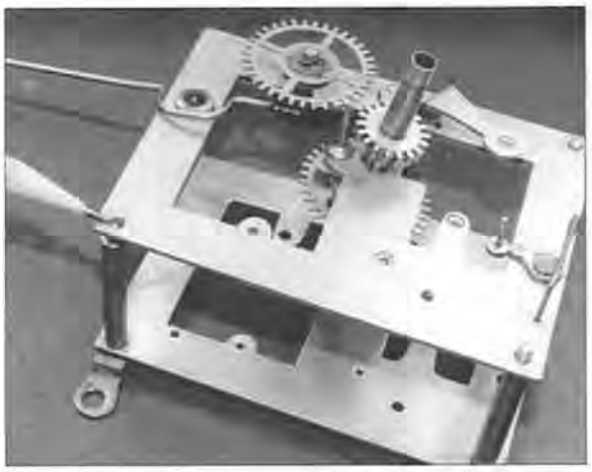


Figure 5. Plate does not mate with the pillars. The lower plate is not flat.



Figure 6. Tip each arbor in all directions. A warped plate can bring pivots into a bind.

After the pillars and plates are in order, check your arbors. In this class of clock you should be able to tip each arbor about five degrees in each direction. This pivot hole had a problem on that test (see Figure 6).

Check each pivot for side and end shake. Holes may need to be broached or bushed and broached. The wheel and arbor of Figures 6 and 7 was not fully free in the pivots holes. A slight friction that could be tolerated in a strike train could well be a "latent stopper" in the time train. The time train must be able to start very quickly on each escapement beat. Strike trains can tolerate a "slow start" to some extent. Check as in Figure 7.

Figures 8-10 deal with simple power robber items in the escapement. See that your crutch loop is in order, the escapement depthing correct, that the escape wheel has proper side and end shake, and that the escape wheel bridge is in its proper position. Note how the anchor pivot bridge

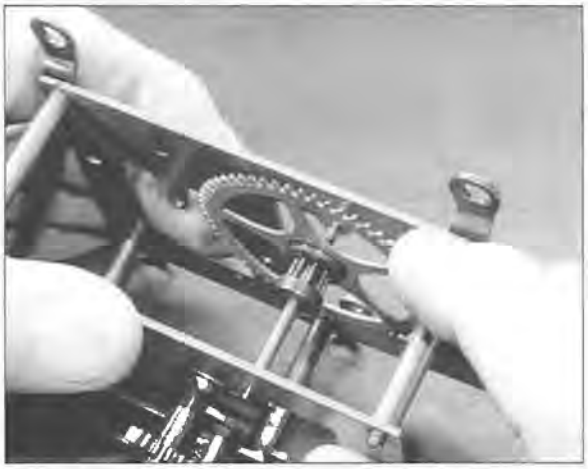


Figure 7. Verify that each pivot has suitable side shake and end shake.

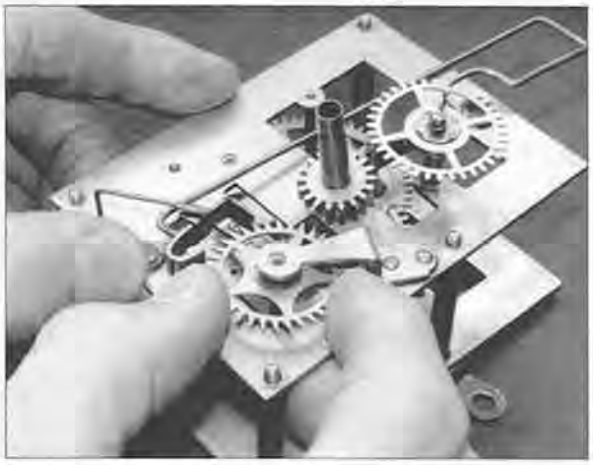


Figure 9. Inspect escape wheel pivots for end and side shake, and wheel bridge for proper location.

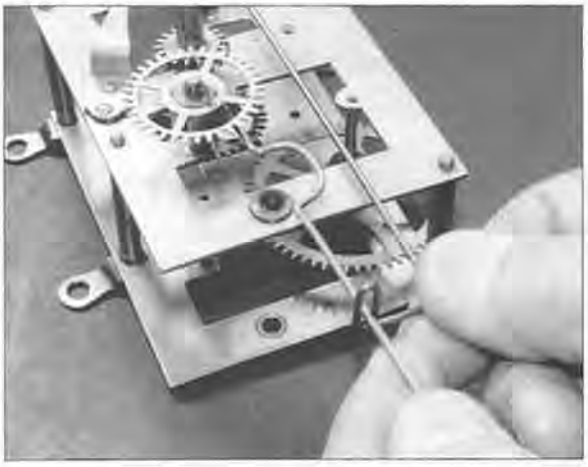


Figure 8. Pendulum rod should have a small clearance side-to-side. It should hang central in the crutch loop front-to-rear.

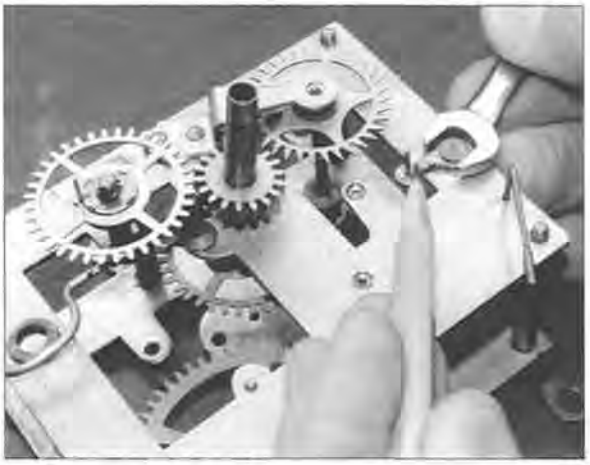


Figure 10. Adjust anchor pivot bridge for proper pallet depthing. Use a wrench for this adjustment.

is adjusted. All of these items should be checked out before any attempt is made to start the movement.

The Train Spin Test

With the mainspring out of the movement, spin the train. Hold the movement dial-up, dial-down, and in various other positions. Observe position or conditions where the train does not spin as free or long. The Figure 11 illustration shows a spin test. An 8-day movement train should be easy to spin with your forefinger as illustrated in Figure 11.

Feature Loads

Check out features that impose a load to the time train. The calendar mechanism of Figure 12 is an example. Strike mechanism as the time train approaches the half hour and hour is another example. Are these loads nominal or excessive?

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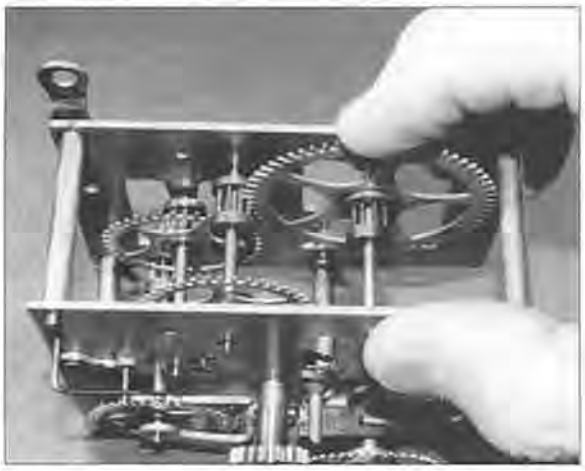


Figure 11. Give the train a spin test in dial-up and dial-down, and other positions.

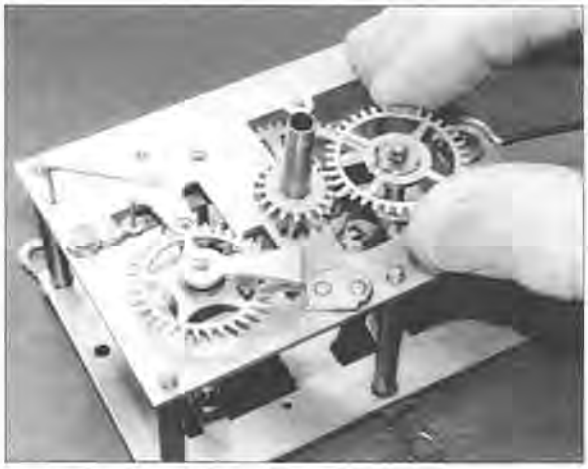


Figure 12. Check the calendar, strike mechanism, or other features that may present a load to the time train.

Test Run Length

What test run is needed? Here is what I do. Let the 8-day mainspring down about 9 turns. That is about 9 days in most old American clocks. Test for operation through an entire hour which also is to check out the calendar loading (some calendars may require up to 4 hours). When all is well, check the rate at about 1/2 wind on the mainspring. It is very rare that I test run a movement outside the case. It is also rare that I need to go back into the movement.

Conclusion

I urge each worker to concentrate on Power Robbers. In so doing you will greatly increase your productivity and surely agree "there is no demon in that clock."

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.

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WPWCA Holds Hermle Workshop

On Sunday, October 25th, fifteen members of the Western Pennsylvania Watchmakers-Clockmakers Association (WPWCA) attended a workshop featuring a Hermle triple chime movement. This course was made possible through the generosity of AWI and the Hermle Clock Company. AWI presented twenty movements to WPWCA last June for training purposes. The program was developed and conducted by our members. Mark Baker was chief instructor, with individual help by Cliff Conn, Willie Adams and Neil Rassnick, all experienced clockmakers.

This model is unusual in that the timekeeping mechanism is quartz, while the chime and strike is spring-powered. After a lecture on the operation of the strike and chime mechanisms, the students disassembled the movement completely; removed, cleaned and lubricated the mainsprings and replaced in the barrels. The clock was then reassembled and the chime and strike synchronized.

Considering the fact that some of the members had never worked on a clock before, it was a tribute to the skills of the instructors that all clocks were finished by the end of the day. All agreed that it was a day well spent.

Future programs, such as re-bushing, are being considered, using the same movement. WPWCA is grateful to AWI and Hermle for this opportunity.



L to R: Ritchie Mills, Willie Adams, Holly Rassnick, Neil Rassnick, Mark Baker, John Zavada, Jim Mongelli, Leo Langerholc, Joseph Jakim (rear), John Paige (front), Bob Bishop, Mario Bocchicchio, Cliff Conn, Eugene Eckstein, Dan Sorbo, Don Wessel.



Willie Adams (left) and Mark Baker (right) giving individual instruction.

