

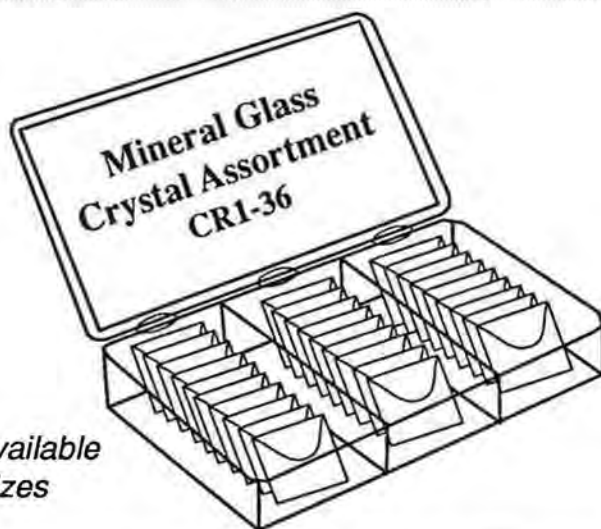
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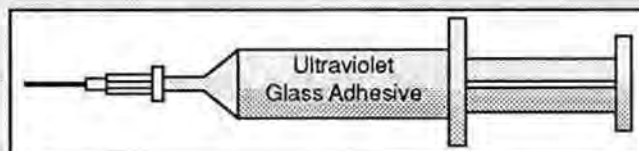
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President's Message



1990 will be a milestone in the history of AWI, for we will be entering our fourth decade of service to our members and our industry. For nearly 30 years, we have strived to make life a little easier for our watch- and clockmaker members. To this end I believe we have succeeded, and our goal is to continue to improve each year.

We will be celebrating our 30th Anniversary at our June 1990 Annual Meeting. We are in the planning stages of a program we believe will attract members and non-members alike. I have asked Alice Carpenter, Vice President, to chair the planning committee, and I am sure that she and her committee members will do a fine job.

I can tell you now some of the things we plan on doing. There will be a full day of special programs and speakers. Most of us have a keen appreciation of the skills and talent required to create a timepiece, so we will sponsor an exhibition of handmade timepieces and related items. Many of our members and others who have such skills in design and construction of horological pieces deserve recognition. We believe such an exhibition will both honor the creator and provide for the rest of us a chance to see that part of our craft that many of us rarely participate in because we are too busy earning a living. AWI Director Donald Loke is in charge of the exhibition. If you wish to display your craftsmanship, please contact him or the AWI office. If your item is for sale, I am sure you will be able to make that fact known at the exhibition. Security will be provided.

As you know, we have sold a few pieces of our AWI watch collection to provide the funds to operate AWI in a proper manner. The rest of the collection is intact and secure in a vault. Because of its value and cost of security, we could not afford to display it except on rare occasions. However, we do plan putting it on display during our 30th celebration. We hope to have a special program highlighting some of the more interesting and rare pieces. Many of our members have expressed interest in seeing this collection, and this will be the ideal opportunity to do so.

Other events will be scheduled, including prominent speakers from around the world. Current plans are to hold this program on Saturday, June 23rd, in Cincinnati, with the Affiliate Chapter Meeting on June 22nd and the Board of Directors Meeting on the 24th and 25th. You will be welcome to attend all sessions.

Make your plans now. Show us that you believe in what we are doing by coming to this gala celebration. We will make it worth your while.

Robert F. Bishop

ON THE FRONT: Herbert M. Ingraham of Munising, Michigan sent the "Horological Times" many slides that his father had taken over the years. This was one depicting a typical cornfield in Michigan, late October/early November.

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UP FRONT

AREA REPRESENTATIVES

AWI Directors are elected at large and thus represent all members at AWI meetings. Each year the President assigns specific areas of membership to a particular person as their area of responsibility. These individuals are known as Area Representatives. In recent years we have assigned these responsibilities to the various elected directors.

Frequently, when a member wishes to bring something to the attention of the Board, he or she usually selects a Board member they know personally or goes directly to the President or to an AWI staff member. Some members feel

more comfortable having one person designated to represent them. They want this person to serve as an ombudsman. Since communication is an essential part of insuring a viable organization, we are pleased to make these Area Representatives available for that purpose.

Area Reps will welcome the opportunity to be of service to any member residing in the area they represent. Call upon them as often as you like. Below is a list of the various Area Representatives and regions they serve.

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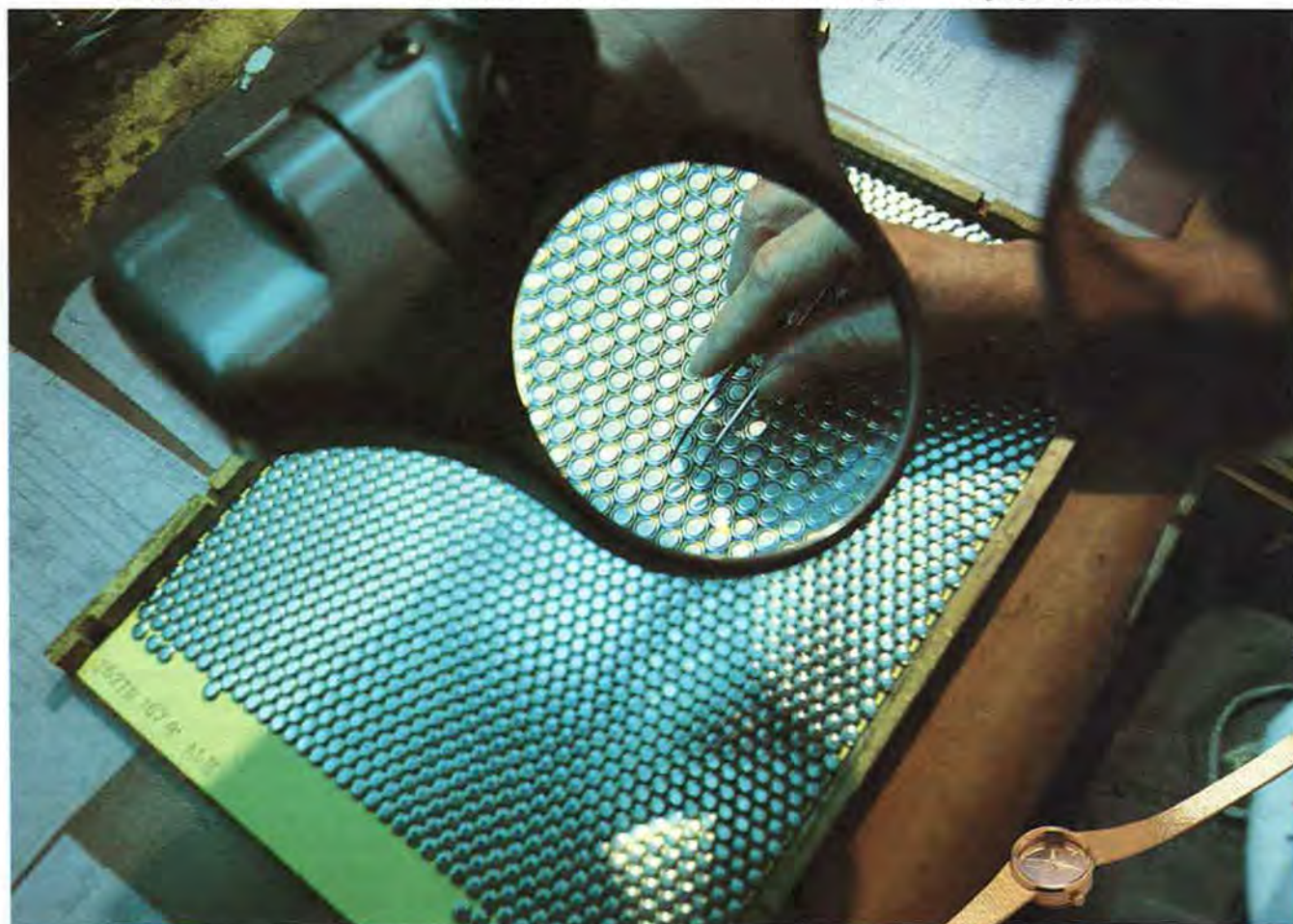
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Questions & Answers

Henry B. Fried, CMW, CMC, FAWI, FBHI, ★FNAWCC



EMILE PERRET MOVEMENT

Q I have enclosed some photos of the movement that I had previously written to you about. The photos aren't the greatest and I'm hoping that they show enough detail.

I'm not positive what the first letter is



Emile Perret
Perret
Terret

The balance cock and center wheel bridge are two separate parts. Attached to the hairspring is a ———. What is its purpose? The movement has a pivoted detent.

Do you think that this movement warrants the expense of having a case made or should I wait until one comes along? I like the movement and would like to get a case. Could you recommend a casemaker?

When I first started in this business I took the advice of my uncle and read everything that I could get my hands on. I could see from articles written by you, Mr. Hagans, and Mr. Coleman that this was a sure way to develop and expand skills. I have an extensive library and although I searched, I just couldn't find the information I needed. I just wanted to let you know that I'm not taking the lazy man's way of getting information. I've tried!

I know you've experienced many things that are not in print form anywhere and have seen many of the things that we, out here in the boonies, consider rarities. Thank you for your kind consideration.

John Nagle
Myerstown, PA



A I have examined your movement and I am familiar with this ebauche. The maker, Emile Perret was a member of a large family of watchmakers situated in leLocle, near the French border and then the center of Swiss watchmaking during the 1860-1890 period, today having moved nearby to Neuchatel.

Your watch dates from the 1870 period. That little "affix" to the hairspring is an attempt to poise it. Some of the slower beat springs had to be a little softer, and thus to overcome the sagging in the hanging positions that was added. In other models, if the extra stud-like affix was upright, it prevented over-motion and overbanking.

The ebauche you show is sometimes called a Jurgensen ebauche since his movements of that time looked like it. In the lever models the long regulator was typical and when the lever escapement was used it had a rather long fork.

As for having a case made for it,

I'd say that the expense of having a case made would not enhance its value that much to warrant the expense. Were it mine (and I have had these at times with various names), a good American 18 sized display case can easily be fitted and altered to accept this movement. Since it is keywind and keyset, it shouldn't be such a great job; it could be done with little more than a fine bezel chuck and a slide rest, should you be so inclined.

Should you still want a case made, look through the ads in the *Mart* of the NAWCC where casemakers advertise their expertise and services. In a display case, which can be picked up in some old watchmakers holdings, such a watch looks rather nice. Else, it can be cased in an appropriate brass tubing with snap bezels with glass on both sides; or, likewise, using good lucite which turns rather easily and is cheap.

Henry B. Fried

(Please turn to page 8)

Borel Quartz Crown Assortment

Borel has assembled the 45 most common dustproof and waterproof types used on today's quartz watches, which require smaller sizes and taps. Includes diameters:

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	3.00mm		656/10	656/11	656/12	
	3.25mm		660/10	660/11	660/12	660/13
	3.50mm		664/10	664/11	664/12	
	3.50mm		666/10	666/11		

Waterproof Type	Diameter	Tube	Post	Design	Tap 10	Tap 11	Tap 12	Tap 13
	2.50mm	1.50mm	Flush		752/10	752/11	752/12	752/13
	2.75mm	1.60mm	Flush		754/10		754/12	
	3.00mm	1.60mm	Flush		756/10	756/11	756/12	
	3.00mm	1.80mm	Flush		758/10			
	3.25mm	1.80mm	Flush		760/10	760/11		
	3.25mm	1.60mm	Flush		762/10	762/11		
	3.50mm	1.80mm	Flush		764/10	764/11		
	3.50mm	1.60mm	Flush		766/11	766/11	766/12	766/13
	3.50mm	2.00mm	Flush		768/10	768/11	768/12	
	3.75mm	1.60mm	Flush		770/10	770/11		

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QUESTIONS & ANSWERS

(Continued from page 6)

The following question was referred to Mr. D.J. Blackwell, Curator American Clock & Watch Museum.

Q I would greatly appreciate any information you can provide on the clock in the photos provided. The name on both the face and the movement is "E. Howard & Co. Boston."

The clock looks authentic. There are many holes in the back of the case. It looks like at one time there was more hardware mounted in the case. Just below on both sides of the lower dial are two round circles impressed in the wood, like there might have been something mounted there. The lower dial moves as the minute hand moves. There is a crown gear that drives it all the time (it's not the type that flips over on the hour).

Stephen Raphaelson
Norwalk, CT

A This clock is a rather curious combination. The case appears to be that of an International Time Recording Co. (later IBM), Endicott,



NY, master clock for running secondary clocks, etc. This is the reason for the holes in the case.

The movement is that of a Howard watch-clock ("Watchman's clock" to record rounds made by one or more watchman). This movement is the type usually used with only one or two recording devices mounted in a Howard 89 style case of short form (54 inches overall), having a pendulum shorter than a seconds pendulum. These were supplied with an 11-inch dial.

The lower attachment carried a paper dial with marking for a 12-hour period, or in special cases (such as hospitals) 24 hours.

When the watchman or other person (head nurse, etc.) operated a station at a distance, a series of punch marks indicated the number of the station and time at which its signal was received, or large mills having as many as 12 watchmen, large versions of these clocks had 12 receivers.

The impressed circles on the back of the case are where pilot clocks were located when the case had a master clock movement in it. Inside the case would have also been relays, switches, and advancing keys for setting the clocks it was controlling.

The pendulum is odd in that it appears to be a metal jar, mercury-compensated Howard bob for a full seconds pendulum. The rod has been shortened to adapt it to this movement. This movement would not originally have been supplied with this pendulum since there is no maintaining power or second hand, so a compensated pendulum would have no practical value. Someone has assembled



several unrelated items to make a rather curious clock.

D. J. Blackwell, Curator
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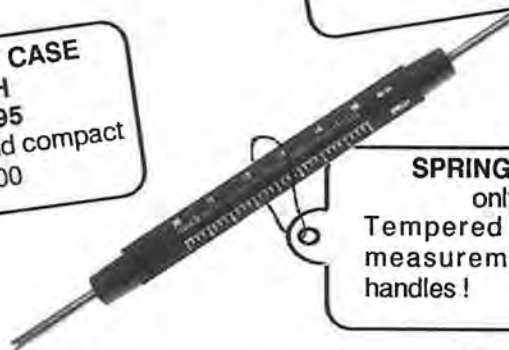
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Bench Tips

J.D. Slaton of Alton, IL sent along two tips for repairing electric clocks. This is the first of the two. We'll print his second tip in December's issue.

THE HAMILTON SANGAMO ELECTRIC CLOCK

I would like to offer this for the clock repairer or collector who still appreciates old and/or antique electric clocks. I have a Hamilton Sangamo electrically wound banjo clock. It has a 7-jewel platform balance, and strikes the hour and half hour by rack and snail. This is a very nicely made clock, but there are several things to watch for during reassembly.