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Affiliate Chapter Report

One of the oldest, active horological groups in the United States is the New York State Watchmakers Association. It was formed in 1938. Several noted horologists have been members. Henry Fried was the 1946 president of this group. Henry Frystak is a life member. The state organization is made up of two guilds, the Albany and Rochester chapters. There are 80 members between the two guilds. The state association has a yearly convention in September and a board meeting in late November. At each convention they utilize Bench Courses, Speakers, VCR, Slide and Tape Programs supplied by AWI.

The following report and photos were submitted by Dale E. LaDue, CMW.

The New York State Watchmaker's Association held their 60th annual convention September 25-27, 1998, in Syracuse, New York.

We were honored to have David A. Christianson, CMW, CMEW, President of AWI, present his bench course on the Seiko Kinetic wristwatch. His expertise and ability to convey his depth of knowledge to us were greatly appreciated.



David Christianson instructs Tracy Petrocy during the AWI Seiko Kinetic Bench Course.

President Mark Mongillo opened the convention with Friday night's board meeting. Business was tended to, committees appointed, and concerns addressed.

A full day of information was presented on Saturday. August Cornell started the program with his presentation on poor balance wheel motion, its causes and cures. It was an excellent discourse with visuals on understanding and adjusting the watch escapement.

David Christianson followed with a very informative program on restoration, repair, and conservation of clocks. His slides and talk explained in detail his methods of clock repair and restoration. David conveyed to us our responsibility to conserve antique clocks for future generations through proper repair techniques.

Tracy Petrocy, CMEW, finished out



AWI Seiko Kinetic Bench Course. Mark Mongillo and David Christianson.



August Cornell speaking on poor balance wheel motion.

Saturday's programs with a "hands on" quartz watch repair and tips seminar. Tracy handed out quartz watch movements with different problems. He then worked us through the problems utilizing diagnostic procedures from his experience and the technical repair guide.

The ladies program was presented by Carolyn Stella. Carolyn's program was on quilt making, piecing, and appliqué quilting in particular. She has displayed her work in many shows.

Saturday evening was our banquet. The keynote speaker was AWI president David Christianson. David spoke to us about AWI and its focus for the future. Stearns Cummings was awarded a certificate for 50 years membership in New York State Watchmaker's Association.

Sunday's program consisted of Dale E. LaDue, CMW, presenting and demonstrating techniques on repivoting. Dale's procedures included a quick drill-making technique, hardening and annealing techniques culminating in the repivoting of a balance staff.



David Christianson presenting a program on clock restoration and repair.



Tracy Petrocy presenting a quartz watch repair and tips seminar.



Saturday evening banquet.



David Christianson, AWI President, awarding Stearns Cummings his 50-year certificate.



Amedeo Sylvester, Paul Wadsworth, and Louis Stella looking on as Dale LaDue demonstrates repivoting techniques.



Repeater, Petite and Grande Sonnerie Clocks

Carriage Clocks, Part 39

Leo A. Jaroslaw

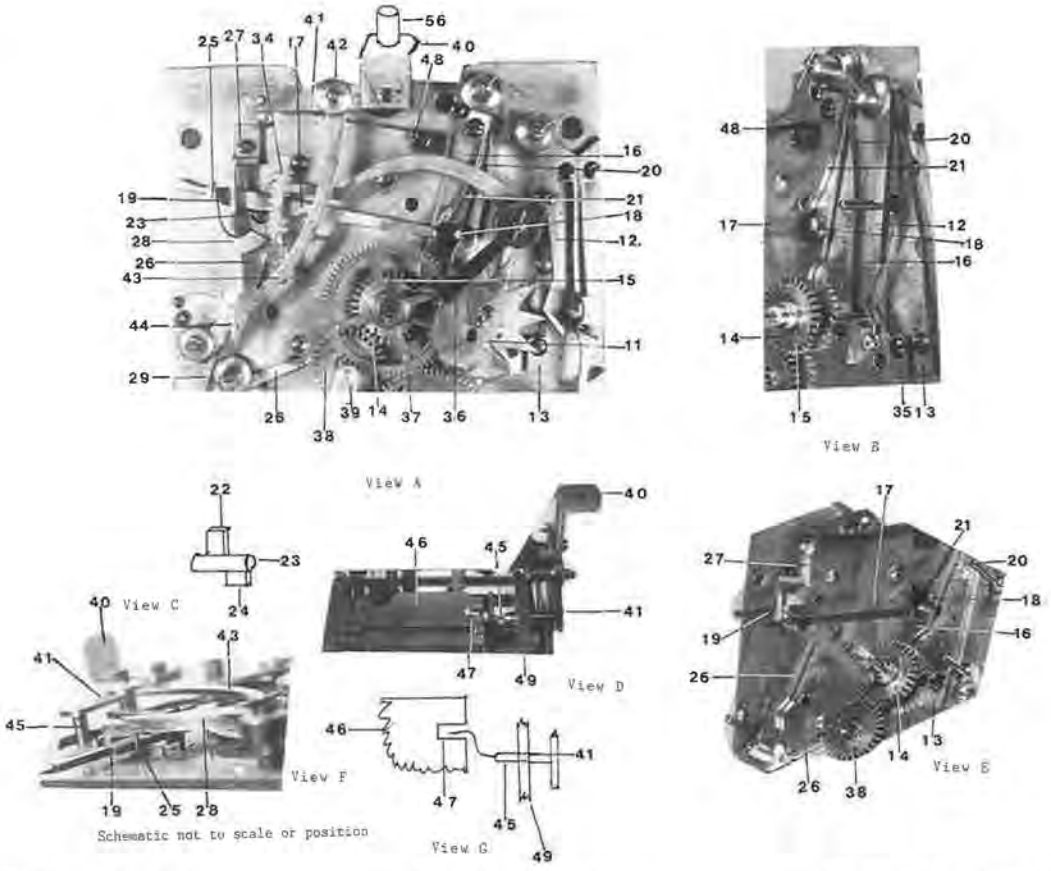
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Introduction

In Part 38 we covered the description of components and the operation of the hour strike system in typical carriage clocks. In this part we will start by describing the differences in the Drocourt clock and then go into the half-hour strike system.

The Drocourt Hour Strike (Figure 39.1)

The Drocourt hour strike is similar to the typical we discussed in Part 28. There are two exceptions: one is the repeat control, which will be discussed later; the other is the flirt guide (27), which is located in a different position. It



11 Hour Snail/Starwheel	23 Gathering Pallet	39 Minute Wheel Cock
12 Jumper	24 Gathering Face	40 Repeat Button
13 Jumper Spring	25 Flirt Knockout Pin	41 Repeat Lever
14 Cannon Pinion/Minute Pipe	26 Half-Hour Control Lever	42 Repeat Lever Pivot
15 Starwheel Pin	27 Flirt Guide	43 Repeat Arm
16 Flirt Vertical Arm	28 Rack Hook	44 Repeat Pin
17 Horizontal Arm	29 Rack Hook Spring	45 Warning Pin
18 Flirt Hinge Joint	34 Hour Rack	46 Strike Fan
19 Flirt Step	35 Hour Rack Spring	47 Fan Slots
20 Flirt Spring	36 Hour Rack Tail	48 Repeat Spring
21 Horizontal Arm Spring	37 Hour Wheel	49 Front Plate
22 Arm Lifter	38 Minute Wheel	56 Case Repeat Button

Figure 39.1. Drocourt Hour/Half-Hour, Repeat Controls

also acts as a stop for the rack hook (28) when the rack (34) is fully gathered and the hook falls beneath the rack.

As the components are practically the same as the typical described in Part 38, so is the operation of the system.

Drocourt Half-Hour Strike Component Description and Operation (Figures 39.1 and 39.2)

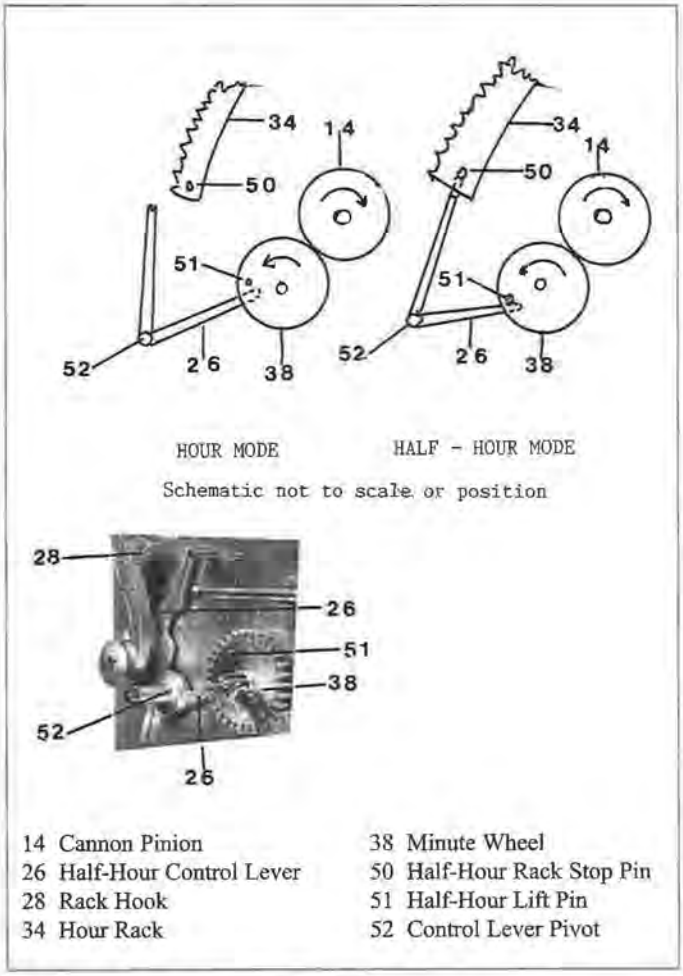


Figure 39.2. Half-Hour Controls

The half-hour strike is initiated by a lift pin (51) on the underside of the minute wheel, which rotates counterclockwise (CCW). As the time approaches the half hour this lift pin contacts the horizontal arm of the control lever (26). As it continues, the pin rotates the control lever clockwise (CW) compressing the half-hour lever spring (not shown). The vertical arm of the lever (26) ends up just under the hour rack (34) in line with the stop pin (50 half-hour mode schematic). Just about that time, the rack is released upon the half hour. The pin (50) drops onto the vertical arm of the control lever. This action limits the drop of the hour rack to allow only one stroke.

As the clock continues to run, the pin (51) under the minute wheel releases the control lever. The compressed spring (not shown) rotates the control lever CCW. A stop pin (not shown) limits its rotation. In this position the vertical arm is clear of the hour rack (hour mode schematic). On the hour, the rack is clear to fall until it is stopped by the rack tail (36) landing on a step of the hour snail (21).