Be sure to check pivots, and rebush where necessary. The electric motor, of course, should not be immersed in cleaning solution. It can be oiled on each end, however. The bottom end can be reached by removing it from the movement. The top end is accessed by removing the set screw in the center of the top.

The mainspring barrel is internally threaded. Be sure the threaded sleeve insert (which is around the barrel arbor) is fully extended (unscrewed). A small pin or wire is inserted through the wheel, and then through a slot in the sleeve, which makes the sleeve turn when the wheel turns, and allows the sleeve to move in or out as the mainspring winds/unwinds.

Joe Crooks



The brake arm which stops the electric motor has a fork which rides between the threaded sleeve and the barrel. As the spring is wound, the sleeve moves toward the barrel, which in turn moves the fork and the brake arm. The brake pad then moves closer to the first wheel, slowing, and when the spring is fully wound, then stopping the motor.

The first wheel is the one engaging the power source—in this case, the small electric motor. Adjustment is accomplished by screwing the brake pad stud in or out. Care must be taken not to let the movement overwind because the sleeve will come too close to the barrel, causing the fork end of the brake arm to bind up, thus stopping the clock. After the electric motor is energized, observe the action. The wheel with the sleeve will start turning, and in turn moving towards the barrel. After a few minutes, the balance will start operating, assuming all else is in good working condition! A few minutes later the brake will make contact with the first wheel, and the electric motor will stop. This is why the pivot on this end of the wheel is so heavy. Mine is set so that the brake will engage when the sleeve is approximately half of the way in. This electric/mainspring combination provides for the clock to keep running through periods of power interruptions—still a nice feature today!

Next month J.D. will give us some tips on repair procedures he used on a Highland, IL battery clock. See you next month!

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4	3.5mm	11	2.90mm
5	3.5mm	11	2.70mm
6	3.5mm	12	2.40mm
7	3.5mm	12	2.00mm
8	3.5mm	12	2.00mm
9	3.75mm	10	2.60mm
10	3.75mm	10	FLUSH
11	4.0mm	10	2.50mm
12	4.0mm	11	2.70mm

36 Yellow; 12 White

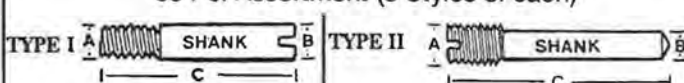
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	3	1.00 mm	1.00 mm	9.00 mm
	4	1.00 mm	1.20 mm	11.50 mm
	5	1.00 mm	1.00 mm	14.00 mm
TYPE II	6	1.20 mm	1.20 mm	5.75 mm
	7	1.20 mm	1.20 mm	6.75 mm
	8	1.20 mm	1.20 mm	8.50 mm
	9	1.55 mm		2.50 mm
	10	1.40 mm	1.00 mm	15.00 mm
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DECK WATCH Waltham Model 1622-S-12

16 SIZE, 22 JEWELS, SWEEP SECOND, W.T.S. 16

The 16 size Waltham deck watch was first manufactured in May 1944, the first movement number being No. 31,788,001. Five thousand deck watches were produced. Those tested at the Naval Observatory were consigned to the British Admiralty. The Observatory was only responsible for the performance portion of the test, as described in paragraphs F-6a through F-6g in the Army-Navy Aeronautical Master Navigation Watch Specification AN-GG-W-108.

Basically, the movement was Waltham's 16 size, 1899-1908 model pocket watch with jeweled main wheel (barrel). Several different combinations of jewels—namely, 17, 19, 21, and 23—were used on these models. However, in the deck watch, the upper and lower center wheel bearings were not jeweled, the 22nd jewel being positioned in the center second bridge. Since the majority of the parts were identical and interchangeable with those used in their 1899-1908 models, it was only necessary to redesign the four bridges and several wheels and pinions which were required

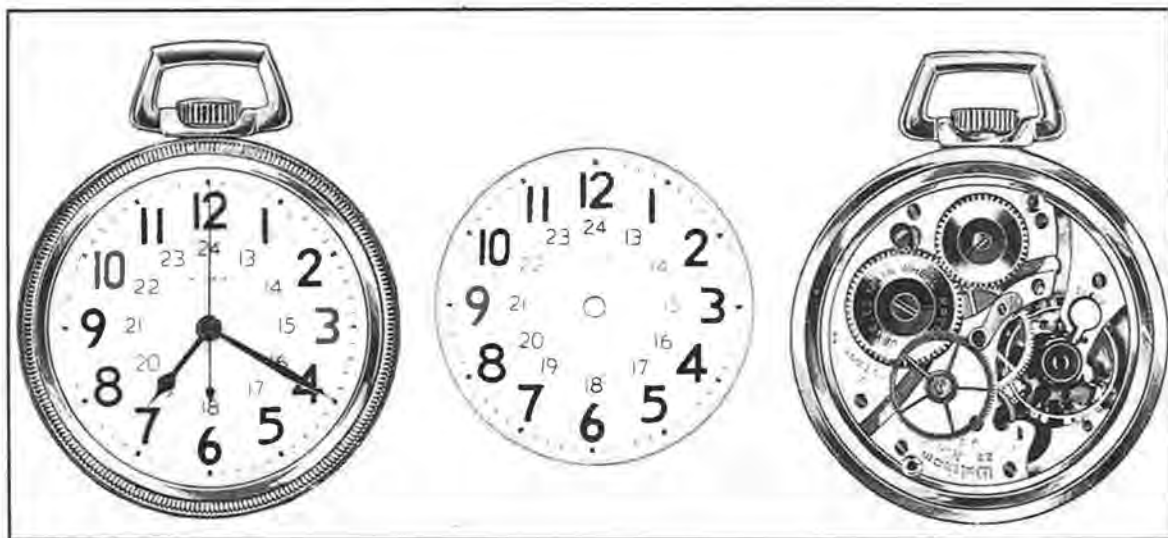
due to the addition of the center-pivoted sweep second hand.

The center second 24-hour marked white porcelain dial had large Arabic numerals, 1 to 12, indicating the hours. Although the watch was referred to as having a 24-hour dial, it only had a 12-hour dial train. Hence, a secondary row of numerals running from 13 to 24 was marked on an inner circle so that it could be used with the 24-hour military time system. A line mark was used to indicate each minute graduation with a dot appearing above each hour figure indicating each 5-minute increment. All hands were blued steel with the hour and minute hands of the pointed spade type.

The movement was cased in a plain nickel-silver or base metal case with a circular grain finish. The case was of the open face type with a screw back and bezel with knurled edges.

The sweep second mechanism was of the indirect drive type. It did not have a scion setting or "hacking" device.

PLEASE NOTE: In the September '89 issue on page 41, the caption in Figure 5 has a typographical error. The last sentence of that caption should read: "A pair of 6-inch machinist dividers with the points slightly ground off makes an excellent crystal retainer ring tool."



TESTING METHODS

Each watch shall be subjected to the following tests in the order given below:

F-6a. Daily Rate, Room Temperature, Horizontal Position. The watch shall be run for one day to allow it to settle down. The daily rate of the watch shall then be determined for a period of five days with the watch in horizontal position, dial up, and with daily winding. The average of the daily rate during the test period shall not exceed five (5) seconds. The average variation from the average daily rate shall not exceed two (2) seconds.

F-6b. Daily Rate, Room Temperature, Vertical Position. The daily rate of the watch shall be determined for a period of five days with the watch in a vertical position, with the numeral 24 of the dial up, and with daily winding. The average of the daily rate during the test period shall not exceed two (2) seconds. The difference in the average daily rate obtained in this test and in the Room Temperature Rate test, Horizontal Position, shall not exceed five (5) seconds.

F-6c. Isochronism. The watch shall be fully wound and the errors determined at the end of the first 12 hours and at the end of 24 hours. The difference between the error for the first 12 hours and a half ($\frac{1}{2}$) the error for the 24 hours of this period shall not exceed one (1) second. The watch shall be tested for isochronism in the horizontal position, dial up, and in the vertical position, with the numeral 24 of the dial up. The isochronism tests may be combined with the Room Temperature Rate tests, Horizontal and Vertical positions.

F-6d. Daily Rate, $+35^{\circ}\text{C}$ ($+95^{\circ}\text{F}$), Horizontal Position. The watch shall be fully wound and then subjected to a temperature of $+35^{\circ}\text{C}$ ($+95^{\circ}\text{F}$) for a period of 24 hours. The daily rate of the watch shall then be determined.

F-6e. Daily Rate, $+5^{\circ}\text{C}$ ($+41^{\circ}\text{F}$), Horizontal Position. The watch shall be fully wound and then subjected to a temperature of $+5^{\circ}\text{C}$ ($+41^{\circ}\text{F}$) for a period of 24 hours. The daily rate of the watch shall not differ from the daily rate obtained in the Daily Rate test, $+35^{\circ}\text{C}$ ($+95^{\circ}\text{F}$) Horizontal Position, by more than ten (10) seconds.

F-6f. Daily Rate, -20°C (-4°F), Horizontal Position. The watch shall be tested as in the $+35^{\circ}\text{C}$ ($+95^{\circ}\text{F}$) Rate test, except that the watch shall be at a temperature of -20°C (-4°F). The daily rate of the watch shall not differ from the daily rate obtained in the rate test at $+5^{\circ}\text{C}$ ($+41^{\circ}\text{F}$) by more than sixteen (16) seconds.

F-6g. Rate Recovery, Room Temperature, Horizontal Position. The daily rate of the watch shall be determined for a period of three (3) days with the watch in a horizontal position, dial up, and with daily winding. The average of the daily rates during the test period shall not exceed five (5) seconds. The average variation from the average daily rate shall not exceed two (2) seconds. The average daily rate shall not differ from the average daily rate obtained in the room temperature rate test, horizontal position, by more than four (4) seconds. The room temperature for this test should be approximately the same as the temperature in the original room temperature test.

TIME

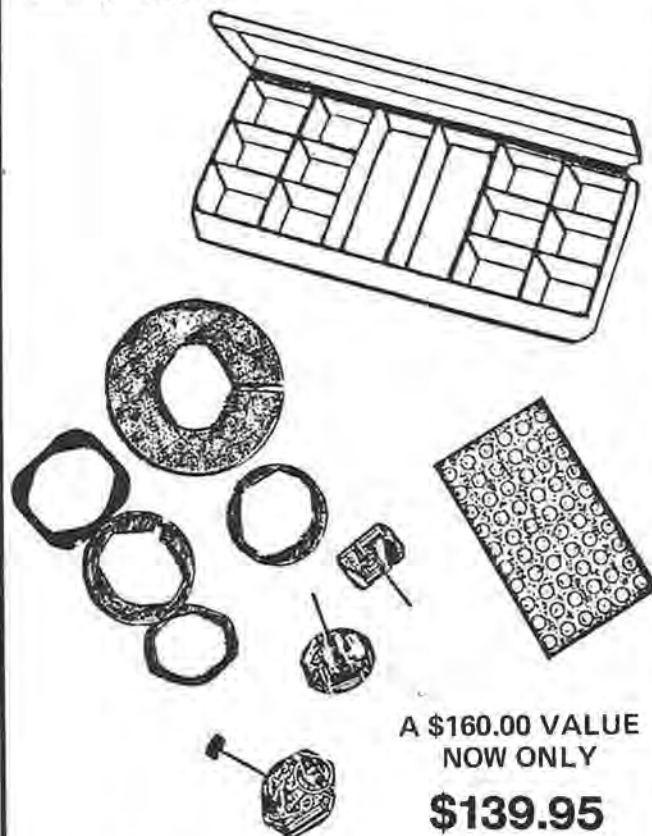
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MAKING WATCH CRYSTALS

Discovering the factory has discontinued a certain model of a watch and the material that was available (including that special "fancy" crystal) warrants us to really consider making our own crystals. In these cases it does become necessary to make our own or let a crystal fitting company do it for us. Today, we will presume we have decided to make our own crystal. Of course we have already checked our complete stock of several hundred or maybe several thousand crystals, and have assured ourselves that we do not have one to fit or one even close enough to trim to fit. Also, we have looked through the crystal catalog and the supplements and find nothing close.

TELLING THE CUSTOMER

If we must make a crystal and we are going to need to adjust the price upward, then we should inform our customer. Most of them are happy to pay a little more to have us handcraft a crystal for their watch instead of returning their watch unrepai red. If they say no, this is the time to find out and return it to them before spending more time.

PRICING THE JOB

The price we charge should be fair and not reflect an abnormal amount for our "learning time." We may even lose money or just break even on the first two or three jobs. Actually, if we have fitted crystals before, maybe most of our experience has come from some alterations such as cutting plastic crystals down to size. If so, we will probably make money on the first handcrafted crystal we fit, that is if we have the proper equipment.

CRYSTAL BLANKS

Glass crystal blanks are available in various sizes. I buy the 1¼ inch square size, 1 mm thick. From these squares we can cut any shape necessary to fit the bezel.

CRYSTAL CUTTING GRINDER

Two years ago when I wrote on this subject, much mail and phone calls were received asking various questions about cutting procedures and materials used, especially the source for materials. I will mention some suppliers by name,

only because several inquires stated a lack of availability from their sources. However, please check with your own supplier first as they may have what you want.

Crystal cutting machines are now available. One marketed by the American Perfit Crystal Corp., 653 Eleventh Ave., New York, NY 10036, is called the Glass Starter System (see ad, page 17, *Horological Times* October 1988 issue). It has a crystal grinder with a 4-inch wheel (which is better than my 2-inch wheel). This comes with a 20-minute videotape on Fitting Glass Watch Crystals. Crystal blanks are also available from them. All this is also available from your watch material wholesaler. Since the machine is open, one might choose to close it in as I did on my homemade model to prevent splattering (Figure 1). This model is still made; however, on page 15 of the *Horological Times* October 1989 issue they show their new "Kronoglass" machine. These are closed in and look like state-of-the-art modern machines for crystal grinding for those who are doing lots of crystal work. These are also available through your watch material supplier. This machine is semi-automatic. It will duplicate crystals (both flat and curved types) from the original sample. Even if the original crystal is missing, we can use this machine to make a new crystal. Crystals are generally just cracked or broken, but by the time we press out the old one it might as well be missing. Anyway, as I was explaining, we can make a mold from our case bezel and then use this mold in the machine. Of course we keep this mold for future use; we can almost bet we will need it again shortly. I think one of Murphy's laws states that this same person will be back again with another broken crystal.

If you decide to buy one of these machines now, I guess you won't want to read about how I made my homemade model. Well, you decide . . .

HOMEMADE GRINDER

Basically, a grinder consists of a diamond impregnated wheel attached to a motor arbor. Mine turns at 1,725 RPM and is probably the best available to us. I do not recommend a 3,450 RPM. Figure 1B shows a 2-inch diameter diamond-impregnated wheel with an arbor which I mounted on

(Please turn to page 16)

HEAR YE! HEAR YE!

In June 1990 we will be celebrating the 30th Anniversary of AWI. We have a program planned with unparalleled guest speakers and exhibits. Our exhibit will consist of handcrafted timepieces and horological tools. We are asking you, the members, who have created a timepiece—watch, clock, or a special tool—to submit photographs or a description to: *Donald R. Loke, 4 Byram Terrace Dr., Greenwich, CT 06831*, or AWI Central.

We will have a display of early and very rare horological tools. We will present them with a complete description of each tool and in front of each one will be a part that was made by that or similar tool to show what it produced.

We are asking you, the membership, to participate as much as possible to make this a great event. So, what have you?

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SHOP TALK

(Continued from page 14)

the right side of the motor. (The arbor fits a 1/2 inch motor shaft.) On the left I placed a taper spindle with a left threaded arbor on which we can attach a 3-inch diameter felt wheel. Next, we need a package of cerium oxide which we will use on the felt wheel (with water) to polish the crystal edges after we have ground the edges of the crystal. The cerium oxide may be purchased from a rock and hobby type of store. They carry this in stock since many "rock hound" gem cutters use this for polishing various gemstones. (I know this by personal experience.) There are substitutes but cerium is my favorite. Buy the minimum, probably one pound, since it will last forever.

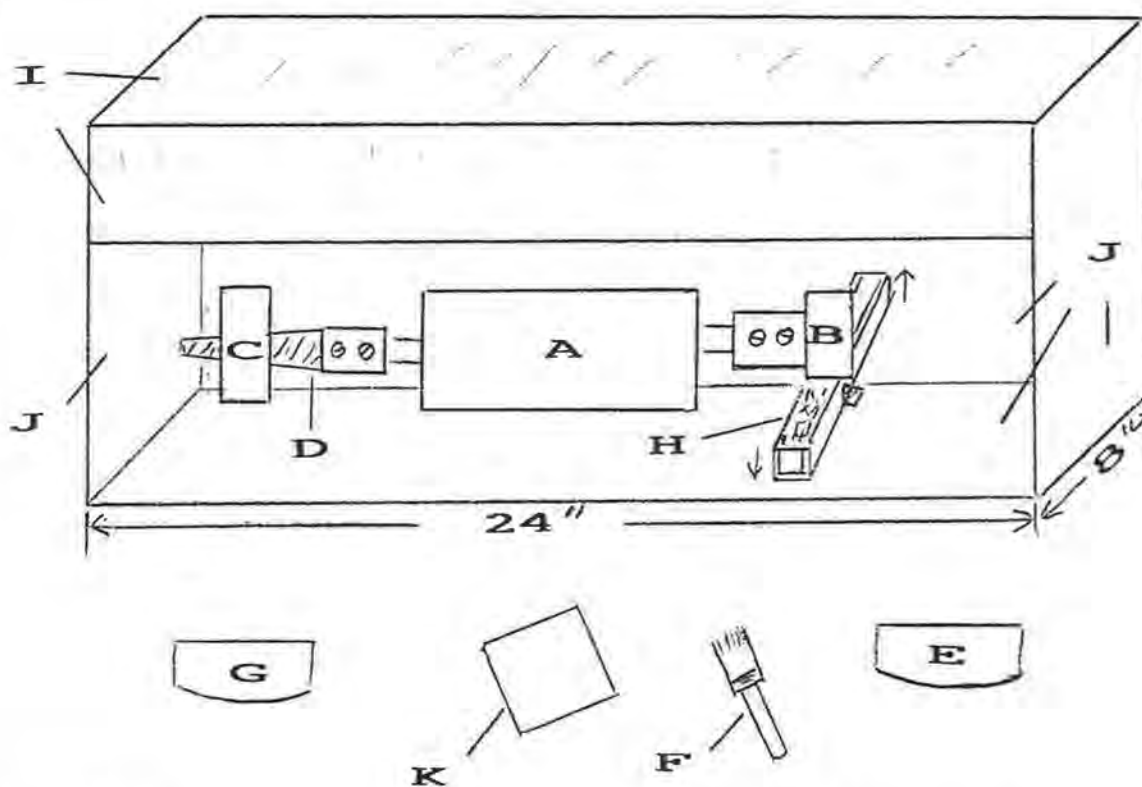
We need to build a frame around our grinding machine so we will not splatter water and cerium oxide on ourselves or all over our shop. The frame may be made of wood and should be large enough to install a light at the top. A glass top can also be used so existing lights can be placed close enough to supply ample lighting. Figure 1 shows measurements but these can vary to suit the space available.

We need water to continually wet the diamond wheel while in use. My latest method is to use a sponge which I place into a U-shaped piece of extruded aluminum about five inches long. I drilled a hole through the bottom area of the center of this aluminum piece and raised it about 1/2 inch above the floor of this frame. Now when I push down on the front of this piece, the back area will rock upward causing the wet sponge to keep the diamond wheel supplied with water. This works good for me except when I left the sponge set overnight against the diamond wheel and it produced rust spots on the wheel.

Several calls and letters have indicated trouble in locating suppliers from which to purchase these diamond wheels. Ask your own supplier, and if no luck here's my source: Mayer Bros., P.O. Box 750, Seattle, WA 98111.

Motors can be purchased from local electrical supply stores. They can generally be wired (or rewired) to rotate the direction you desire. Instead of rewiring, the motor can just be rotated 180 degrees to change direction so long as this doesn't relocate the switch in a poor location. I prefer the motor be placed so the top of the wheel is coming toward me. I believe this would be considered counterclockwise, but some prefer a clockwise rotation.

Figure 1



ITEMS NEEDED

- A Motor 1/4 or 1/3 (1,725 RPM)
- B Arbor with 2 inch diamond impregnated wheel (1 1/4 inch wide)
- C 3 inch felt wheel (1 1/4 inch wide)
- D Taper threaded spindle (left threads)
- E Dish to hold water

- F Brush (paintbrush 1/2 inch or any size)
- G Dish to hold cerium oxide with water
- H Wet sponge in holder that rocks up and down
- I Two pieces of 1/4 inch plate glass 22 x 5 1/2 inches for front and top
- J Four pieces of wood for back, bottom and ends
- K Crystal blanks 1 1/4 inch square, 1 mm thick.

USING THE GRINDER

By holding the crystal blank in our hands and gently pressing it into the watered diamond wheel, it is easy to cut. We should hold the crystal at an angle to allow for a proper fit into the bezel. With practice, we can do a very nice job.

POLISHING

After cutting our crystal to fit, we may want to polish the edges. By having a double arbor motor, we can have our polishing area on the left side of the motor. We need to brush some water and cerium oxide onto our felt wheel. We may need to apply a little more pressure than we did for cutting. NOTE: Some have told me this polishing is not necessary since these thin flat crystals fit mostly into the bezel and are not seen, especially after sealing. This is optional and strictly up to you.

SEALING

I hate to suggest sealing methods because each person has their preferences, but here goes anyway. I use Epoxy 330™ and a special heater (heat lamp) for about 10 minutes. If pressure would be placed on the inside of the crystal after it sets up, in most cases the crystal would break before the seal would give way.

I hope this article answers some of the questions for those who haven't yet tried crystal making. Good luck!

TIME

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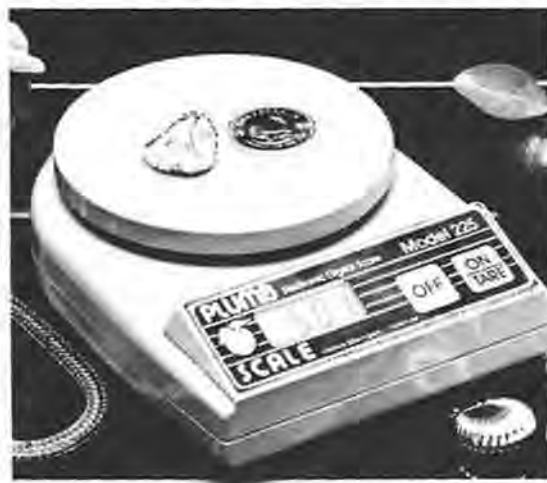
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REPAIRING CLOCK HANDS

by

John R. Plewes
CMC

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Broken hands must be replaced or repaired, and each solution has its problems. Replacements are not always available or they may involve rebushing or other modifications. From the viewpoint of originality, repair is always desirable, particularly when the broken pieces are available. Few owners want to look at a new aluminum minute hand over an original steel hour hand on a century-old regulator clock, for example. It is not generally feasible to repair aluminum hands, and as they only appear on relatively modern clocks, they are best replaced, assuming that the clock is valuable enough to warrant repair.

Vintage clocks and most modern ones have hands of steel or brass; both are usually repairable. Steel hands may be soft soldered or silver soldered, depending on the geometry of the break, but brass hands must only be soft soldered in order to preserve their hardness.

Breaks in metal occur at points of maximum stress or fatigue, and I am surprised that the clockmakers of centuries past did not pay more attention to this. Countless repairs could have been avoided, for example, if a small radius had been left at the inner end of clock hands and where the spokes of gears touch their rims. Despite their inherent weak-

ness, sharp, clean corners were the norm in these and other areas, and were always insisted upon without further thought. Matters are not much different even today in 1989.

Typical of such breaks is the common spade hand shown in Figure 1a which has broken at its weakest point the inner end. Usually such hands can stand being 0.10" or so shorter, and a slot of this depth can be filed in the disc, as shown; a firm fit is necessary. The whole joint is then cleaned, fluxed, and silver soldered. Note that soft solder is inadequate for this repair—it simply is not strong enough.

Figure 1b shows an enlarged and ragged mounting hole in a typical American minute hand. It can be repaired by soft soldering a similar, but intact, disc from another broken hand. The separate pieces must be carefully filed bright and clean, and tinned separately before being joined together. Note that the new square, or slit, must be oriented accurately before it is finally soldered.

Figure 1c shows how a break in the shaft part of a hand can be repaired. A new tip, or lower section, from another broken hand, is bent as shown and the two sections are soft soldered together. Such a repair is not easily seen from the front, as the tiny gap on the top surface is filled in with

Figure 1



solder and the whole hand repainted on both sides.

Figure 1d shows how the pressed steel minute hand of a German box clock can be repaired using a loop of 0.040" steel wire. The wire must be very clean and bright before being formed into a snug fit around the hand collet. It is then filed slightly flat on both sides and soft soldered in place, with the legs securing the shaft of the hand. If it is necessary to synchronize the hand with the clock's strike, the loop solder—and only the loop solder—is melted, while the collet is turned slightly with a small screwdriver. Gripping the shaft of the hand and both legs of the loop in pliers will hold everything together and provide a heat sink, too, meanwhile. This repair, although unseen, makes the hand much stronger than it was originally.

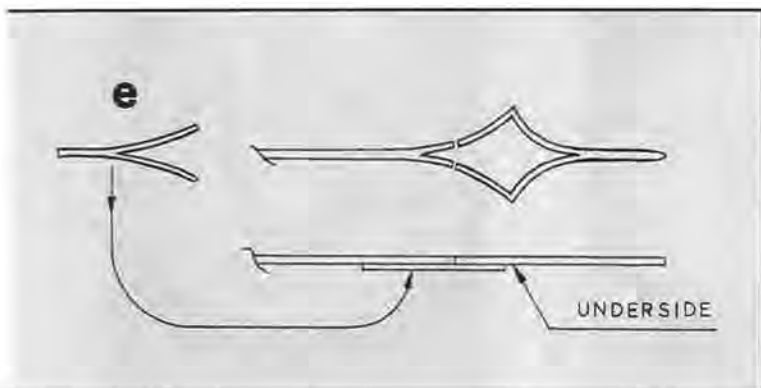
Figure 1e shows how a brass longcase hand can be repaired by soft soldering a fork, bent from 0.040" wire or cut from 0.040" steel sheet, underneath it. If wire is used it should be filed slightly flat as in Figure 1d above. Such filing gives a better surface-to-surface contact and makes for a slimmer, neater, and less visible repair.

Similar methods using different shapes can be used to repair breaks in most types of hand. Ordinary washers can be drilled out, slimmed down, and used to repair or modify the larger types of hands. They can be filed artistically to blend in with the original patterns and curlicues, and the original thickness need not be materially increased thereby.

I cannot stress too strongly that all the repairs dealt with above depend upon scrupulous cleanliness prior to soldering—and the application of flux and sufficient heat thereafter. Note that flux is NOT a cleaning agent; it is applied to prevent oxidization while the job is heated, thus giving the solder first crack at a clean metal surface.

Steel hands which have been silver soldered can be heat blued afterwards, as long as the repair is unobtrusive. Soft soldered steel hands will fall apart if heat bluing is attempted. They must therefore be painted on both sides, or suitably dyed.

The repair-rather-than-replace philosophy expressed above is not applicable only to hands; it should apply to the whole clock. Clock owners therefore should always keep each little piece of veneer, trim, finials, parts of hands, or whatever else happens to fall off their clocks, because such findings can almost always be put back on again. 



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Reality Sets In

The Dearborn NAWCC show in September proved to be a real eye opener for the many dealers and collectors who attended the show. This is perhaps the last big show of the year and the trend of this show will carry through to next February when the Florida show opens.

Watches that had sold immediately at shows just 10 months ago were sitting on the tables with lower prices on them. Rolex bubblebacks (the first automatic model) dropped in price even further. There were three Gruen jump hour doctors watches for sale at less money than I sold mine just four months ago. Gold filled watches were dead. Most of the European customers, who normally bought a large quantity of unusual gold filled watches, said they were no longer selling at the same rate as last year.

One of the biggest surprises to me was the price drop

on enamelled bezel watches. There seemed to be quite a few Hamilton "Piping Rock" enamelled watches for sale under \$1000.00. Hamilton electrics are still dead. The rest of the world has finally found out what the American watchmakers learned 20 years ago. If you don't want to constantly repair them, then don't sell them. Ulysse Nardin and Movado chronographs were still going strong. Patek Philippe and Vacheron & Constantin were as strong as ever. Common 14K gold watches were very soft also. Modern Rolex were very strong in both price and demand. Gruen curvex were soft in price and demand. Modern solid gold watches with permanently attached mesh bands were still available at bargain prices when compared to new ones.

The whole atmosphere seemed to be one of caution. Last year I would have described the atmosphere as one of

Figure 1



Figure 2

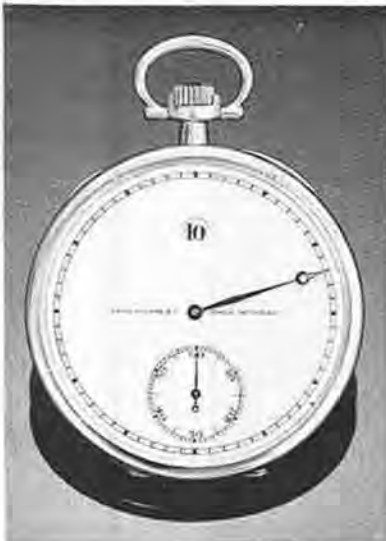


Figure 3



reckless abandon. Several watches changed hands for more than \$100,000.00. Many dealers were willing to take a chance on anything high grade and unusual. There was so much excitement to owning these top watches that dealers were willing to pay within two percent of what they thought a watch would bring them just for the thrill of owning it. Besides, prices were still rising and if you made a mistake you could wait three or four months till the price rose enough to sell the watch. Now in a declining market these same dealers are no longer willing to take chances like in the past years.