Another Half-Hour Strike Control System - Component Description and Operation (Figure 39.3)

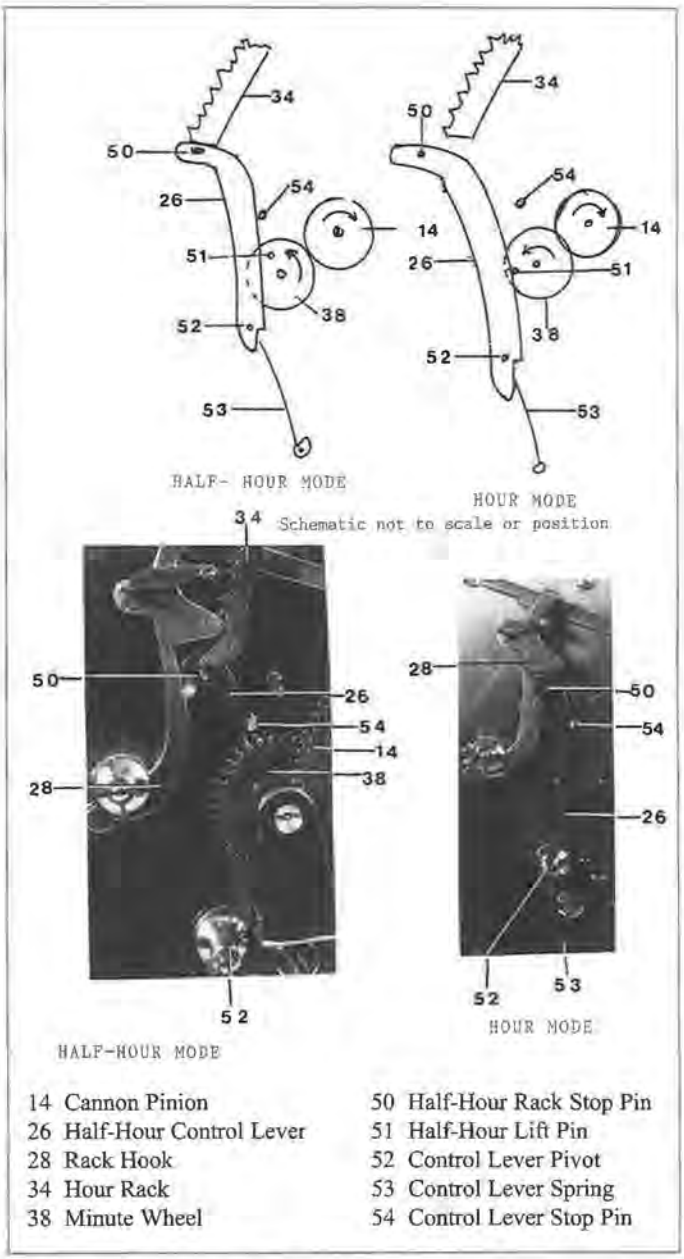


Figure 39.3. Another Half-Hour Control

As in the Drocourt system just described, the pinion revolving CW drives the minute wheel CCW. The pressure of the spring (53) against the stop pin (54) holds the control lever (26). In this position the rack stop pin (50), which is on the control lever, is directly under the hour rack (34). The control lever at this end is beneath the hour rack, which is riding on the pin (50 half-hour mode

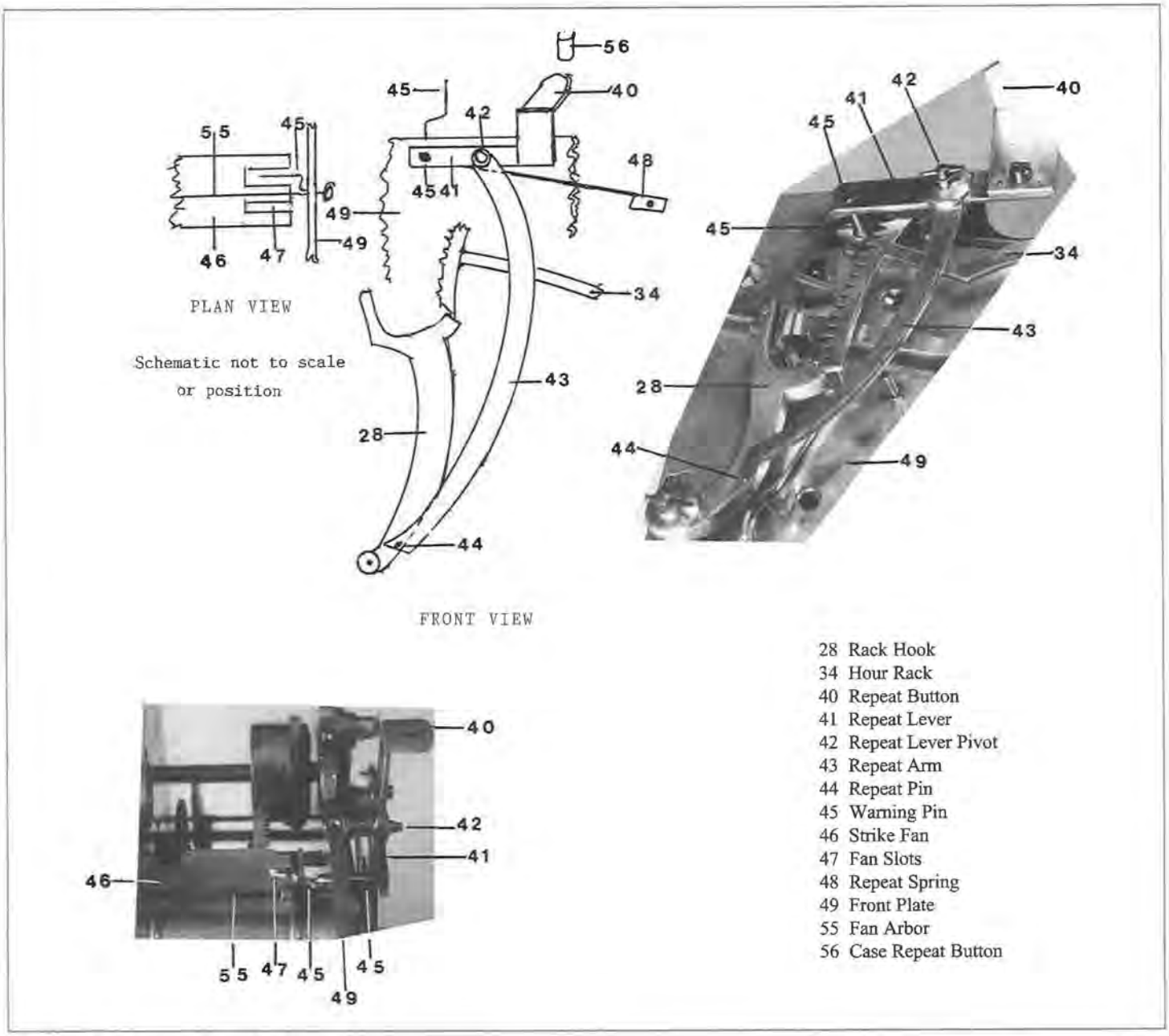


Figure 39.4. Repeat Control Schematic

schematic). This sets the hour rack for one strike on the half hour.

After the half-hour strike, as the clock continues to run, the half-hour lift pin (51) on the minute wheel contacts the control lever (hour mode schematic). As the rotation continues, the pin shifts the control lever CCW compressing the spring (53). At the maximum shift, the stop pin (50) is clear of the hour rack. When the hour rack drops on the hour, it rides over the control lever until it is stopped by the tail landing on a step of the hour snail.

Repeat Control System - Description and Operation (Figure 39.4)

When pressing the repeat button (56) to initiate the repeat, several actions take place sequentially. The case repeat button contacts and pushes down on the movement repeat button (40). This latter button is part of the repeat lever (41). This repeat lever is pivoted approximately at its center on the repeat lever pivot (42), rotating the lever CW. This movement raises the warning pin (45) within a slot in the front plate (49). The repeat arm (43) is also attached to the repeat lever at the point of the pivot. Therefore the repeat arm also travels CW. A pin, which I call the repeat pin (44), is on the underside of the lower end of the repeat arm. In the arm's travel CW, the pin contacts the rack hook (28) and lifts it out from under the hour rack (34) allowing the rack to drop. The rack tail drops onto the hour snail stopping on the last hour. This action also releases the gathering pallet and the strike train starts to run.

However, as mentioned above, the warning pin was lifted when the repeat lever was rotated. This lifting

of the warning pin took it out of the slot (47) in the fan and placed it in the path of the fan proper. The train is now stopped in warning. It is held there as long as the case repeat button is depressed.

When the button is released the spring rotates the lever CCW. The warning pin therefore drops back into position, in line with the slots. The fan is now able to rotate with the warning pin in the slots clear of the fan. The strike train strikes the last hour. If the time train were within one to two minutes of the hour, the hour snail would have already shifted to the next hour. In some cases the strike train would already be in normal warning. You would not get a repeat. In other clocks there is no warning in strike. The repeat would be the coming hour.

This completes Part 39. In Part 40 we will discuss the alarm system and controls.

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Dead Beat Escapement Pallet Face Regrinding

By Robert D. McLaughlin, BSME, MSME

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I think the way to start this article is to reflect on the numerous times that a clock has come into our shop where the pallet faces of the dead beat escapement exhibit deep wear grooves, or have been repaired by an individual who has left the faces rounded. The clock usually will not run in either case. What will be presented here is a method to correct this problem and the methodology to re-define the angles of the entrance and exit pallet faces. The article will also cover how to make and use some relatively simple tooling. The assumption has been made that most of my colleagues have a drill press and a small lathe and this article has been structured to the use of these tools.

In developing this method, two previously written articles, one very practical and the other quite mathematical will be referred to, but there is excellent correlation between the two.[1,2]

I would suggest that those who are interested obtain a copy of Reference 1, as that is the starting point.

Below are some definitions that will help.

PALLET ARM LENGTH (PAL) - The distance from the center of rotation of the anchor to the centerline going through the pallets.

REFERENCE CIRCLE or **Impulse Circle** - The circle that is used to define the pallet face angles and can be determined from physical measurement of the verge assembly.

The length of the pallet arm is obtained from the unit called the *Anchor Assembly*, or *Verge Assembly*. This is done by direct measurement with a dial caliper. In other words, if we measure the diameter of the verge shaft, the thickness of the pallets, and the overall distance from the outside of the verge shaft to the outside of the pallets, the arm length can then be calculated. See calculation below.