Now for the good news. Finally after eight years I could go to the safety deposit box and get out those high grade pocket watches that I put away after the big price crash in the early 1980s. Fueled by the declining wristwatch prices over the past six months, dealers are becoming more active in the high grade and unusual pocket watch market. The turning point was the Patek Philippe sale back in April. The American railroad watches are still struggling to get back to the price levels of 1980. Even the early keywind watches haven't drawn the attention of the European and American wristwatch dealers. These are the people who tend to drive the prices higher because they are the ones who seem to have most of the cash right now. The following is a list of watches that are on the way up right now.

Patek Philippe
Vacheron & Constantin
Breguet
Audemars Piguet

Jules Jurgenson
A Lange & Sohne
Cartier

There are a number of other high grade makers whose time-only watches don't seem to sell very well. Their complicated watches are a different story. Some of the more desirable features are: tourbillon escapements, perpetual calendars, repeaters, chronographs, world time, pivoted detent escapements, enamelled cases, jewelled cases, multi-colored cases, digital dials, and skeletonized movements.

Here are a few of these unusual and complicated watches that were offered for sale in the October 15, 1989 auction by Habsburg Feldman, Geneva, Switzerland.

Figure 1 is an 18K gold world time calendar moon-phase pocket watch by John Walker, London. The reverse of this two-sided watch is pictured here. The front of the watch has subsidiary dials for the days of the week, the dates and months with inner seconds, and moonphase also. The reverse has seven small dials giving the time for New York, Berlin, St. Petersburg, Paris, Vienna, Calcutta, and Melbourne. The pre-auction estimate for this watch was \$4,800 to \$7,200.

Figure 2 is a thin platinum Patek Philippe dress watch with digital jumping hours. This estimate was \$36,000 to \$48,000.

Figure 3 is an 18K gold quarter hour repeating watch circa 1790. It has an exquisite enamelled case set with pearls and rose cut diamonds. Ld. Bordier is the maker. The estimate on this watch was \$3,600 to \$4,800.

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BULLETIN BOARD

A. NEW REQUESTS

Bill Callaway of Deerbrook, WI has two items for the Bulletin Board. They are:

ADAPT A MODERN ELECTRIC MOTOR TO A 1930 VINTAGE INGRAHAM CLOCK

Mr. Callaway needs advice on how to adapt an electric clock motor presently available to an Ingraham synchronous, hour/half-hour striking clock, model SS T7. This clock dates back to the mid-1930s.

CAST BRASS BEZELS

He also needs a source for someone who can custom make or has a stock of cast brass bezels. A source for other brass clock bezels (not cast) is also needed.

CUSTOM CUT 32-TOOTH ESCAPE WHEEL

William Crane, Ft. Smith, AR, has tried to get a 32-tooth French clock escape wheel cut from a number of those who offer custom wheel cutting service. None were able to cut such a wheel for him. We would like to compile a list of those who could perform this service.

A STICKY PROBLEM

Stephen A. Fabes of Walnut Creek, CA writes:

I need to glue the front of a 3" diameter brass movement to the back of a clear (etched chapters) 7.5" diameter glass dial. I need to know what type of glue or adhesive to use.

I also have a secondary objective. I would prefer to not have the movement plate showing through the glass dial. I know that the original assembly used a black pitch-type spread adhesive that did the binding and at the same time hid the plate. If the only present day option is clear or translucent glue, I would like to know if you would consider introducing a thin black (metal/plastic/wooden) piece to glue between the glass dial and the movement plate.

A final consideration: The adhesive has to provide a rigid/firm bond as the movement is wound from the rear and the natural action will be to hold the clock in one hand by the glass dial and wind with the other hand. (There is no case intended to attach to the dial.)

I do not want to use Crazy Glue® as it will seriously risk later disassembly.

B. RESPONSES

CLEAR NON-YELLOWING LACQUER

Since last month's Bulletin Board, we have received several more recommendations for a clear non-yellowing lacquer. We thank everyone who has shared this information with us!

KESTENMAN BROS.

Jack Friedman of Superior Watch Service, Inc. informed us that the following two firms acquired the Kestenman Bros. Company:

Dutches Industry
399 Main Street
Lodi, NJ 07644

Mormac Co.
121 West 19th Street
New York, NY 10011

WATCHCRAFT CRYSTALS

Several were good enough to respond to the request regarding Watchcraft crystals. Had we been aware that "Watchcraft" was the trade name of crystals marketed by C. & E. Marshall, we could have given James Hernick the information much sooner.

BARHILL CLOCK COMPANY

Greg Hostetter, who requested the address of the Barhill Clock Company, later wrote and answered his own request. The address is:

Barhill Clock Company
44 Lehigh Avenue
Paterson, NJ 07503

C. ITEMS STILL NEEDED

SINGING BIRD CAGE

Gene Hollingsworth of Emmeit, ID is looking for someone to repair a Singing Bird Cage. In the *Watch & Clockmakers Buyers Guide* which AWI published seven years ago, we had a list of nine firms who repaired them. Hollingsworth reports that none of these firms listed repair them at this time. AWI would like to develop a list of firms who repair the Singing Bird Cage.

"LOUIS BERNET" QUARTZ WATCHES

Tom Murray, Blackwood, NJ, is looking for a source for crystals, case parts, etc. for a watch which he identifies as "Louis Bernet." Usually these can be obtained from the agent who distributes the watch or the firm that does their in-warranty servicing. AWI has no listing in its files for the named watch. Can anyone supply a lead?

KOREAN CLOCK MOVEMENT ITF 370-M11

Loal Huffman, Santa Maria, CA, has a School House Clock marked ITF 370-M11. The strange thing about this clock is that it has a large wheel at the rear of the center wheel arbor (approximately 1.687" diameter) which has 64 teeth which have a sharp point, straight sides, and which appear to be cut with a "V" cutter. The cuts are very rough. The profile looks like this:



Mr. Huffman seeks to purchase replacement parts or a new movement. No one seems to distribute Korean clocks at

this time. If you can name a distributor of either spare parts or complete movements, it would help solve Loal Huffman's problem.

HADDON CLOCK MOTOR

Harold Thompson of Owatonna, MN asks: Does anyone have specs for the novelty Haddon clocks of the 1940s? It looks as if the style "C" Synchron motor will work, but I would like to have a chart showing the rotation and RPM of the old Haddon motors.

REBUILDING SWINGER PIVOT

The second request Harold Thompson has is for information (instructions) for rebuilding the pivot on Ansonia Swinger clocks. He believes that the pivot point to dial center is critical.

DO YOU HAVE INFORMATION REGARDING THIS MONTH'S REQUESTS?

DO YOU NEED INFORMATION

ABOUT ONE OF THIS MONTH'S RESPONSES?

If so, send a self-addressed stamped business-size envelope and your request to the address below

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- ☐ I do not have #200 Catalog.

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Wholesaler's Name _____

WANTED: Patek Philippe

WRIST & POCKET WATCHES

I want to buy displays, boxes, catalogs, parts, dials, whole or partial movements and anything else pertaining to Patek Philippe.

Also needed: Boxes for Rolex, Vacheron & Constantin, Audemars Piguet, Movado, Le Coultre, Tiffany, Cartier & Piaget — any age, any condition.

1920-1940 boxes for Gruen, Hamilton, Bulova, or other early wristwatch boxes—mens only for these more common companies.



Always needing movements by Patek Philippe, Piaget, Audemars Piguet, Vacheron & Constantin, Rolex, European Watch & Clock Co., Cartier, especially complicated movements by these companies.

WANTED — Patek Philippe moonphase calendar. This one pictured: 1969 model, paying \$15,000 and up.

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Member: AWI, NAWCC
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WATCHES Inside & Out!



Robert D. Porter, CMW

A SNAP, CRACKLE, & POP SOLUTION

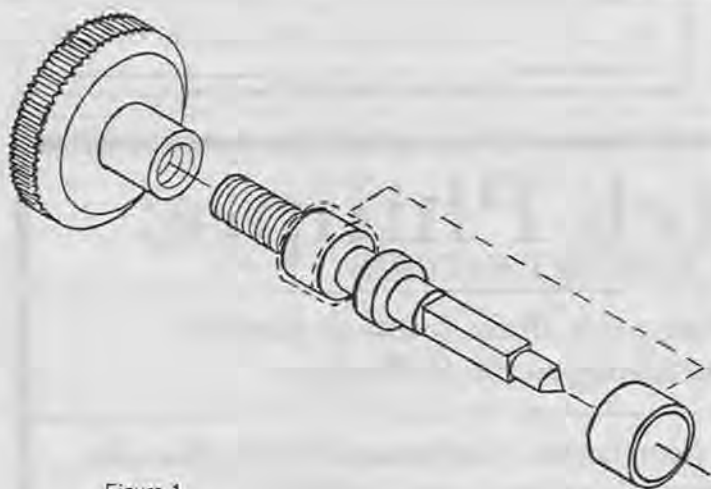


Figure 1

You have just finished cleaning and lubricating a ladies' wristwatch movement of 1950s vintage. The sparkling movement is to go into its freshly polished and cleaned 14K diamond case as soon as you have completed the timing adjustments.

While winding the crown a few turns to start the watch running, you hear: *Snap! Crackle! Pop!* . . . that all-too familiar sound caused by the disengagement of the winding pinion and crown wheel due to a worn plate and bridge which allows the stem to move out of position. Making a new stem with a larger hub is often not a cost-effective solution.

Figure 1 illustrates a way to overcome this problem. A steel sleeve has been made to fit over the undersize hub to compensate for plate and hub wear.

Chuck a piece of balance staff wire in your lathe collet, face off the end of the stock, and turn the end to a diameter approximately 0.010" (0.25 mm) larger than the hub of the winding stem. Try the stem opening of the movement on the end of the stock. Keep reducing the sleeve diameter until it enters the plate with just enough clearance to turn freely. Select a drill size as close as possible to the winding stem hub diameter and drill the sleeve. Cut the sleeve off to the same length as the hub. Slip the sleeve into position on the stem using a minimal amount of "Lock-it"™ anaerobic/liquid lockwasher to secure both the crown and sleeve in place.

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Ask Huck

By J.M. Huckabee
CMC, FBHI

Q: Pendulum wobble is a frequent problem in the American schoolhouse clocks. What suggestions can you offer?

A: We all experience the problem you described. It is more acute in the clocks mentioned, but prevalent in many others.

The most obvious cause is a deformed suspension spring, crooked pendulum rod, spring and rod out of plumb, etc. The less obvious is related to width, length, and thickness of the spring.

If the spring dimensions and strength, along with the physical makeup of the pendulum, sets a torsional oscillatory rate equal to or harmonically related to the beat rate, it is almost certain to wobble.

Let's make an observation: Twist the pendulum slightly and let it go, observing its action. Does it make two torsional beats to one normal beat? It may make 1, 2, 3, etc; but rarely will a higher order of harmonic be observed. This situation may be observed with the pendulum out of the clock, on a dead hanger.

The secondary oscillation observed is a power robber and also degrades our ability to maintain a constant timekeeping rate.

Solution to the problem is achieved by making the spring wider, thicker, longer, or shorter such that the torsional rate is harmonically unrelated to the beat rate. Other more obvious problems should be corrected prior to this action.

Q: Where can I obtain a bulk supply of suspension spring material? How do you cut and drill the spring?

A: I purchase shim stock from an automotive parts supply house. The material is sold from rolls about 6 inches wide and priced per linear inch. A piece 3x6 inches will make lots of springs. It is available in blue steel and stainless steel; I prefer the stainless. A thickness in the range of 3 thousandths of an inch is most commonly used. The material is available in most stores at 2-5, plus some thicker gauges.

A large seamstress scissors will cut the material. Keep the spring length lengthwise to the material.

Cut the hole with a flat-faced punch and a close fitting hole in the die plate of a watchmakers staking set. A dimple may be formed with a ball-end punch over a hole that is somewhat larger than the punch ball. These tools make suspension spring work very simple.

TWES



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The Use of Roller Bearings

PART I

THE PHENIX CALIBRE 200

In self-winding watches, the point of greatest wear is at the axle bearing of the oscillating weight. This heavy swinging weight exerts a great frictional force at the center of oscillation and wear does occur.

To overcome this friction, some watches have hard, alloy bearings which delay the wear, while others are jeweled. However, while jewels serve efficiently with little friction and wear, they are still subject to breakage at this spot because of their heavy burden and the sudden shocks and jars to which oscillating weights are subjected.

A resilient arm is supplied to some jeweled self-winding arbors and weights. This helps somewhat. Most watchmakers are also familiar with the Eterna-Matic with its oscillating weight swinging in ball bearings. This too has proven very efficient.

The Phenix, 11½ lignes, caliber 200 (Rollamatic) features an oscillating weight with a roller bearing. A roller bearing is different from a ball bearing in that instead of little balls housed in a race or bushing, cylindrical pins are used. Thus, the Rollamatic has its oscillating weight axle turn on vertical pins set into a tube which surrounds the pins and axle. The advantage claimed, aside from friction-free swinging, is that the weight axle is better supported in the horizontal position with the use of roller (pin) bearings.

Figure 1 shows the movement in actual size. The rim of the oscillating weight is a heavy metal secured to the oscillating weight plate by three screws equally spaced near its edge.

Aside from its roller bearing feature, this model contains two additional and unusual features of interest in the operation of its self-winding mechanism. These will be explained in the following paragraphs and illustrations.

Figure 2 shows an exploded view of the oscillating weight components and axle. The rollers consist of the group of hard, polished, pointed and cylindrical pins (E). These fit inside the tube of the three-pointed star-cam (F). The pins are prevented from falling out by the pronged cup-plate (H). The oscillating weight axle (I) fits up through the hole in the pronged cup-plate (H) and then through the center of the group of pins which rests in the tube of cam (F).

The oscillating weight (C) has a pipe-like center which is driven friction-tight over the pipe of cam (F). To keep the roller-pins from falling out through the top of the oscillating weight side, the cover plate (B) is fastened down into the recess atop the oscillating weight by the three screws. The underside of the coverplate (B) is cupped downward around its hole so that it conforms to the bevelled contour of the group of pointed roller pins.



Figure 1. This is an actual-size illustration of the Phenix Rollamatic Calibre 200, using a roller bearing.

To keep the oscillating weight unit from falling off, the oscillating weight axle (I) is slotted. As this slot-neck of the axle emerges through the oscillating weight, the bolt-spring (A) is placed over it. It will be noticed that the bolt-spring (A) has its hole off-center. In order for the bolt-spring to stay in place, it must be manipulated horizontally so that its hole moves sideways against the slotneck of the axle post.