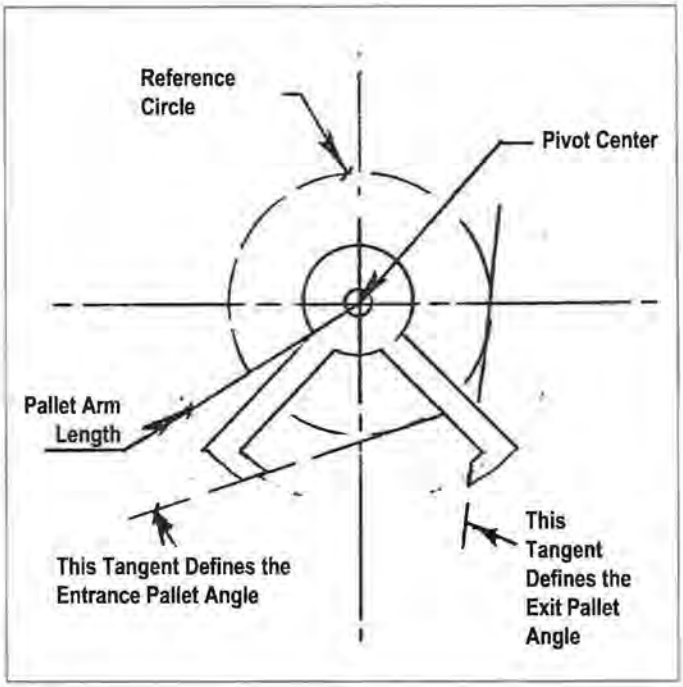


Figure 1.

Pallet Arm Length = (Overall Length) - (Verge Shaft Dia./2) - (Pallet Thickness/2)

PAL = (_____)-(_____/2)-(_____/2)

The pallet arm length and some data extracted from **Reference 1** will now be used to determine the Reference Circle.

The following data has been taken from **Reference 1**. This data is to be used as a given.

1 degree of lift is equal to ¼ of the pallet arm length.
1½ degrees of lift is equal to 3/8 of the pallet arm length.
2 degrees of lift is equal to ½ of the pallet arm length.
Most standard pendulums use 2 degrees of lift. Heavy pendulums (over 2 pounds) usually use 1½ degrees of lift. Vienna Regulators typically use 1½ to 1¾ degrees of lift.

From the measurement of the pallet arm length and the corresponding selection of the lift, the reference

Reference 1: "Restoring the Lift Angles of A Dead Beat Escapement," by Jerome M. Faier, CMC, *Horological Times*, August 1997, pages 24 & 25.

Reference 2: "Studies in the Dead Beat Escapement," A research project by Derwent Mercer, published in the *Watch and Clock Journal*. (I apologize for the lack of further information, as my copy does not show any publication dates). I do know that this article was funded by the Royal Society of London.

circle or impulse circle can now be determined.

Reference Circle diameter = Pallet Arm Length X (lift factor; 1¼, 3/8, ½)

RC or IC diameter = (_____) X (_____)

With the diameter known, draw the reference or impulse circle on a heavy piece of card stock. Then add a line tangent to this circle. We can now determine if the unit is a classic deadbeat. The pivot anchor shaft is now inserted into the center hole of the circle, which has been punched through the card stock. The pallet face angles are now compared to the tangent line. If the assembly is a classic deadbeat, both the pallet faces should match the tangent line at the exact same spot.

Refer to Figure 1. We have shown the tangents that are drawn through the entrance and exit pallet faces, which define the angles of these faces. The next step will be to fabricate a piece of hardware that will be used for grinding these angles. Figures 2 and 3 show the parts that make up the grinding disk assembly. The dimensions were selected to allow for its use in any lathe that is 8 mm or larger.

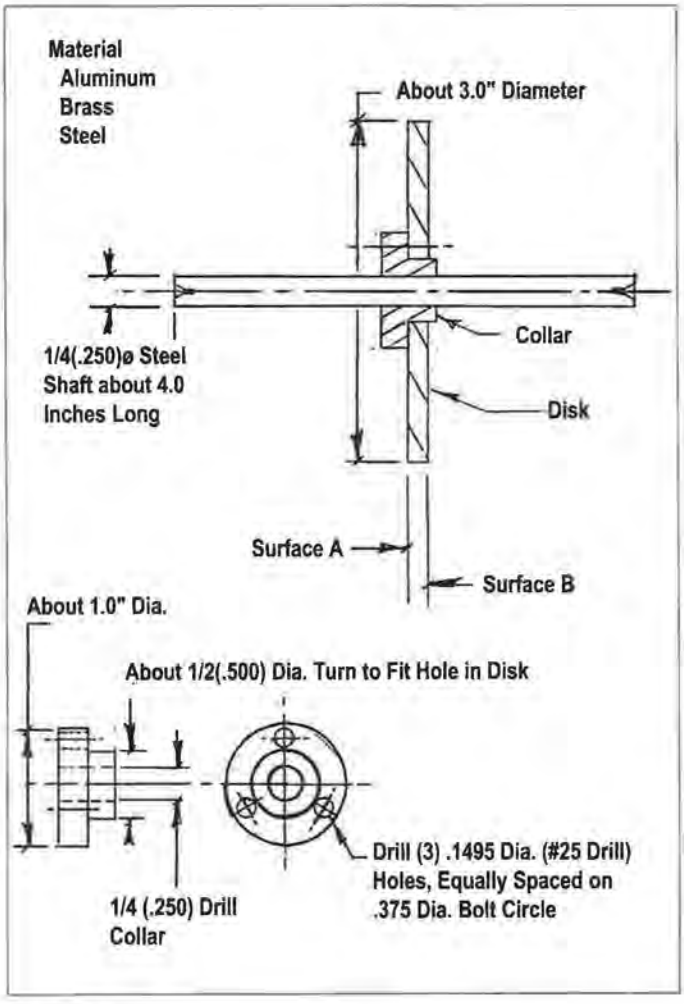


Figure 2.

NOTE: If you do not have a lathe that has collets large enough to accept a ¼ inch diameter shaft, the shaft can be center drilled on each end and the machining can be accomplished between centers. Drill the collar to fit the diameter of the shaft and attach it to the center of the shaft with **Loctite® Studlock**. Next, drill the hole in the disk so that the hub on the collar can be machined to fit the disk. After the **Loctite® Studlock** has cured, machine the hub

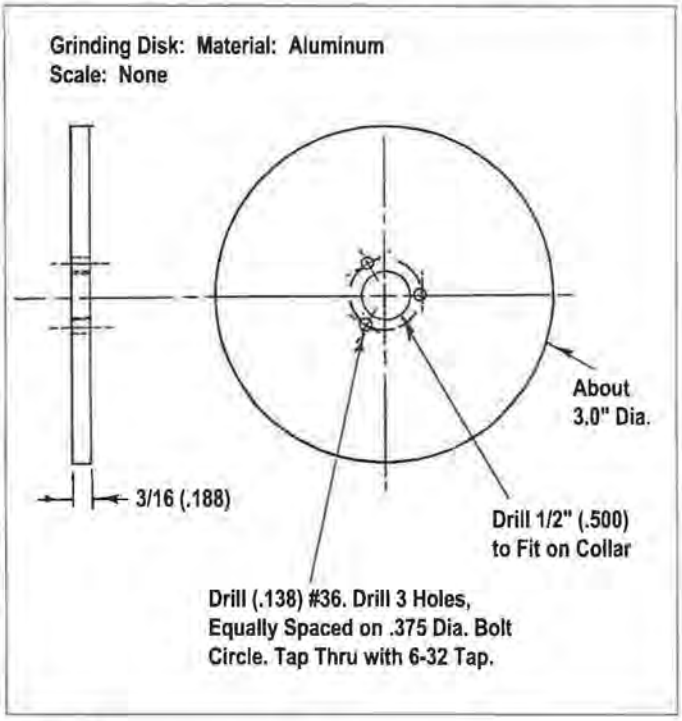


Figure 3.

to fit the disk, and attach the disk to the hub. The next step will be to set up the assembly in the lathe and machine both faces so that they are parallel. Once this is completed, the disk is finished as follows:

1. Apply double masking tape to one side;
2. Use a piece of 400- or 600-grit masking tape, cut out a center hole to fit over the shaft, and apply over the masking tape.
3. Trim the outside to match the disk diameter.
4. Repeat this process for the other side. Now the disk is completed.

Since a picture can be worth a thousand words, a picture of how the disk is used to grind the pallet faces would be helpful. Refer to Figure 4. This drawing shows the relationship between the grinding disk-shaft assembly, the verge or anchor assembly, and an item called the anchor platform. The platform has to be attached to the cross-slide of the lathe and it must be set up so that it is perpendicular to the grinding face of the disk. When in use, the grinding disk-shaft assembly is rotated at a reasonable speed by the lathe. The verge assembly is held so that the pallet face is maintained against the grinding disk

face with moderate pressure, and the cross-slide is moved in and out by use of the handle on the cross-slide assembly.

PLEASE NOTE. On many verge assemblies the crutch may not be removable, so the pallet faces will be seen as if you are looking at them from the rear of the clockworks.

The next two Figures 5 and 6 will show the verge and pallet face positions with the crutch up, and will define how the anchor platform is fabricated and set up. The

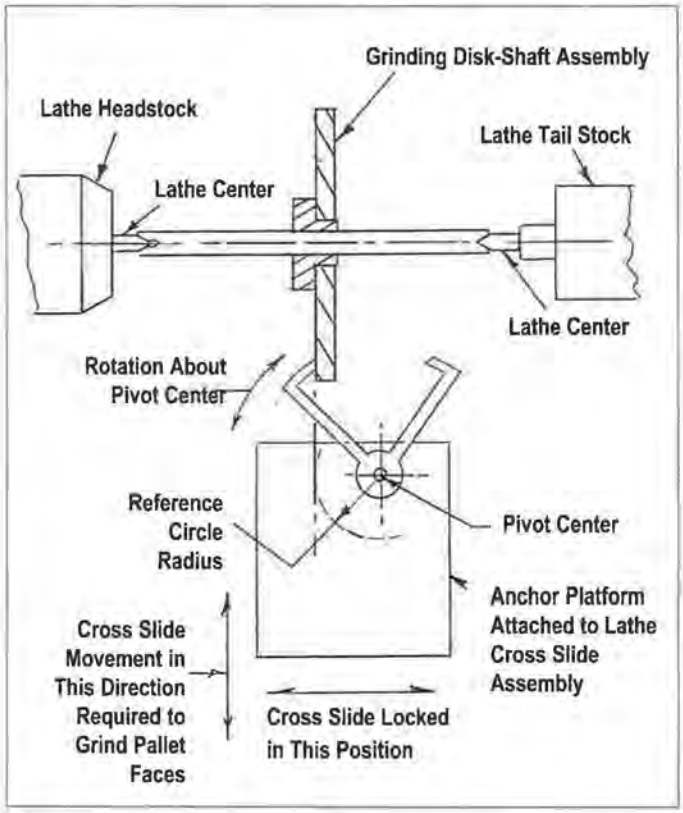


Figure 4.

anchor platform is the easiest of all the parts to fabricate and it requires only one set of three holes, for each of the entrance and exit pallets. Referring to Figure 5 the spacing between the alignment pin centerline (APC) and the pivot center for the entrance pallet is equal to APC = (Impulse Circle Radius) + (Diameter of Alignment Pin/2).