Both ends of the bolt-spring (A) fit into the diametrically opposite holes (D). The spring plate (H) upon which the pointed roller-pins rest is retained in place by having each of its three prongs fit into a reversed countersunk hole (G), situated in each point of the cam (F). The axle (I) is riveted to the base plate (J) which in turn is fastened to the movement by the three screws into the holes (K).

The assembly of the roller bearing unit may be better understood if we examine the side, sectional view in Figure 3. This is arranged so that each part in Figures 2 and 3 has the same letter and should make referrals from the sectional view to the exploded view simpler.

The top view shows the bolt-spring (A) with its two bent ends in their holes in the oscillating weight and with its off-center hole nudged under and inside the neck of the oscillating weight axle (I). The coverplate (B) is shown fastened down to the oscillating weight (C) by the screws. In the middle view, the oscillating weight (C) is shown driven friction-tight onto the outside of the tube of the cam (F).

Here, also, it can be seen that the coverplate (B) acts as a cover-container for the vertical roller pins (E). The

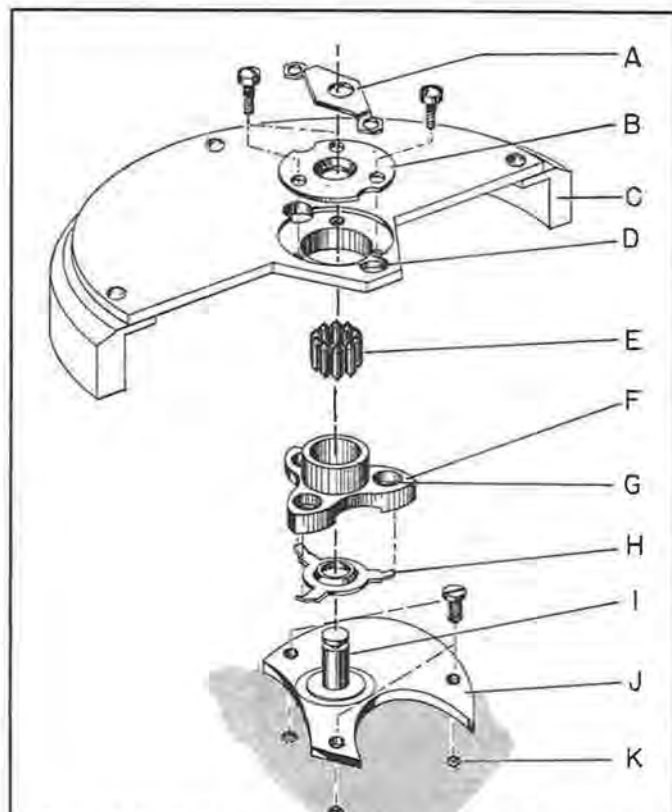


Figure 2. Exploded view of the roller bearing unit contained in the Rollamatic oscillating weight. The roller bearings are cylindrical pins E which rest in the pipe of cam F. The oscillating weight axle I fits up through the cam and the roller pins. The pipe of this cam fits friction-tight into the pipe of the oscillating weight. The roller pins are kept in their place by the cover plate B and the spring plate H. This unit must not be dismantled.

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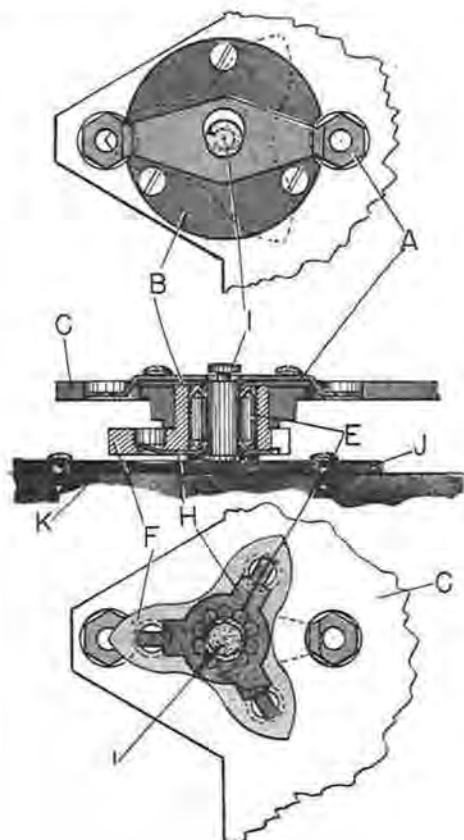
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Figure 3, This is a side and sectional view of the roller bearing unit, assembled to show its relationship to that in Figure 2. This is arranged so that each part in Figures 2 and 3 has the same letter and should make referrals from the sectional view to the exploded view simpler.



pins (E) surround the axle (I) and are contained on the outside by the tube of the cam (F). The axle (I) is shown with its base plate (J) fastened to the movement (K).

The bottom view shows this part of the roller and cam unit on the oscillating weight as seen from the bottom. Notice how the lower retaining plate (H) acts to contain the roller pins in place by having its hole cupped so that the points of these pins follow the cupped contour of this plate.

The prongs of the plate (H) are nudged to fit into the reverse countersunk holes of the cam (F), making this plate secure. Also shown through the bottom of the oscillating weight in the lowest view is the underside of the bolt-spring (A) with its extremities in the holes of the oscillating weight.

When the oscillating weight is removed, it comes off as a unit containing the roller-pins, star-cam, and upper and lower retaining plates. The makers emphatically advise against removing either the upper or lower cover plates and specifically warn against removing the three screws securing the coverplate atop the oscillating weight.

WHS

BOOK REVIEW

ROLEX TIMELESS ELEGANCE, by George Gordon. 300 pages, fully illustrated with color photographs, 9"x12", hard bound with sleeve. Published December 1988 by Alan Lie Younder @ \$165.00.

Mr. George Gordon has compiled a volume containing the history, achievements and products of this prestigious watch manufacturer. The book is, in a way, a tribute to Hans Wilsdorf, German-born who as a youth immediately became enamored with horological mechanisms and in 1905 founded the company which today is Rolex. This company originally was based in London as Wilsdorf and Davis; his brother-in-law was Davis, also based in London, and Wilsdorf later became a British subject.

At about that time, the wristwatch on that side of the Atlantic was making an appearance. Hans Wilsdorf foresaw the potentials of a quality wristwatch and strove towards this end in producing such a product. His first order amounted to a sum five times greater than that of his entire capital.

In 1908 the name Rolex was coined since it was easily pronounced in most continental languages and still short enough to allow good dial composition. Until then, the movements used such names as XL, Marconi, Unicorn, Genex, Rolco, Oyster and Tudor.

Wilsdorf soon entered especial products for observatory testing, resulting in being the first wristwatch chronometer. Later his other wrist timepieces received class A

certificates from various testing observatories in Europe and England.

Later improvements to the Rolex wristwatch was the "Oyster" with its twin-lock winding crown system, a first in water and moisture protection.

When the young London stenographer Mercedes Gleitze, wearing a Rolex "Oyster" watch successfully swam the English Channel after being in the water for 15 hours, the further success of these Rolex products was assured.

Other endurance feats by well-known pilots, explorers and navigators solidified that reputation. Another first was the introduction of the rotor by Rolex's technical director, Emile Borer. This provided automatic winding regardless of the direction the swinging weight turned.

Still later, in 1960, Prof. Piccard's bathyscaphe with a special Rolex Oyster watch attached to its outside plunged to a depth of 35,800 feet, emerging unharmed, resisting pressures greater than seven tons per square inch. Other feats and accomplishments are recorded in nine pages of this book.

Four pages list the chronological progress, successes and the many awards of this company. Another 16 pages select some of the especially attractive advertisements which appeared in the *London Daily Mail*, displaying the Rolex Oyster with Miss Gleitze's channel swim. There are trade journal ads showing observatory awards as well as newspaper ads of the late 20s and early magazines with equally stylish

wristwatch designs. Two pages of especial observatory certificates, in color, are reproduced as well.

Another of the book's section is a reproduction in full color of their famed Jubilee Collection of 1946. This contains 26 plates which includes three thin pocket watches.

Vintage (Rolex) wristwatches take up over a hundred pages and to the dealer of older wristwatches or collectors, this section may be a valuable reference since 257 different watches are pictured, again in full color.

A shorter section with the heading "References" pictures 120 wristwatches by reference number and debut dates. An additional page lists the production by case serialized production numbers. For example: Case number 28,000 is dated 1926 and number 9,999,999 is dated 1987. Following these numbers are R,000,000, also 1987.

Nine pages show 60 "Latest Models from Rolex." This is followed by a short section of photographs of a chronograph movement and the parts of this Valjoux Calibre VZ23.

A page of old wristwatch movements used by Rolex reveal a few Rebberg, Favre, and what appears to be a Gruen model as well as Rolex ebauches. Case backs are also pictured and their clarity reveals their inner logo stampings.

The end of this volume contains "Original Designs of Rolex" showing almost 150 black and white designs in triple fold-out gray pages. There are five extra pages of advertisements of books on vintage wristwatches.

To the dealer and collector of Rolex or vintage wristwatches, this well-constructed volume should make a valuable reference for authenticity, history, and dates of Rolex watches.

MANUAL, OVERHAUL, REPAIR AND HANDLING OF HAMILTON SHIP CHRONOMETER (with Parts Catalog). Soft covers, 8"x10½", 98 pages, 113 illustrations. Originally published by the Navy Department Bureau of Ships, October 1948. Republished 1989 by Arlington Books @ \$14.95.

This is the official repair manual for the repair of the Hamilton detent escapement marine chronometer model 21, 14 jewels, with drawings and factory-supervised instruction, as well as drawings by the engineering company of Van Valkenburg, Nooger, & Neville of 15 Maiden Lane, New York. The drawings and instruction are first class. Aside from teaching of the proper handling of this mass-produced marine chronometer, it's a very fine manual for anyone planning to service or repair any detent marine chronometer. Tools, materials, cleaning fluids, and safety precautions are described in detail and illustrated.

Each part, each section, and each unit is illustrated in detail with exploded views. Escapement adjusting, mainspring assembly and equalizing, and set-up are all clearly shown and explained.

Created for the maintenance of these instruments in the field, this should serve as a reliable guide to anyone planning to service marine chronometers in general and in particular the model 21 Hamilton Marine Box chronometer.

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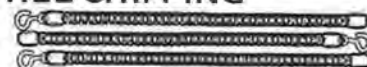
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Repairing or Replacing Catches

Most every piece of jewelry or watch attachment has to have a catch if the two ends are to be fastened together with a device that can be opened and closed. Last month spring rings were discussed. They are no doubt the most used of all catches. There are many other types of catches such as fishhook types for pearls or beads, sister hooks for chains, lobster claws, box catches, tube catches, ratchet slide buckles used for wristwatch bands, tongue catches that are used with box catches or tubular bangle bracelets, and many other types.

Many of these catches can be repaired, but in many cases it is more practical and less expensive to replace even the karat gold clasps. Most catches can be replaced with a new one found in the findings catalogs. They are available in nickel, nickel silver, silver, karat gold, gold plate, gold filled, and even the less expensive ones in nickel plate. Many of these catches have to be altered to make them work. This requires the skill of a jewelry repairman that has learned these procedures from practical experience, but often these alterations can be made simply by bending using the different types of pliers we have in our tools.

Pearls and beads are always a most popular item. Catch problems or the cord on which they are strung breaking are repairs that frequent the bench of the jewelry repairman. For single strand pearls or beads, the most popular catch is the fishhook catch (Figure 1A). For two or more strands a box type catch with a tongue is usually used (Figure 1B). The fishhook (Figure 1C) is replaceable without replacing the entire catch and the same with the tongue for the box catch (Figure 1D). Artificial pearls or less expensive beads have the clasps fastened to the ends of the strung pearls or beads with bead tips. Bead tips are a small, round concave metal (usually silver or gold-plated base metal). A small piece of metal extending from the edge of the concave is bent to form

a hook that can be hooked to the ring on the clasp and bent down to make it secure. The center of the concave has a small hole which the bead cord from the end bead is passed through and knotted tight. By bending or prying the metal hook of the bead tip, it can be removed from the clasp then rehooked on another clasp or replacement part and retightened. When even inexpensive beads or pearls are restrung, these bead tips should be replaced with new ones.

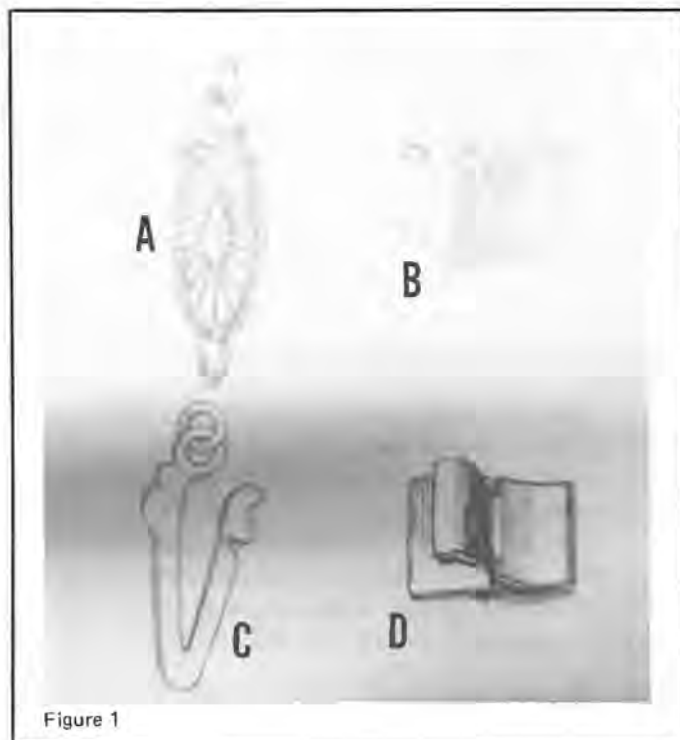


Figure 1

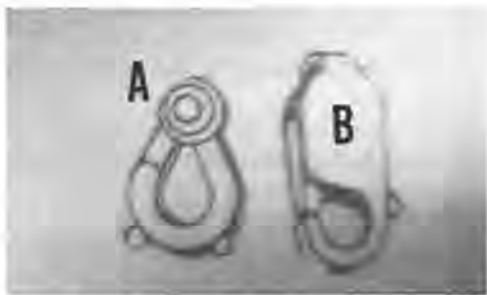


Figure 2

The fishhook end of the fishhook clasp can be purchased in assortments from most any findings supplier as well as the tongues for the box catches. These assortments of fishhooks may vary in size and shape from the one being replaced, but one that will function properly with a slight alteration can usually be found in the assortment. Tongues are made for single strand up to many strands with the end having holes drilled. They are made in many widths, so usually to get a replacement one must be chosen that can be cut down for width. After cutting it down for width and it is drilled for three strands and you need only two, the outside two holes can be used. If it is for a one strand the center hole can be used. I usually cut away the metal from the holes not being used with a separating disc in the flex-shaft tool. These are small grinding discs that are very thin and can be used to cut off excess width as well as trimming the unused holes to make the tongue reasonably match the box catch that it is being used with.