And the spacing for the exit pallet, see Figure 6,
APC = (Impulse Circle Radius) -(Diameter of Alignment Pin/2).

Fabrication of the anchor plate is easily done if one has a drill press with an **X** & **Y** stage. If not, the alignment pinholes can be drilled by clamping a guide to the table and drilling these holes at the same time. The pivot center can be located and drilled by using spacers, having the correct thickness and banked against the alignment pins. In practice, the pivot center should be drilled a few thousandths undersize and then opened with a cutting broach

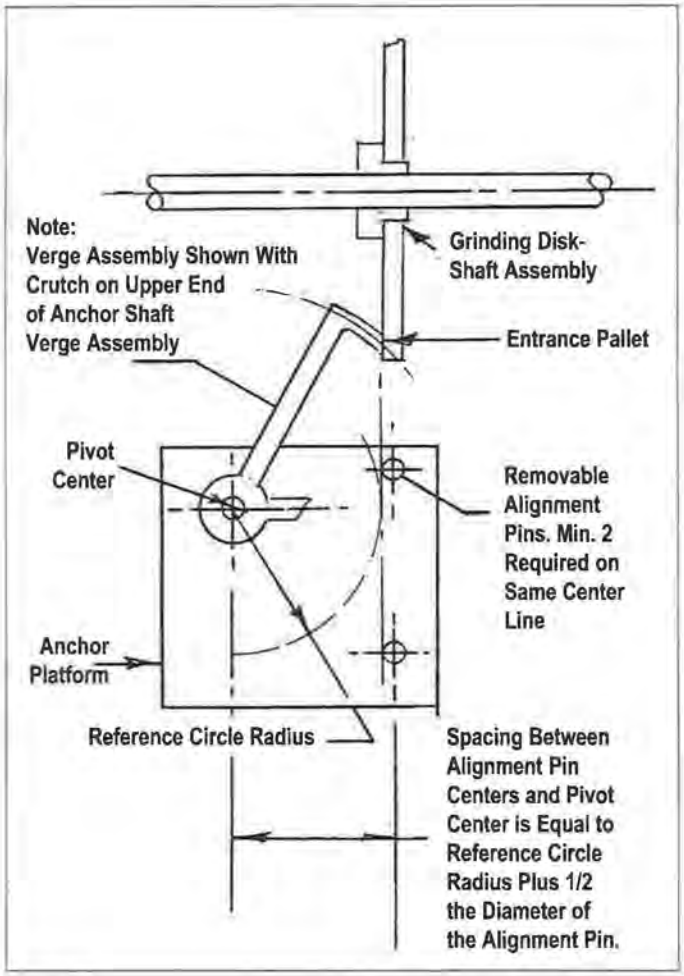


Figure 5.

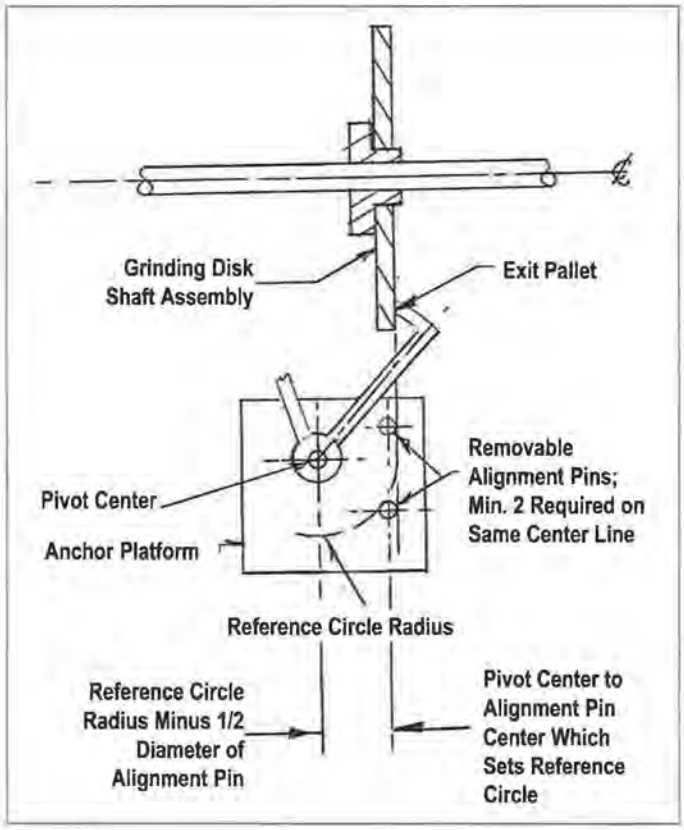


Figure 6.

to allow just enough clearance for rotation.

Now that the parts are all fabricated, the setup should be addressed. The two most important considerations are:

1. The platform must be 90 degrees to the grinding face, to insure that the pallet faces will not be ground at an angle.

2. The removable alignment pins that define the tangent to the reference circle must have their tangent points in line with the grinding disk face.

Item 1 can be accomplished by using a machinist square and shims at the tool post. Item 2 can be accomplished by clamping a piece of ground stock against the grinding face and at the same time adjusting the anchor platform so that the alignment pins are in contact with the ground stock. This is how one sets the tangent to the reference circle.

Before proceeding to grind the pallet faces be sure to measure the stick-out of each of the pallet faces with reference to their corresponding arm. These dimensions are necessary so that after grinding, both the entrance and exit pallets can be reset to their original dimensions. If the verge has adjustable pallets this is relatively easy to do, but if the pallets are fixed it may be necessary to add material to the faces and then regrind. To add material I have found that hard soldering a portion of a single-edge razor blade will work nicely.

The following is a Process Sheet to keep us trouble free.

Measure Stick-out of Pallets
Entrance Pallet: (_____)
Exit Pallet: (_____)
Diameter of Alignment Pins: (_____)

Diameter/2: (_____)
Pallet Arm Length: (_____)
Lift Factor: (_____)

Reference Circle; (PAL X LF): (_____)

Alignment Pin/Pivot Center Spacing;
Entrance Pallet:
(Ref. Circle Radius + Align Pin Dia./2) (_____)
Exit Pallet:
(Ref. Circle Radius - Align Pin Dia./2) (_____)

This article was written to help the many individuals who have struggled with the dead beat escapement. My method of going to the basics in it was so that more of my colleagues would have an opportunity to use it. I sincerely hope I have generated a paper that will be of use to many of you.





Oro Logics II: The Aurum Perspectives

Peter J. Kinberger,
Goldsmith

The Euro-American Ring Size Tables that follow, although formatted like the previously published U.S. Standard Tables, are different in some respects.

As mentioned before, the U.S. Standard is abased on equidistances of .032" between sizes. Equidistances in the E.A. Standard are abased on .80 mm between sizes.

The U.S. Standard calculations begin in the column noted as Inside Diameter in Inch Fractions in the previously published tables in this column series. All calculations in the U.S. Standard tables are based on this inch fraction column.

In the E.A. tables all calculations begin in the column marked Inner Diameter in mm. In this column the .80 mm equidistance becomes evident.

Equidistancing remains constant throughout the entire E.A. tables in the metric Inner Diameter and circumference columns; however, the inch fraction Diameter column indicates the lack of equal distances between whole sizes.

The U.S. tables are reversed in that equal distancing is found in the inch fraction Diameter column and not in the metric.

Apparently what seems to surface is that a legitimate sizing scale must be abased on diameters as the basis of all calculations and that there must be equal distancing between whole sizes. Both the E.A. and the U.S. Standard tables that are presented within this series of writings fit those two primary considerations.

One other consideration should be given to the ring blank length portion of these tables. Ring blank tables are frequently published detached from the primary ring size tables. Often times a ring blank table is published and elsewhere within the publication a ring size table is published. Too frequently these two tables have no direct relationship to each other.

In the E.A. and the U.S. Standard tables published within these writings both ring size tables and ring blank length tables are attached together to make one long continuous table by which all measurements and calculations are accountable in their direct relationships.

Finally, while these tables are exhaustive to the practical end, they are not completely exhaustive. This would require that the inch fraction equivalents to all metric information should also be calculated fully and completely. This would require about three thousand or more calculations or better to do for both tables. This work is still ongoing and may be published in another form with complete inch fraction equivalents for the entire table as a matter of academic interest. However, as Oro Logics II readers, you have the best of this information.