Genuine pearls (cultured or oriental) or more expensive beads usually do not use bead tips. The ends are fastened with the bead cord usually wrapped around a jump ring connecting it to the catch with no knot showing outside the end bead. To replace one end of the catch, the part to be replaced should be cut away from the jump ring which is usually a solid ring with no split. Heat cannot be applied in this situation, so it must be attached by adding a split jump ring.

Repairing and replacing catches can often necessitate restringing the beads. I would like to pass on some observations that I have made and the types of materials that can be used to eliminate problems creating comebacks that you will be expected to repair free under some *implied* warranty. For regular, artificial or cultured pearls, nylon bead cord is usually adequate. For glass or other crystal substances where the edges of the holes can become sharp because of the edge being chipped, nylon or any bead cord can be cut. A good way to avoid this is to sell the customer a restring job using stainless steel nylon-coated cable. It can be obtained in more than one thickness and it is easy to string the beads. This has been introduced in recent years and can be used in place of foxtail chain which is more difficult to use and more expensive.

Sister hooks (Figure 2A) have proved to be one of the more secure catches found on necklaces and bracelets that need a strong and secure catch. They are available in many sizes and in karat gold, sterling silver and gold filled. Heavy chain I.D. bracelets have mostly used this type of a catch. The way they open and close, with the hooks coming

from each side, gives double strength and an almost impossible chance of it becoming unfastened from catching while being worn. In WWII I was issued a sterling silver neck chain with two sister hooks for holding dog tags. It was worn for three years with no problems. The only repair that I have had to make was replacement of the hinge which is just a tube rivet. The one that I replaced was accidentally damaged, but from normal wear this would not ever be necessary.

Lobster claw catches (Figure 2B) are used for heavier pieces of jewelry and are also available in different sizes and made of different metals the same as sister hooks. The advantage they seem to have is how easy they can be fastened or unfastened but are still strong enough to hold heavy necklaces and bracelets securely. These, like most catches of lesser quality than karat gold, are probably less expensive to replace than to repair but the karat gold quality can usually be repaired for less than replacement cost.

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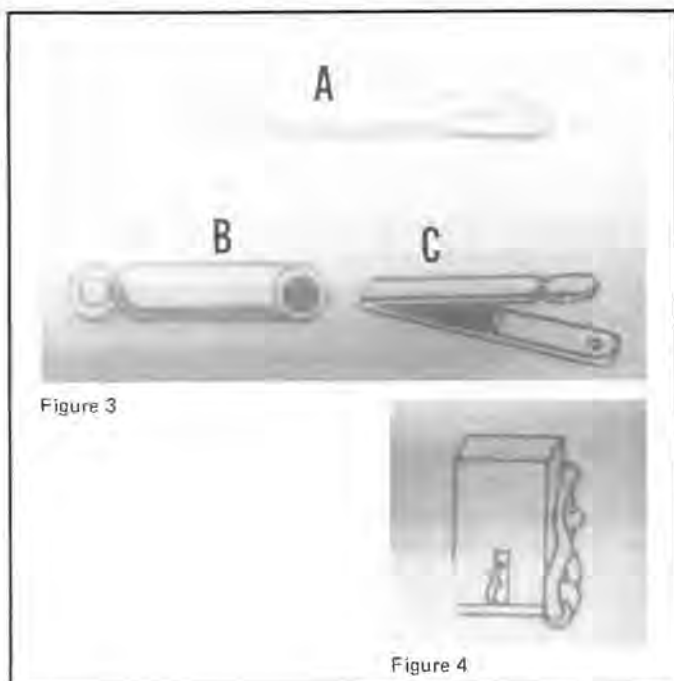
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Tube catches (Figure 3A) shows the complete catch fastened, while Figure 3B shows the barrel only, and Figure 3C shows the tongue. These catches can be used for single strand pearls, beads, or chains and are easy to fasten and unfasten but are reasonably secure. These are often called barrel catches and mechanically function the same as box catches with a tongue. They are available in different sizes and metals. Figure 4 shows a box type barrel catch with a safety device on the side that snaps over a peg. Barrel catches with either round or square tubes are also available with these safety devices.

The old popular catch for ladies' wristwatch cord, mesh or link bands was the ratchet slide catch. These were mostly made of white or yellow gold-filled metal. They were not practical to repair but were easily replaced. They came in two types of ends—one for cord bands with attaching ends and one to be used with other types with a link type of attachment.

Today's ladies' watches usually are equipped with metal bands that are not easily replaced and with foldover type buckles that can be replaced. These buckles come in kits with three widths in yellow or white and each buckle comes with a safety chain. Many of these come in for repair with one part of the buckle or catch missing, but the only practical way to repair these is by replacement. Sometimes they have a problem with the adjustable eccentric clamp slipping and some can be repaired by bending or tightening a hinge. But with the loss of a watch being at risk, it is best to just replace the buckle with a new one.

Some of the major watch manufacturers have a band number stamped on the end of the band underside where it attaches to the watch. Replacement bands and even some catches can be ordered by this number; others can be ordered from the case number on the back of the watch. Bands or buckles ordered from these numbers have to be ordered by your supplier as they do not carry them in stock, so be prepared to pay an exorbitant price. It is best to get a

price quotation before ordering. When these bands are special ordered for you it is a *no cancel, no return order*, so make sure your customer will accept it. Know the price and you will not be stuck with it.

Tubular bangle bracelets have been on the jewelry market since long before my time. They are usually oval or round in shape and made from many different metals. The selling price of these bracelets has always been somewhat governed by the metal they are made of. Some are sterling silver, some yellow or white gold filled, and some of karat gold. Their construction is usually similar with a hinge and directly across a catch which is usually some type of a tongue catch. The hinge is made so each end can be inserted in the tube and then sweat soldered with soft (lead base) solder that flows at a low temperature. The hinge does not have to open completely but if it opens three or four inches it will allow the bracelet to go over the hand. Sometimes the catch is made with a flat wire that slides into the end of the bracelet that the tongue snaps into. This limits the opening and will not allow it to be opened too far causing damage to the hinge or denting the tubing the bracelet is made of. It also serves as a safety. The bracelet would have to slide completely over the hand to be lost. This safety wire is usually attached to or a part of the tongue which snaps in the other end of the bracelet.

The repairs on these usually consist of resoldering one of the sweat solder joints and it is done in the following manner. First clean the inside of the tube where the end is to be soldered, then clean the end that is to be inserted in the bracelet. Flux with soft solder flux (zinc chloride) both inside the bracelet and the end to be inserted and then flow a small amount of soft solder on the end. If you get too much for the end to enter the tubing, then reheat and while still hot wipe with a slightly damp cloth which will remove the excess but leave a thin coat on the end piece. Reflux the end piece and insert it, then apply heat until the temperature of the metal is sufficient to flow the solder. The solder should flow making a strong sweat solder joint. Let cool and check for strength and if O.K. then polish the entire bracelet and clean. In polishing karat gold and gold-filled or sterling silver no special care should be taken for there is little chance of polishing through the outside finish. On electroplated metals care should be taken to polish very lightly or the plating can be polished through to the base metal. I usually burnish plated jewelry using a bronze brush wheel on the polishing motor which does not remove any metal. Sometimes these come in with broken hinges or catches and to my knowledge there are no findings available to replace them. The only way is to repair or make new pieces which requires imagination and ingenuity. This type of work should bring a good price which generally eliminates these repairs on inexpensive bracelets, but if the customer is willing to pay the price and you can make a neat and durable repair the customer is entitled to this type of service. If when examining any repair you do not feel that you can make a neat and durable repair, it is best to turn it down for it can only lead to damaging your good reputation.

In the next article we will discuss repairs that involve genuine and synthetic stones.



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PART XLVII

FORM RELIEVED CONSTANT PROFILE WHEEL AND PINION CUTTERS

To continue the discussion of form relieved wheel and pinion cutters, the correctly form relieved cutter will have a constant profile which remains the same shape any time it is resharpened. This type of cutter is form relieved with a preformed forming tool. The forming tool can be a one-piece tool or a tool made up of two or three pieces clamped together. A forming tool which relieves both sides of the cutter teeth at the same time is more likely to form cutter teeth which do not change shape when the cutter is resharpened. When the teeth of a cutter are formed with a single tooth forming tool on one side, then the cutter reset and the other side of the teeth formed, there is no assurance that the cutter profile will be constant and remain the same after resharpen-

ing. The single tooth forming tool referred to here is shown in View A, Figure 3.

MAKING TOOLS FOR FORM RELIEVING GEAR CUTTERS

In preparation for making forming tools to form relieve gear cutters, one would make some concave form tools. One style of concave form is shown in Figure 1. This style is made by using pieces of soft high carbon square cutter stock. The surfaces of the cutter stock should be surface ground. At least the top side, which forms the cutting edge of the form, should be surface ground flat. The square stock should be of a size that fits closely in the slot of the tool post of the slide rest that will be used for making forming tools. View A, Figure 1 shows a piece of the square stock with a hole drilled in its center near the end of the stock. The size of the hole should be twice the radius of the curve on the wheel or pinion tooth being duplicated. One should make up a series of these concave forms. The holes in these forms could be graduated in twist drill sizes from 50 to 65, then the in-between sizes could be made with pivot drills. These sizes are for watches. Clock sizes would be larger than a 50 drill. After the holes have been drilled, then they are taper reamed from the bottom side of the stock to form a tapered hole. This is shown in View B, Figure 1. The sizes of the holes should be marked on the stock. After this, the end of the stock is filed or ground away to the center of the hole as shown in Views C and D, Figure 1. A top view of the concave form is shown in View E, Figure 1 and a bottom view is shown in View F.

Another style of concave form tool is shown in Figure 2. These are made from high carbon steel discs. Assorted sized holes are drilled on a circle near the edge of the discs as shown in View A, Figure 2. Then the holes are taper reamed from the underside of the disc as shown in View B, Figure 2. The top of the disc is made flat and smooth. The top of the disc is ground flat to sharpen the edges of the holes. The holes should be marked for size (stamped or scribed).

Figure 1

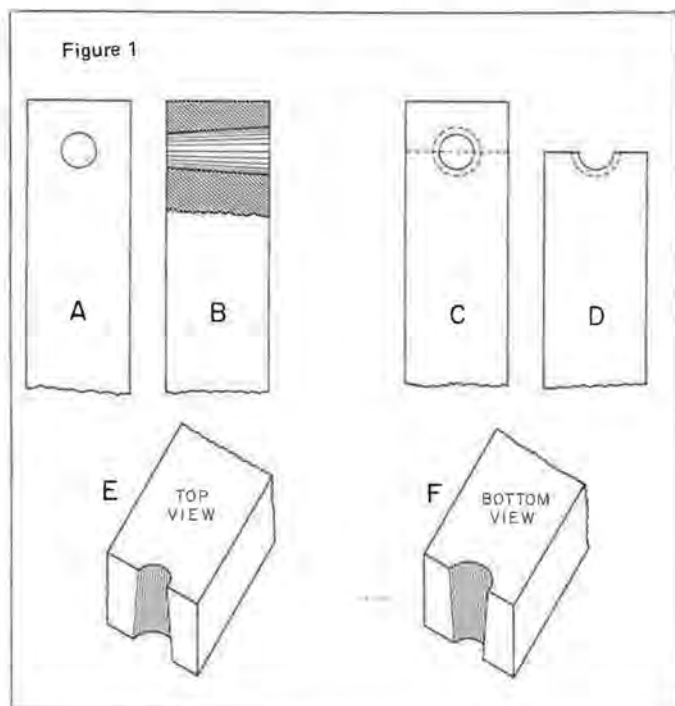
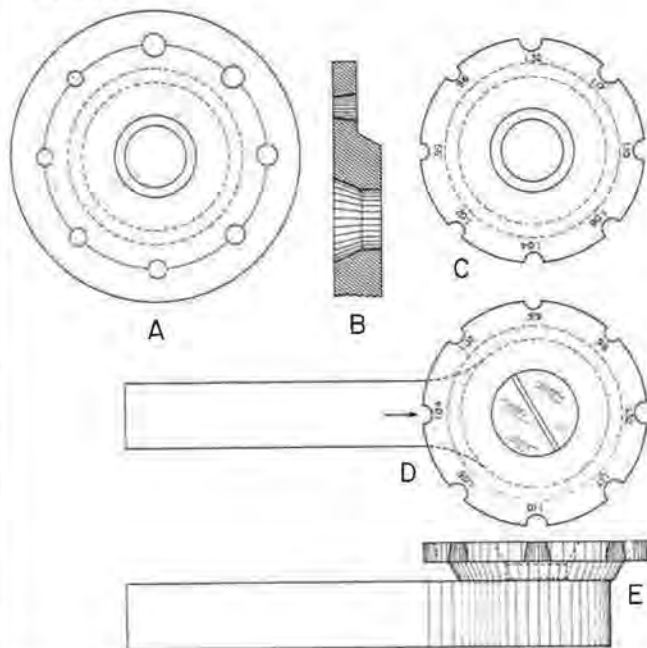


Figure 2



After this, the outside edge of the disc is turned away to the center of the holes as shown in View C, Figure 2. The center hole in the disc should fit closely on a shouldered screw. View D, Figure 2 shows the holder which must also be made up for the discs. The shank of the holder should fit closely in the slide rest tool post. The screw for the discs must tighten the discs securely into position on the holder. View E, Figure 2 shows a side view of the disc and holder. The discs should be hardened and left dead hard after they have been completed.

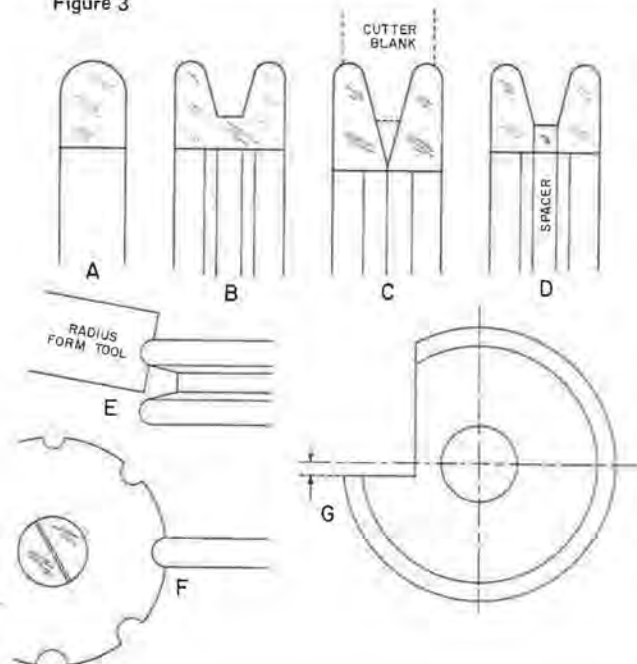
MAKING FORMING TOOLS

Figure 3 shows some styles of forming tools and how the concaved forms are used to make the curved edges of the forming tools. View A shows the edge of a single edge forming tool. This style of forming tool would be used to form one side of the gear cutter at a time. View B, Figure 3 shows a double-edged, one-piece forming tool. This type of forming tool form relieves both sides and the edge of the gear cutter at the same time. This method assures one that the cutter will have a constant profile that will not change shape when resharpener. This forming tool is shaped with a special shaped slide rest tool, then the two edges are rounded with the concaved form.