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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Ring Size Tables of the Euro-American Standard

Ring Size	x.03937	Begin Calculation +.80	×3.14159	Add .5 mm if wider than 4 mm. +1.57	+1.88	+2.51	+3.14	+4.08	+5.03	+6.60
		.40								
		1.20								
		2.00								
		2.80								
		3.60								
		4.40								
		5.20								
		6.00								
		6.80								
		7.60								
		8.40								
		9.20								
000	.394	10.00	31.41	32.98	33.29	33.92	34.55	35.49	36.44	38.01
00	.425	10.80	33.93	35.50	35.81	36.44	37.07	38.01	38.96	40.53
0	.457	11.60	36.44	38.01	38.32	38.95	39.58	40.52	41.47	43.04
1/8	.461	11.70	36.76	38.33	38.64	39.27	39.90	40.84	41.79	43.36
1/4	.464	11.80	37.07	38.64	38.95	39.58	40.21	41.15	42.10	43.67
3/8	.468	11.90	37.38	38.95	39.26	39.89	40.52	41.46	42.41	43.98
1/2	.472	12.00	37.70	39.27	39.58	40.21	40.84	41.78	42.73	44.30
5/8	.476	12.10	38.01	39.58	39.89	40.52	41.15	42.09	43.04	44.61
3/4	.480	12.20	38.33	39.90	40.21	40.84	41.47	42.41	43.36	44.93
7/8	.484	12.30	38.64	40.21	40.52	41.15	41.78	42.72	43.67	45.24
1	.488	12.40	38.95	40.52	40.83	41.46	42.09	43.03	43.98	45.55
1-1/8	.492	12.50	39.27	40.84	41.15	41.78	42.41	43.35	44.30	45.87
1-1/4	.496	12.60	39.58	41.15	41.46	42.09	42.72	43.66	44.61	46.18
1-3/8	.500	12.70	39.90	41.47	41.78	42.41	43.04	43.98	44.93	46.50
1-1/2	.504	12.80	40.21	41.78	42.09	42.72	43.35	44.29	45.24	46.81
1-5/8	.508	12.90	40.53	42.10	42.41	43.04	43.67	44.61	45.56	47.13
1-3/4	.512	13.00	40.84	42.41	42.72	43.35	43.98	44.92	45.87	47.44
1-7/8	.516	13.10	41.15	42.72	43.03	43.66	44.29	45.23	46.18	47.75
2	.520	13.20	41.47	43.04	43.35	43.98	44.61	45.55	46.50	48.07
2-1/8	.524	13.30	41.78	43.35	43.66	44.29	44.92	45.86	46.81	48.38
2-1/4	.527	13.40	42.10	43.67	43.98	44.61	45.24	46.18	47.13	48.70
2-3/8	.531	13.50	42.41	43.98	44.29	44.92	45.55	46.49	47.44	49.01
2-1/2	.535	13.60	42.72	44.29	44.60	45.23	45.86	46.80	47.75	49.32
2-5/8	.539	13.70	43.04	44.61	44.92	45.55	46.18	47.12	48.07	49.64
2-3/4	.543	13.80	43.35	44.92	45.23	45.86	46.49	47.43	48.38	49.95
2-7/8	.547	13.90	43.67	45.24	45.55	46.18	46.81	47.75	48.70	50.27
3	.551	14.00	43.98	45.55	45.86	46.49	47.12	48.06	49.01	50.58
3-1/8	.555	14.10	44.30	45.87	46.18	46.81	47.44	48.38	49.33	50.90
3-1/4	.559	14.20	44.61	46.18	46.49	47.12	47.75	48.69	49.64	51.21
3-3/8	.563	14.30	44.92	46.49	46.80	47.43	48.06	49.00	49.95	51.52
3-1/2	.567	14.40	45.24	46.81	47.12	47.75	48.38	49.32	50.27	51.84
3-5/8	.571	14.50	45.55	47.12	47.43	48.06	48.69	49.63	50.58	52.15
3-3/4	.575	14.60	45.87	47.44	47.75	48.38	49.01	49.95	50.90	52.47
3-7/8	.579	14.70	46.18	47.75	48.06	48.69	49.32	50.26	51.21	52.78
	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 Euro-American Standard

Ring Size	Begin Calculation x.03937	+.80	×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	.583	14.80	46.49	48.06	48.37	49.00	49.63	50.57	51.52	53.09
4-1/8	.587	14.90	46.81	48.38	48.69	49.32	49.95	50.89	51.84	53.41
4-1/4	.590	15.00	47.12	48.69	49.00	49.63	50.26	51.20	52.15	53.72
4-3/8	.594	15.10	47.44	49.01	49.32	49.95	50.58	51.52	52.47	54.04
4-1/2	.598	15.20	47.75	49.32	49.63	50.26	50.89	51.83	52.78	54.35
4-5/8	.602	15.30	48.07	49.64	49.95	50.58	51.21	52.15	53.10	54.67
4-3/4	.606	15.40	48.38	49.95	50.26	50.89	51.52	52.46	53.41	54.98
4-7/8	.610	15.50	48.69	50.26	50.57	51.20	51.83	52.77	53.72	55.29
5	.614	15.60	49.01	50.58	50.89	51.52	52.15	53.09	54.04	55.61
5-1/8	.618	15.70	49.32	50.89	51.20	51.83	52.46	53.40	54.35	55.92
5-1/4	.622	15.80	49.64	51.21	51.52	52.15	52.78	53.72	54.67	56.24
5-3/8	.626	15.90	49.95	51.52	51.83	52.46	53.09	54.03	54.98	56.55
5-1/2	.630	16.00	50.26	51.83	52.14	52.77	53.40	54.34	55.29	56.86
5-5/8	.634	16.10	50.58	52.15	52.46	53.09	53.72	54.66	55.61	57.18
5-3/4	.638	16.20	50.89	52.46	52.77	53.40	54.03	54.97	55.92	57.49
5-7/8	.642	16.30	51.21	52.78	53.09	53.72	54.35	55.29	56.24	57.81
6	.646	16.40	51.52	53.09	53.40	54.03	54.66	55.60	56.55	58.12
6-1/8	.650	16.50	51.84	53.41	53.72	54.35	54.98	55.92	56.87	58.44
6-1/4	.654	16.60	52.15	53.72	54.03	54.66	55.29	56.23	57.18	58.75
6-3/8	.657	16.70	52.46	54.03	54.34	54.97	55.60	56.54	57.49	59.06
6-1/2	.661	16.80	52.78	54.35	54.66	55.29	55.92	56.86	57.81	59.38
6-5/8	.665	16.90	53.09	54.66	54.97	55.60	56.23	57.17	58.12	59.69
6-3/4	.669	17.00	53.41	54.98	55.29	55.92	56.55	57.49	58.44	60.01
6-7/8	.673	17.10	53.72	55.29	55.60	56.23	56.86	57.80	58.75	60.32
7	.677	17.20	54.03	55.60	55.91	56.54	57.17	58.11	59.06	60.63
7-1/8	.681	17.30	54.35	55.92	56.23	56.86	57.49	58.43	59.38	60.95
7-1/4	.685	17.40	54.66	56.23	56.54	57.17	57.80	58.74	59.69	61.26
7-3/8	.689	17.50	54.98	56.55	56.86	57.49	58.12	59.06	60.01	61.58
7-1/2	.693	17.60	55.29	56.86	57.17	57.80	58.43	59.37	60.32	61.89
7-5/8	.697	17.70	55.61	57.18	57.49	58.12	58.75	59.69	60.64	62.21
7-3/4	.701	17.80	55.92	57.49	57.80	58.43	59.06	60.00	60.95	62.52
7-7/8	.705	17.90	56.23	57.80	58.11	58.74	59.37	60.31	61.26	62.83
8	.709	18.00	56.55	58.12	58.43	59.06	59.69	60.63	61.58	63.15
8-1/8	.712	18.10	56.86	58.43	58.74	59.37	60.00	60.94	61.89	63.46
8-1/4	.716	18.20	57.18	58.75	59.06	59.69	60.32	61.26	62.21	63.78
8-3/8	.720	18.30	57.49	59.06	59.37	60.00	60.63	61.57	62.52	64.09
8-1/2	.724	18.40	57.80	59.37	59.68	60.31	60.94	61.88	62.83	64.40
8-5/8	.728	18.50	58.12	59.69	60.00	60.63	61.26	62.20	63.15	64.72
8-3/4	.732	18.60	58.43	60.00	60.31	60.94	61.57	62.51	63.46	65.03
8-7/8	.736	18.70	58.75	60.32	60.63	61.26	61.89	62.83	63.78	65.35
9	.740	18.80	59.06	60.63	60.94	61.57	62.20	63.14	64.09	65.66
9-1/8	.744	18.90	59.38	60.95	61.26	61.89	62.52	63.46	64.41	65.98
9-1/4	.748	19.00	59.69	61.26	61.57	62.20	62.83	63.77	64.72	66.29
9-3/8	.752	19.10	60.00	61.57	61.88	62.51	63.14	64.08	65.03	66.60
9-1/2	.756	19.20	60.32	61.89	62.20	62.83	63.46	64.40	65.35	66.92
9-5/8	.760	19.30	60.63	62.20	62.51	63.14	63.77	64.71	65.66	67.23
	Inner Diameter in Inch Fraction	Inner Diameter in mm	Inner Circumference in mm	24	22	20	18	16	14	12
				0.5 mm	0.6 mm	0.8 mm	1 mm	1.3 mm	1.6 mm	2.1 mm
							Gauges			
							Ring Blank Lengths			

Ring Size Tables of the Euro-American Standard

Ring Size	Begin Calculation x.03937	+.80	×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	.764	19.40	60.95	62.52	62.83	63.46	64.09	65.03	65.98	67.55
9-7/8	.768	19.50	61.26	62.83	63.14	63.77	64.40	65.34	66.29	67.86
10	.772	19.60	61.57	63.14	63.45	64.08	64.71	65.65	66.60	68.17
10-1/8	.775	19.70	61.89	63.46	63.77	64.40	65.03	65.97	66.92	68.49
10-1/4	.779	19.80	62.20	63.77	64.08	64.71	65.34	66.28	67.23	68.80
10-3/8	.783	19.90	62.52	64.09	64.40	65.03	65.66	66.60	67.55	69.12
10-1/2	.787	20.00	62.83	64.40	64.71	65.34	65.97	66.91	67.86	69.43
10-5/8	.791	20.10	63.15	64.72	65.03	65.66	66.29	67.23	68.18	69.75
10-3/4	.795	20.20	63.46	65.03	65.34	65.97	66.60	67.54	68.49	70.06
10-7/8	.799	20.30	63.77	65.34	65.65	66.28	66.91	67.85	68.80	70.37
11	.803	20.40	64.09	65.66	65.97	66.60	67.23	68.17	69.12	70.69
11-1/8	.807	20.50	64.40	65.97	66.28	66.91	67.54	68.48	69.43	71.00
11-1/4	.811	20.60	64.72	66.29	66.60	67.23	67.86	68.80	69.75	71.32
11-3/8	.815	20.70	65.03	66.60	66.91	67.54	68.17	69.11	70.06	71.63
11-1/2	.819	20.80	65.34	66.91	67.22	67.85	68.48	69.42	70.37	71.94
11-5/8	.823	20.90	65.66	67.23	67.54	68.17	68.80	69.74	70.69	72.26
11-3/4	.827	21.00	65.97	67.54	67.85	68.48	69.11	70.05	71.00	72.57
11-7/8	.831	21.10	66.29	67.86	68.17	68.80	69.43	70.37	71.32	72.89
12	.835	21.20	66.60	68.17	68.48	69.11	69.74	70.68	71.63	73.20
12-1/8	.838	21.30	66.91	68.48	68.79	69.42	70.05	70.99	71.94	73.51
12-1/4	.842	21.40	67.23	68.80	69.11	69.74	70.37	71.31	72.26	73.83
12-3/8	.846	21.50	67.54	69.11	69.42	70.05	70.68	71.62	72.57	74.14
12-1/2	.850	21.60	67.86	69.43	69.74	70.37	71.00	71.94	72.89	74.46
12-5/8	.854	21.70	68.17	69.74	70.05	70.68	71.31	72.25	73.20	74.77
12-3/4	.858	21.80	68.49	70.06	70.37	71.00	71.63	72.57	73.52	75.09
12-7/8	.862	21.90	68.80	70.37	70.68	71.31	71.94	72.88	73.83	75.40
13	.866	22.00	69.11	70.68	70.99	71.62	72.25	73.19	74.14	75.71
13-1/8	.870	22.10	69.43	71.00	71.31	71.94	72.57	73.51	74.46	76.03
13-1/4	.874	22.20	69.74	71.31	71.62	72.25	72.88	73.82	74.77	76.34
13-3/8	.878	22.30	70.06	71.63	71.94	72.57	73.20	74.14	75.09	76.66
13-1/2	.882	22.40	70.37	71.94	72.25	72.88	73.51	74.45	75.40	76.97
13-5/8	.886	22.50	70.68	72.25	72.56	73.19	73.82	74.76	75.71	77.28
13-3/4	.890	22.60	70.99	72.56	72.87	73.50	74.13	75.07	76.02	77.59
13-7/8	.894	22.70	71.31	72.88	73.19	73.82	74.45	75.39	76.34	77.91
14	.898	22.80	71.63	73.20	73.51	74.14	74.77	75.71	76.66	78.23
14-1/8	.901	22.90	71.94	73.51	73.82	74.45	75.08	76.02	76.97	78.54
14-1/4	.905	23.00	72.26	73.83	74.14	74.77	75.40	76.34	77.29	78.86
14-3/8	.909	23.10	72.57	74.14	74.45	75.08	75.71	76.65	77.60	79.17
14-1/2	.913	23.20	72.88	74.45	74.76	75.39	76.02	76.96	77.91	79.48
14-5/8	.917	23.30	73.20	74.77	75.08	75.71	76.34	77.28	78.23	79.80
14-3/4	.921	23.40	73.51	75.08	75.39	76.02	76.65	77.59	78.54	80.11
14-7/8	.925	23.50	73.83	75.40	75.71	76.34	76.97	77.91	78.86	80.43
15	.929	23.60	74.14	75.71	76.02	76.65	77.28	78.22	79.17	80.74
15-1/8	.933	23.70	74.45	76.02	76.33	76.96	77.59	78.53	79.48	81.05
15-1/4	.937	23.80	74.77	76.34	76.65	77.28	77.91	78.85	79.80	81.37
15-3/8	.941	23.90	75.08	76.65	76.96	77.59	78.22	79.16	80.11	81.68
	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 Euro-American Standard