View C, Figure 3 shows a two-piece forming tool which is used to form relieve both sides of a gear cutter at the same time. Then the edge of the cutter is relieved in a separate operation with a square-ended or concaved forming tool depending on whether the cutter is to cut a square bottom or a round bottom gear. When making the two piece forming tool, each side is made separately with the proper angles. After this, the two sides are clamped together on an arbor chuck, then the two edges are rounded with a concaved form.

View D, Figure 3 shows a three-piece forming tool. This arrangement has the two separate sides held apart with a spacing washer. One advantage to this arrangement is that, by

Figure 3



using different thickness washers, the forming tool can be used to form relieve gear cutters which need different widths. Views E and F, Figure 3 show the concaved form being used to round the edges of forming tools. View G, Figure 3 shows how the edge of a circular forming tool is notched out to form its cutting edge. The edge of the forming tool is notched out so the cutting edge is below the center of the tool. This is so the clearance angle below the cutting edge will be sufficient to allow the forming tool to cut cleanly without dragging on the cutter blank. The amount that the cutting edge is made below center depends somewhat on the relationship between the diameter of the cutter blank and the diameter of the forming tool.

Some rules to consider when designing circular forming tools for gear cutters are:

1. The smaller the cutter is made in diameter with a given forming tool diameter, the more clearance the forming tool will have and vice versa.
2. The more the forming tool is notched below its center, the more relief the forming tool will have.
3. The smaller the forming tool is made in diameter with a given cutter blank diameter, the more clearance the forming tool will have and vice versa.

The diameter of the forming tool should not exceed the diameter of the cutter blank being form relieved. It would be wise to make the diameter of the forming tool two-thirds to three-fourths the diameter of the cutter blanks being form relieved. The relief needed on a forming tool should be 10 to 12 degrees. When making forming tools, one should make a scale drawing of the cutter blank and the forming tool (enlarged 20 times). This helps to determine the amount that the notch in the forming tool must be cut below center in order to have the 10 to 12 degree relief on the forming tool. The diameter of the forming tool can also be determined with a scale drawing. When a forming tool is being used, its cutting edge should be centered with the lathe center.

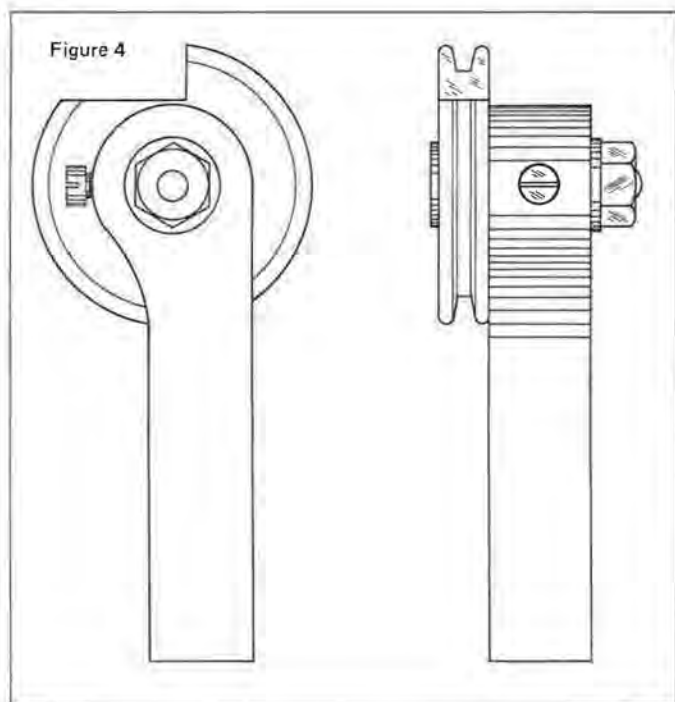


Figure 4 shows the holder that must be made up for the forming tools. A bolt, nut, and washer hold the forming tool to the holder. A flat surface is filed or milled on the bolt to receive the end of a set screw. This is to prevent the bolt from turning in the holder when the nut is being turned to tighten the forming tool to its holder. The shank of the holder should fit closely in the slot of the tool post of the slide rest.

ARRANGEMENT FOR FORM RELIEVING GEAR CUTTERS

Figure 5 shows an arrangement that can be used by the watchmaker for form relieving circular gear cutters. To create this arrangement, one would need a slide rest which has three slides. The slide rest should be of the type which has its base milled out to fit a shoe on the bed of the lathe. This arrangement prevents the slide rest from twisting on the lathe bed when it is being used. The old Wolf-Jahn slide rests were of this type. Other slide rests fit on a shoe but have only two slides. The old Wolf-Jahn slide rest is ideal for use in form relieving gear cutters since it meets both requirements of fitting on a shoe and having three slides. When using a slide rest to form relieve gear cutters, the lead screw which operates the bottom set of slides is completely removed from the slide rest so the slide is free to move back and forth freely by hand. Note: To form relieve gear cutters, the equipment must be set as closely as possible, yet it must be free to move smoothly. The next thing to do is to take a 9/16 or 5/8 inch diameter blank arbor chuck which has a body length of at least one inch long for making an arbor chuck to hold the cutter blank. Note: When form relieving a gear cutter, the arbor chuck should be supported by a center in the tailstock. The cam needed to move the forming tool in and out on the cutter blank is also fastened to the same arbor chuck. As seen in Figure 5, a shoulder is cut on the arbor chuck near the lathe spindle to hold the cam. The end of the shoulder for the cam is threaded to receive a nut for holding the cam tight and flat against its seat on the arbor chuck. Next, the end of the arbor

chuck is turned down to fit the cutter blanks. This shoulder is also threaded for a nut. The forming tool and its holder are held in the tool post of the slide rest as shown. The cam arm with its roller is fastened to the side of the upper part of the lowest set of slides (the one from which the lead screw was removed). The cam roller should always rest on the edge of the cam and follow the contour of the cam. Note: The diameter of the roller should be 1/8 to 1/10 the diameter of the cam. This in and out contour of the cam causes the forming tool to move in and out as the lathe headstock is turned. This in and out motion allows the forming tool to form relieve the cutter blank. In order that the cam roller is always held against the cam, a cord is fastened to the end of the upper part of the lower slide. This cord goes over a pulley and a weight is attached to the end of the cord. This condition could also be created by the use of a spring instead of using the weight. Note: The watchmakers lathe is used for making watch gear cutters and is not large enough for making clock cutters. This principle can be applied to larger clockmakers and machinists lathes for making clock gear cutters.

Figure 6 shows an end view of this arrangement. The cam arm and roller are hidden and are shown in dotted lines. Note that the cam roller is on one of the cam's lowest points when the forming tool has just finished form relieving a cutter tooth. Now, as the cam and cutter turn further counter-clockwise, the roller goes up an incline plane on the cam to reach a high point on the cam. This action moves the forming tool outward on the cutter so it is in position to start form relieving the next tooth. The forming tool is started at the very edge of the cutter blank and is fed into the blank very gradually as the cutter blank turns until all of the teeth on the cutter are form relieved to the correct depth. The lead screw of the top slide is turned to move the forming tool deeper into

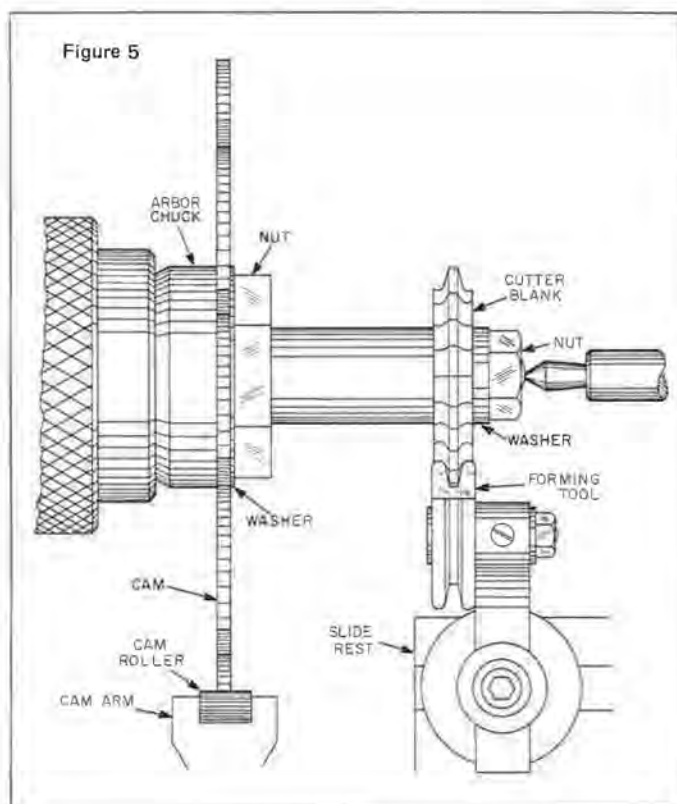


Figure 6

The diagram illustrates a mechanical linkage system. A large cam wheel, labeled "CAM", is shown rotating clockwise. It is connected to a gear mechanism. A cord is attached to the gear and passes over a pulley, which is connected to a weight. The weight is shown as a rectangular block with vertical lines. The cord is labeled "CORD" and the pulley is labeled "PULLEY". The weight is labeled "WEIGHT".

The lathe spindle should be turned very slowly when form relieving gear cutters. The lathe spindle should not turn faster than 10 to 15 revolutions per minute and very light cuts should be taken with the forming tool. A special slow turning motor must be used to turn the lathe headstock. A good motor to use for this purpose is a barbecue spit motor. These turn at about $6\frac{1}{2}$ to 7 turns per minute. A pulley is placed on the spit motor shaft which is about two times the diameter of the headstock pulley. This would cause the lathe to turn about 13 to 14 revolutions per minute. The motor could also be used to turn the countershaft with the countershaft driving the lathe. The spit motor is a very strong motor and this feature is needed when form relieving gear cutters. For a more positive drive, sprocket wheels can be used on the motor, lathe headstock, and countershaft; then roller chains are used on these to transmit power. These can be purchased from the Boston Gear Works. Another idea is to use non-slip geared pulleys and non-slip geared belts to fit. A good motor to use is a ratio motor with worm drive. These can sometimes be found in a surplus store or they can be purchased new from a motor supply house.

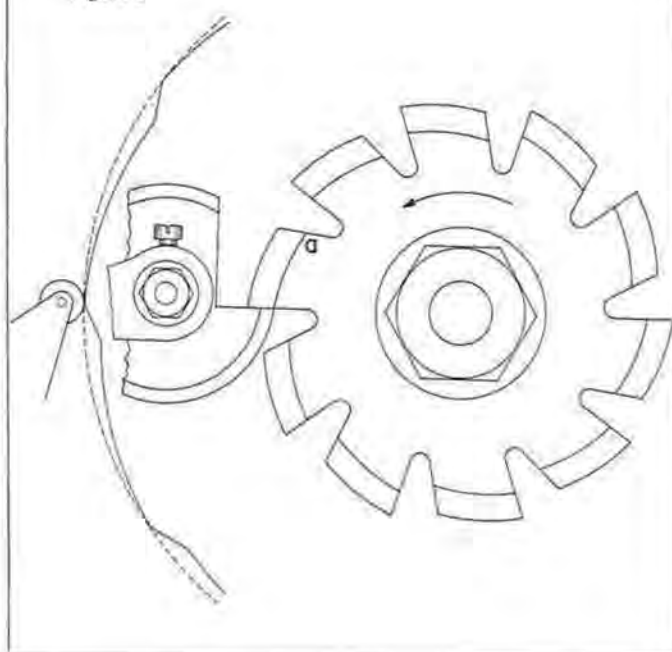
The following procedure is used to lay out and make the cam for form relieving gear cutters. First, one would decide the number of teeth that the cutter is to have. In this example, we will choose 10 teeth. We now determine the angle of relief needed on the cutter. We will make this 10 degrees since the cutter is to cut steel. The cutter diameter is to be 20.00 mm. The diameter of the cam must be made to fit the equipment being used. This would depend somewhat on the length of the roller arm and the distance needed for the forming tool. The diameter of the cam should be between 50 and 60 mm for a watchmakers lathe. The thickness of the

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MAKING AND FORM RELIEVING GEAR CUTTERS

When setting up to make gear cutters, it would be wise to decide on the system to be used, the diameter of the cutters, the thickness of the cutter stock, the number of teeth the cutters are to have, the diameter of the hole in the cutters, etc. In other words, standardize the equipment and materials used in order to make a standard product that can be used over and over again. If one is making very small delicate cutters, then the cutter blank should be thinned down at its edge with a graver by beveling each side of the blank so the edge of the blank will be a more realistic thickness where the teeth will be formed on the blank. The beveling or excess metal removing is done prior to forming the shape of the cutter. It is very important that the arbor chuck runs true and that the hole in the cutter blank is a close fit on the arbor chuck. When forming the edge of the cutter blank, some of the excess metal can be removed by hand with a round pointed graver to partially shape the edge of the blank. Then the forming tool can be used (without the roller on the cam) to form the shape of the edge of the blank. Now the cutter blank is notched to lay off its teeth. This can be done without disturbing the blank on the arbor chuck. After this is done, the roller is brought back on the edge of the cam in preparation to form relieve the cutter. Before starting to form relieve

Figure 8



the cutter blank, make sure that the teeth on the cutter blank are in the proper position in relationship to the high and low points on the cam. If the cutter does not line up, it can be loosened on the arbor chuck and aligned. Figure 8 shows this condition. Note: Also make sure that the forming tool is properly centered with the cutter blank, and that cutter blank runs true in the flat and round.

In Figure 8, note that the roller is situated on a high point of the cam while the forming tool has just reached the front edge of a cutter tooth. Now, as the cutter and cam turn counterclockwise, the roller gradually goes down a curved incline. As this happens, the forming tool is fed into the cutter the same amount. This causes the forming tool to cut a curved surface on the tooth which has a uniform decreasing radius the same as the shape of the cam. By the time the roller has reached the lowest point on the cam, which is shown at "a", Figure 8, the forming tool should have just left the tooth and be in the space between two teeth. After this, the roller goes up an incline on the cam which lifts the forming tool outward far enough to have it in position for forming the next tooth, etc. Note: When forming a cutter, it must not be disturbed on the arbor any time during the making of the cutter. The cutter that is shown in Figure 8 has been completely form relieved. One would start the operation by setting the forming tool so it removes material at the very tips of the cutter teeth. Then as the lathe continues to turn, the forming tool is gradually fed into the blank until the teeth of the cutter are completely form relieved as shown. After the cutter has been completely form relieved, then it is stamped with the module, number of teeth it is to cut, and the profile shape if it is a pinion cutter. After this, the cutter is heat treated.