Ring Size	Begin Calculation x.03937	+.80	×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	.945	24.00	75.40	76.97	77.28	77.91	78.54	79.48	80.43	82.00
15-5/8	.949	24.10	75.71	77.28	77.59	78.22	78.85	79.79	80.74	82.31
15-3/4	.953	24.20	76.03	77.60	77.91	78.54	79.17	80.11	81.06	82.63
15-7/8	.957	24.30	76.34	77.91	78.22	78.85	79.48	80.42	81.37	82.94
16	.961	24.40	76.65	78.22	78.53	79.16	79.79	80.73	81.68	83.25
16-1/8	.964	24.50	76.97	78.54	78.85	79.48	80.11	81.05	82.00	83.57
16-1/4	.968	24.60	77.28	78.85	79.16	79.79	80.42	81.36	82.31	83.88
16-3/8	.972	24.70	77.60	79.17	79.48	80.11	80.74	81.68	82.63	84.20
16-1/2	.976	24.80	77.91	79.48	79.79	80.42	81.05	81.99	82.94	84.51
16-5/8	.980	24.90	78.22	79.79	80.10	80.73	81.36	82.30	83.25	84.82
16-3/4	.984	25.00	78.54	80.11	80.42	81.05	81.68	82.62	83.57	85.14
16-7/8	.988	25.10	78.85	80.42	80.73	81.36	81.99	82.93	83.88	85.45
17	.992	25.20	79.17	80.74	81.05	81.68	82.31	83.25	84.20	85.77
17-1/8	.996	25.30	79.48	81.05	81.36	81.99	82.62	83.56	84.51	86.08
17-1/4	.999	25.40	79.80	81.37	81.68	82.31	82.94	83.88	84.83	86.40
17-3/8	1.004	25.50	80.11	81.68	81.99	82.62	83.25	84.19	85.14	86.71
17-1/2	1.008	25.60	80.42	81.99	82.30	82.93	83.56	84.50	85.45	87.02
17-5/8	1.012	25.70	80.74	82.31	82.62	83.25	83.88	84.82	85.77	87.34
17-3/4	1.016	25.80	81.05	82.62	82.93	83.56	84.19	85.13	86.08	87.65
17-7/8	1.019	25.90	81.37	82.94	83.25	83.88	84.51	85.45	86.40	87.97
18	1.023	26.00	81.68	83.25	83.56	84.19	84.82	85.76	86.71	88.28
18-1/8	1.027	26.10	81.99	83.56	83.87	84.50	85.13	86.07	87.02	88.59
18-1/4	1.031	26.20	82.31	83.88	84.19	84.82	85.45	86.39	87.34	88.91
18-3/8	1.035	26.30	82.62	84.19	84.50	85.13	85.76	86.70	87.65	89.22
18-1/2	1.039	26.40	82.94	84.51	84.82	85.45	86.08	87.02	87.97	89.54
18-5/8	1.043	26.50	83.25	84.82	85.13	85.76	86.39	87.33	88.28	89.85
18-3/4	1.047	26.60	83.57	85.14	85.45	86.08	86.71	87.65	88.60	90.17
18-7/8	1.051	26.70	83.88	85.45	85.76	86.39	87.02	87.96	88.91	90.48
19	1.055	26.80	84.19	85.76	86.07	86.70	87.33	88.27	89.22	90.79
19-1/8	1.059	26.90	84.51	86.08	86.39	87.02	87.65	88.59	89.54	91.11
19-1/4	1.063	27.00	84.82	86.39	86.70	87.33	87.96	88.90	89.85	91.42
19-3/8	1.067	27.10	85.14	86.71	87.02	87.65	88.28	89.22	90.17	91.74
19-1/2	1.071	27.20	85.45	87.02	87.33	87.96	88.59	89.53	90.48	92.05
19-5/8	1.075	27.30	85.76	87.33	87.64	88.27	88.90	89.84	90.79	92.36
19-3/4	1.079	27.40	86.08	87.65	87.96	88.59	89.22	90.16	91.11	92.68
19-7/8	1.083	27.50	86.39	87.96	88.27	88.90	89.53	90.47	91.42	92.99
20	1.087	27.60	86.71	88.28	88.59	89.22	89.85	90.79	91.74	93.31
20-1/8	1.091	27.70	87.02	88.59	88.90	89.53	90.16	91.10	92.05	93.62
20-1/4	1.094	27.80	87.34	88.91	89.22	89.85	90.48	91.42	92.37	93.94
20-3/8	1.098	27.90	87.65	89.22	89.53	90.16	90.79	91.73	92.58	94.25
20-1/2	1.102	28.00	87.96	89.53	89.84	90.47	91.10	92.04	92.99	94.56
20-5/8	1.106	28.10	88.28	89.85	90.16	90.79	91.42	92.36	93.31	94.88
20-3/4	1.110	28.20	88.59	90.16	90.47	91.10	91.73	92.67	93.62	95.19
20-7/8	1.114	28.30	88.91	90.48	90.79	91.42	92.05	92.99	93.94	95.51
21	1.118	28.40	89.22	90.79	91.10	91.73	92.36	93.30	94.25	95.82
21-1/8	1.122	28.50	89.53	91.10	91.41	92.04	92.67	93.61	94.56	96.13
	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 Euro-American Standard

Ring Size	Begin Calculation x.03937	+.80	×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	1.126	28.60	89.85	91.42	91.73	92.36	92.99	93.93	94.88	96.45
21-3/8	1.130	28.70	90.16	91.73	92.04	92.67	93.30	94.24	95.19	96.76
21-1/2	1.134	28.80	90.48	92.05	92.36	92.99	93.62	94.56	95.51	97.08
21-5/8	1.138	28.90	90.79	92.36	92.67	93.30	93.93	94.87	95.82	97.39
21-3/4	1.142	29.00	91.11	92.68	92.99	93.62	94.25	95.19	96.14	97.71
21-7/8	1.146	29.10	91.42	92.99	93.30	93.93	94.56	95.50	96.45	98.02
22	1.150	29.20	91.73	93.30	93.61	94.24	94.87	95.81	96.76	98.33
22-1/8	1.154	29.30	92.05	93.62	93.93	94.56	95.19	96.13	97.08	98.65
22-1/4	1.157	29.40	92.36	93.93	94.24	94.87	95.50	96.44	97.39	98.96
22-3/8	1.161	29.50	92.68	94.25	94.56	95.19	95.82	96.76	97.71	99.28
22-1/2	1.165	29.60	92.99	94.56	94.87	95.50	96.13	97.07	98.02	99.59
22-5/8	1.169	29.70	93.30	94.87	95.18	95.81	96.44	97.38	98.33	99.90
22-3/4	1.173	29.80	93.62	95.19	95.50	96.13	96.76	97.70	98.65	100.22
22-7/8	1.177	29.90	93.93	95.50	95.81	96.44	97.07	98.01	98.96	100.53
23	1.181	30.00	94.25	95.82	96.13	96.76	97.39	98.33	99.28	100.85
23-1/8	1.185	30.10	94.56	96.13	96.44	97.07	97.70	98.64	99.59	101.16
23-1/4	1.189	30.20	94.88	96.45	96.76	97.39	98.02	98.96	99.91	101.48
23-3/8	1.193	30.30	95.19	96.76	97.07	97.70	98.33	99.27	100.22	101.79
23-1/2	1.197	30.40	95.50	97.07	97.38	98.01	98.64	99.58	100.53	102.10
23-5/8	1.201	30.50	95.82	97.39	97.70	98.33	98.96	99.90	100.85	102.42
23-3/4	1.205	30.60	96.13	97.70	98.02	98.64	99.27	100.21	101.16	102.73
23-7/8	1.209	30.70	96.45	98.02	98.33	98.96	99.59	100.53	101.48	103.05
24	1.212	30.80	96.76	98.33	98.64	99.27	99.90	100.84	101.79	103.36
24-1/8	1.216	30.90	97.07	98.64	98.95	99.58	100.21	101.15	102.10	103.67
24-1/4	1.220	31.00	97.39	98.96	99.27	99.90	100.53	101.47	102.42	103.99
24-3/8	1.224	31.10	97.70	99.27	99.58	100.21	100.84	101.78	102.73	104.30
24-1/2	1.228	31.20	98.02	99.59	99.90	100.53	101.16	102.10	103.05	104.62
24-5/8	1.232	31.30	98.33	99.90	100.21	100.84	101.47	102.41	103.36	104.93
24-3/4	1.236	31.40	98.65	100.22	100.53	101.16	101.79	102.73	103.68	105.25
24-7/8	1.240	31.50	98.96	100.53	100.84	101.47	102.10	103.04	103.99	105.56
25	1.244	31.60	99.27	100.84	101.15	101.78	102.41	103.35	104.30	105.87
25-1/8	1.248	31.70	99.59	101.16	101.47	102.10	102.73	103.67	104.62	106.19
25-1/4	1.252	31.80	99.90	101.47	101.78	102.41	103.04	103.98	104.93	106.50
25-3/8	1.256	31.90	100.22	101.79	102.10	102.73	103.36	104.30	105.25	106.82
25-1/2	1.260	32.00	100.53	102.10	102.41	103.04	103.67	104.61	105.56	107.13
25-5/8	1.264	32.10	100.84	102.41	102.72	103.35	103.98	104.92	105.87	107.44
25-3/4	1.268	32.20	101.16	102.73	103.04	103.67	104.30	105.24	106.19	107.76
25-7/8	1.272	32.30	101.47	103.04	103.35	103.98	104.61	105.55	106.50	108.07
26	1.275	32.40	101.79	103.36	103.67	104.30	104.93	105.87	106.82	108.39

	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						

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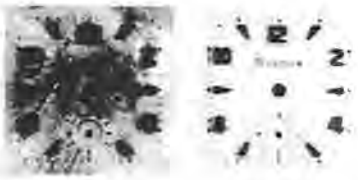
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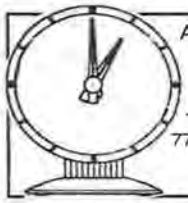
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27-March 2	Phase II - Clockmakers Micro Lathe Fairfax, VA	Roy Hovey $260.00
• 28	Auto-Quartz Minneapolis, MN	Tamara Houk $65.00
• 28	Sequential Chime Minneapolis, MN	Jim Williams $65.00
MARCH 1999		
13-14	Clock Escapements Sacramento, CA	Jerry Faier $130.00
19-22	Phase II - Watch/Clockmakers Lathe Program Irvine, CA	Roy Hovey $260.00
APRIL 1999		
2-5	Phase I - Clockmakers Micro Lathe Program Austin, TX	Roy Hovey $350.00
16-19	Phase I - Micro Lathe Program Springfield, MO	Roy Hovey $350.00
MAY 1999		
14-17	Racks & Snails Lathe Course Charlotte, NC	Roy Hovey $350.00
• 28	Seiko Kinetic Quartz Watch Repair Boone, NC	David Christianson $75.00
JUNE 1999		
5-6	American Pocket Watches Austin, TX	Alice Carpenter $130.00
11-14	Phase III - Watch/Clockmakers Lathe Program Irvine, CA	Roy Hovey $260.00
JULY 1999		
16-19	Phase I - Watch/Clockmakers Lathe Program Tampa, FL	Roy Hovey $350.00
AUGUST 1999		
7-10	Phase III - Watchmakers Lathe/Clockmakers Micro Lathe Fairfax, VA	Roy Hovey $260.00
20-23	Phase IV-A - Watch/Clockmakers Lathe Program Irvine, CA	Roy Hovey $440.00
SEPTEMBER 1999		
17-20	Phase IV-B - Watch/Clockmakers Lathe Program Irvine, CA	Roy Hovey $440.00

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18-21	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	Turning Between Centers	Stewart Lesemann	$250.00
22-26	Chronograph Repair	Jim Lubic/Tamara Houk	$250.00
MARCH 1999			
22-26	Basic Electronics & Meter Reading	Jim Lubic	$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
JUNE 1999			
1-4	CEWT & CMEW Examinations	Jim Lubic	Exam Fee
7-11	CW & CMW Examinations	Jim Lubic	Exam Fee

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DATE	CLASS	INSTRUCTOR	FEE
MAY 1999			
3-7	Course I Introduction to Jewelry Repair	David Christianson	$595.00
AUGUST 1999			
16-20	Course I Introduction to Jewelry Repair	David Christianson	$595.00
TO BE ANNOUNCED			
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   a. keep the present format ____
   b. go back to floral or landscape covers ____
   c. include the following cover topics: _____

2. The following are current regular features in *Horological Times*. Please rate these features from 1 to 5, with 1 being abysmally low and a 5 indicating that life would lose meaning without it:

____	President's Message	____	Questions & Answers
____	Executive Director's Message	____	Bulletin Board
____	Letters to the Editor	____	From the Workshop
____	Education Update	____	Battery of Information
____	Affiliate Chapter Report	____	Material Search

3. The following are regular contributors to *Horological Times*. Please rate these authors' work on the scale of 1 to 5 on the basis of quality of writing, technical expertise and relevance to your knowledge needs:

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4. The following are ideas for new features in *Horological Times*. Please use the scale of 1 to 5 to rate whether the magazine should invest space in them:

____	Business and Tax Tips	____	Restoration and Conservation
____	Quartz and Basic Electronics	____	More information about new products & manufacturers
____	Hazardous Waste and EPA Rules	____	Craftsman of the Month (our members)
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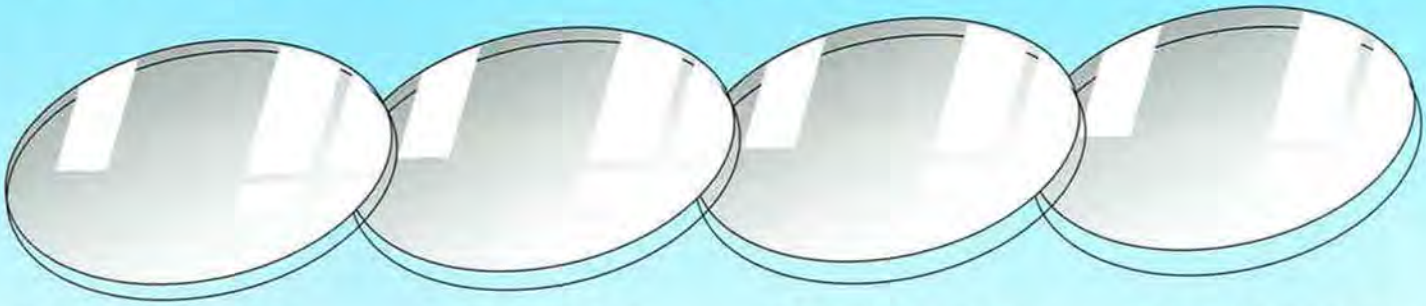
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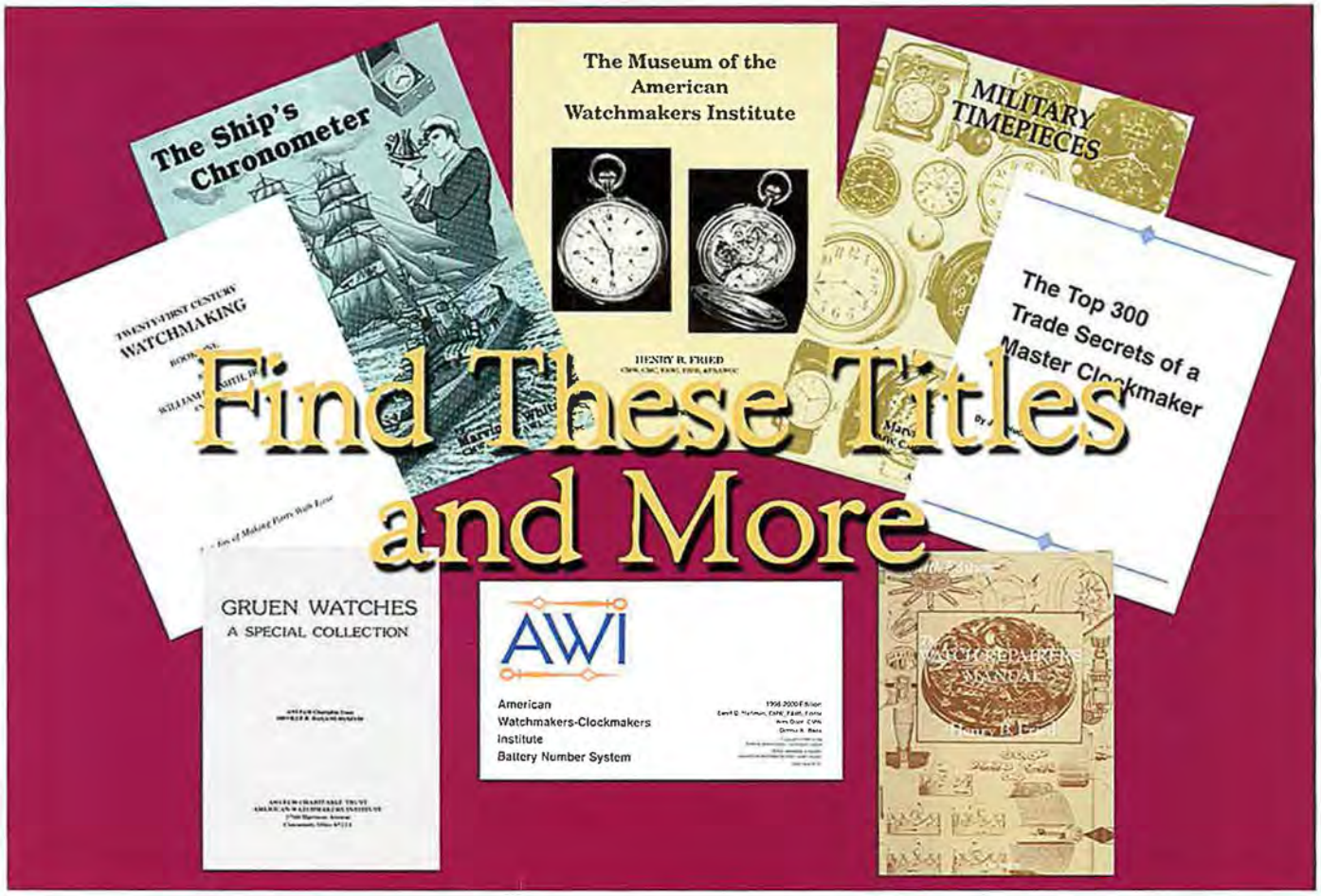
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