"Antique Watch Restoration" will continue next month.

AWI

MATERIAL SEARCH NETWORK

EDITOR'S NOTE: This is a new column designed to work in conjunction with the AWI Material Search Network and Movement Bank. See "Horological Times," October 1989 issue, page 4, if you missed details. If you can supply any of these items, send details to the Material Search Network—DO NOT SEND THE ITEMS. Members requesting these items will be advised of their availability and will contact you direct.

AWI Material Search Network Needs As of October 10, 1989:

Item 1A: A 16 size Illinois, A. Lincoln model cannon pinion.

Item 2A: Mainspring for a Junghans "Plato" clock.

Item 3A: A complete movement for Elgin calibre 965 (AS 1748)—auto/date/ss hand.

Item 4A: A replacement dial for a 16 size Illinois "Bunn Special" pocket watch.

Item 5A: Uncollected hairsprings for Bergeon hairspring assortment which contains numbers 1 through 32.

Item 6A: Collected or uncollected hairsprings in all strengths in either individual packages, or in assortments.

NOTE: Items 5A and 6A are wanted for a course AWI plans to teach on hairspring vibrating.

IF YOU CAN SUPPLY ANY OF THESE ITEMS, PLEASE CONTACT: Material Search Network, AWI Central, P.O. Box 11011, Cincinnati, Ohio 45211.

TIMES

TIMES

THE HISTORY & DEVELOPMENT OF THE QUARTZ WATCH

PART I

For almost 300 years (1660-1957) all watches were mechanical and their fundamental design and construction remained unchanged. This incredible longevity is probably a record for a complex mechanical device.

But then came a revolution. It began with a laboratory model in 1952 and progressed to an overwhelming technological transformation. By 1982, only 16% of the watches and movements imported into the United States were mechanical, by 1983 only 9%, and by 1988 the figure had reached a low of 7½%.

What happened? The quartz watch!

The quartz watch was the final result of an evolution which took quite a number of years to complete, yet the time span between each advance was incredibly fast. It started with the breakaway electric watch in 1952 and ended with the quartz digital watch of 1970. In order to understand this progression, it is essential and rather intriguing to know that all modern timepieces, including the revolutionary quartz watch, work on the very same operational principles. They all have:

- 1) An object that swings back and forth in equal intervals
- 2) A power source which energizes the swings
- 3) A system that counts the swings

It is odd, but true, that a pendulum that is swinging back and forth is performing the same operation as a quartz crystal vibrating at 32,768 times per second. The technical term for the swinging or vibrating object is an "oscillator." Other "oscillators" are the balance wheel, tuning fork, and caesium atom.

It may also seem strange that the power energizing the swings, which is supplied by gravity or a mainspring in mechanical timepieces, is performing the same operation as the electricity from a battery in a quartz watch. Other sources of power are the electricity from a generator or from solar/light energy. Still another is the internal energy of the caesium atom which is the power source of the atomic clock.

And, finally, the system which counts the swings, technically the "indexing system," consists of the gear train, escapement, setting mechanism, dial and hands in a mechanical watch. It performs the same function as the integrated circuit and time display in a digital watch. Additional "indexing systems" will be discussed later.

And now, on to the technological revolution which totally transformed portable timepieces from the electric watch to the electronic to the quartz. The first electric watch had a battery, an electric circuit, and an oscillator/motor. The next big advance, the electronic watch—the Accutron—had a tuning fork and electronic circuit. And, finally came the



Ben Matz, CMW

quartz analogs and digitals which triumphed over all its predecessors. This is how it all began:

In 1952, the Elgin Watch Company announced that it had produced a *laboratory model* of an electric watch*. This watch was never marketed.

In 1957, the Hamilton Watch Company produced the first successful commercial electric watch which it marketed that year. It contained a battery which powered a miniature oscillator/motor which drove gears that turned the hands.

Soon, other companies also produced electric watches.

In evaluating the extraordinary design changes that occurred in this new technological development, it is helpful to refer to the basic operational principles and compare the mechanical with the electric watch.

	MECHANICAL	ELECTRIC
POWER SOURCE	Mainspring	Battery
OSCILLATOR	Balance Wheel	Balance Wheel
INDEXING SYSTEM	Gear Train Escapement Setting Mechanism Dial & Hands	Oscillator/Motor Gear Train Setting Mechanism Dial Hands

The two significant changes, the battery and oscillator/motor, were dramatic and spectacular breakthroughs.

Previously, batteries and oscillator/motors were huge units that could not possibly fit into a watch. Only when they were miniaturized could they be used in portable timepieces.

But to begin with, what is a battery? It is a portable source of electricity which derives its power from the conversion of chemical into electrical energy. It consists of a housing which contains electrodes and an electrolyte.

Electric power is created when electrons are released at one electrode and caused to flow through an external circuit to the other electrode. Originally, this description applied only to a single cell. A battery was a group of cells connected into an electric unit. Today, however, a single cell is also called a battery.

Let us review the history of the cell and battery as far back as 1791.

In 1791, **Luigi Galvani** discovered that by bringing two dissimilar metals into contact with a moist substance he could cause a flow of current along an electrical conductor.

* A collaboration between Elgin and Lip (of France) engineers.

In 1800, **Allessandro Volta** created the first battery. It consisted of silver and zinc discs, in pairs, separated by a sheet of pasteboard soaked in salt water. When the top disc of silver was connected by an external wire to the bottom disc of zinc, a current was produced. Volta constructed piles (voltaic pile) with as many as 60 pairs of discs. He later modified the battery with an arrangement called the "crown of cups."

In 1836, **John F. Daniell** developed the first primary cell (nonchargeable and nonreusable). In this cell the anode was a zinc rod coated with mercury immersed in sulphuric acid. The cathode consisted of a copper canister containing sulphuric acid and saturated with copper sulphate.

In 1865, **Georges Leclanche** invented the first "dry" primary cell that later made the first portable cells possible. In its original form, it contained a liquid electrolyte (ammonium chloride solution). However, the construction of the cell enabled other researchers to replace the liquid electrolyte with a jelly absorbed in porous material.

In the early '40s, **Samuel Ruben**, an independent inventor, created a mercury cell which P.R. Mallory & Company (now the Duracell Battery Company) manufactured. This was small enough to later fit into heart pacemakers and hearing aids. Eventually this type of cell was used in the Elgin laboratory electric model. A carbon-zinc cell, specifically designed for watches, was later manufactured by Union Carbide and used in the 1957 Hamilton Electric. Shortly thereafter, a silver-oxide cell was produced which was used in quartz watches.

Let us now examine the other technological advance, the oscillator/motor. To do this, let us deal with electric motors in general.

An electric motor is a device which converts electrical energy into mechanical energy. The motor works on the principle that when electrical energy flows through a conductor (e.g., a wire) in the presence of a magnetic field, the conductor tends to move. When it moves, mechanical energy results.

The conventional motor has a rotor and a stator on which are mounted the conductors. In many types, the rotor revolves freely, without hindrance, and its speed depends upon the power in the circuit. A good example of this is the electric fan.

Unlike such motors, the oscillator/motor works differently and has an automatic "on/off" switch built into the circuit. In the first Hamilton Electric Watch, it worked like this: When the oscillating balance wheel, carrying a coil of wire, pushed against a contact spring, current flowed through the coil. This produced a magnetic field in the coil which interacted with the magnetic field of permanent magnets in the mainplate. The resultant forces pushed (impulsed) the balance wheel which turned the gears for the hands. When the balance wheel was free of the contact spring, the current was turned "off." This "on/off" switching action was repeated over and over again.

This system was a definite breakthrough. For the first time, the hands of a commercial watch were advanced by electrical rather than mechanical power.

By present-day standards, however, this arrangement was very primitive. It used electric rather than electronic circuitry and a mechanical make-break contact system. This is a far cry from the sophisticated stepper motors used in present-day analog quartz watches. Between then and now, motors have gone through many technological advances. But it is

important to note that in all instances the watch's oscillator governs an automatic "on/off" switch in the circuit.

A short history of the development of the electric motor follows:

In 1819, **Hans Christian Oersted** discovered that a magnetic needle of a compass was deflected by a current flowing through a wire.

In 1831, **Michael Faraday** discovered the principles of electromagnetic induction. And also:

In 1831, without knowledge of Faraday's experiments, **Joseph Henry**, at the Albany Academy in New York, constructed the first electric motor.

In 1952, **Elgin Watch Company** made an oscillator/motor for a laboratory watch model.

In 1957, **Hamilton Watch Company** produced the first successful oscillator/motor for use in an electric watch.

The next major advance in the technology of watch manufacture was the electronic tuning fork watch.

In 1960, **Bulova Watch Company** produced the Accutron which contained a number of new design elements such as a tuning fork oscillator and a vastly improved electronically activated oscillator/motor. After a few years, other companies also began to produce tuning fork watches.

Now let us compare the components of the mechanical, electric, and electronic watches.

	MECHANICAL WATCH	HAMILTON ELECTRIC	BULOVA ACCUTRON
POWER SOURCE	Mainspring	Battery	Battery
OSCILLATOR	Balance Wheel	Balance Wheel	Tuning Fork
INDEX SYSTEM	Gear Train Escapement Setting Mechanism Dial & Hands	Oscillator/Motor Gear Train Setting Mechanism Dial & Hands	Improved Oscillator/Motor Gear Train Setting Mechanism Dial & Hands

The construction changes, shown above, produced extraordinary improvements in watch performance. Compare the Hamilton and Bulova oscillators! The tuning fork vibrates 360 times per second, whereas the balance wheel vibrates 5 times per second.

The rhythm of an oscillator's vibrations is disturbed by shocks. But the faster the frequency, the greater momentum, the less disturbance occurs. And, as a rule of thumb, therefore, the faster the vibrations, the more accurate the timekeeping. Consequently, the introduction of the tuning fork produced a far more precise watch. In fact, it enabled the factory to mass-produce a watch, without extensive regulation, which could keep time within a minute a month.

Also, compare the oscillator/motors of the two watches. The Hamilton's oscillator/motor was turned "on" and "off" with a mechanical switch, whereas Accutron's more sophisticated oscillator/motor was turned "on" and "off" with a transistorized electronic switch. This eliminated the possibility of burnt contacts and produced a more efficient and trouble-free timepiece.

And then, seven years later, technology took a giant leap forward. The quartz watch appeared and triumphed over all its predecessors.

In 1967, two prototypes were simultaneously submitted to the Neuchatel Observatory for its international competition. One, called "Beta 1," was the creation of the Swiss Center of Electronic Horology (CEH). The other, which would later be called "Astron," was the creation of the Japan-

ese watch-producing organization, Hattori Seiko. Both of these models introduced components completely new to watch construction and design—the quartz crystal oscillator and the integrated circuit with its microchip. And more highly developed motors were used.

In 1969, **Hattori Seiko** produced the first successful commercial quartz wristwatch. As in its prototype, the battery activated a quartz crystal and caused it to oscillate. Its integrated circuit with microchip delivered the impulses to a stepper motor.

Let's examine the new components, the quartz oscillator, the integrated circuit, and the changes in the motor. In reviewing these revolutionary improvements, let us start with the quartz oscillator.

A quartz oscillator, a thin wafer of rock crystal, later shaped into a tuning fork in most modern watches, vibrates at extraordinarily high frequencies when subjected to an electrical stimulus.

The following comparison chart of the vibrations of oscillators tells a dramatic story.

TYPE OF WATCH	OSCILLATOR	NUMBER OF VIBRATIONS PER SECOND
Mechanical	Balance Wheel	5
Accutron	Tuning Fork	360
Quartz	Quartz Crystal	32,768 (standard)

Aside from providing an extraordinarily high frequency, the quartz oscillator has another important characteristic. When activated, it produces electrical charges (piezo-electrical effect) which supplies very stable time signals to the electronic circuit. As a result, for the first time, a mass-produced wristwatch could be accurate to within a minute per year.

The history of the quartz oscillator starts, strangely enough with **Pierre Curie** and his brother **Jacques**.

In 1880, they discovered piezoelectricity. They found that certain crystals, when stressed, create electrical charges. One of the crystals used in the experiments was quartz.

In 1922, **Walter G. Cady** discovered that vibrations of an electrically activated quartz crystal were amazingly stable. As a result, he invented quartz frequency control units which were first used in the radio industry.

In 1928, **W.A. Morrison**, at Bell Laboratories in New Jersey, applied a quartz frequency control unit to a clock.

In 1967, as we have noted, it was introduced into watches.

Now for the other new component—the integrated circuit.

The invention of the integrated circuit, with its microchip, is one of the most revolutionary technological advances of the twentieth century. It is used in every type of electronic appliance—from computers to anti-missile devices.

An electronic circuit, in the past, usually consisted of bulky components such as vacuum tubes, diodes, transistors, capacitors, resistors, etc. which were interconnected with wires and fastened to a baseboard. Depending on the number of elements required, it could be so large as to require housing in a room or even in a building.

But then a miracle of miniaturization occurred. Today, no matter how complex, circuitry in a watch takes up less than a square inch of space. And, in some instances, it can fit on the head of a pin. It is made by photographically applying materials, semiconductor metals, etc. to a tiny piece of silicon.

The integrated circuit is the perfect answer to a watch's need.

How does it function? It electronically reduces the frequency (high number of quartz vibrations) to standard time intervals of seconds and fractions of seconds. It then controls the impulses to a motor (for an analog) or to a time display (for a digital). It is also used to activate add-on features such as alarm, talking, or television.

Its background is interesting.

In 1958 and 1959, **Jack St. Clair Kilby** and independently, **Robert Norton Noyce**, invented the integrated circuit (popularly called the microchip). Jack Kilby, an engineer working at Texas Instrument, Dallas, Texas, came up with the invention while working on a company assignment to solve the problem of the "tyranny of numbers," the problem of how to interconnect the innumerable electronic components in a complex circuit.

Robert Noyce, an engineer who was co-founder of the Fairchild Semiconductor Corporation, worked on the same problem, "the tyranny of numbers," and came up with the same solution, although in a different form, six months later. As a result of complex litigation, however, both Jack Kilby and Robert Noyce are officially considered co-inventors.

In 1959, microchips were used by the Air Force for military and space applications.

In 1964, the first limited commercial application was to hearing aids.

In 1965, they were used in large computers and industrial equipment.

In 1966, they were utilized in television—the first mass-produced consumer product.

In 1967, they were used in the prototype quartz watches.

At this point, the revolution which had begun in 1952 with the Elgin laboratory watch model, and which led to the first electric watch by Hamilton in 1957, was almost complete. The basic construction and design of the mechanical watch was now unalterably changed with a different power source, oscillator, and indexing system. Only the setting mechanism with its hands and dial remained in the new breed of quartz analog watches. The quartz digital—to be discussed later—was different, in every respect, from its predecessor.

Referring to the basic operational principles, let us compare the components of the quartz watch with previous types of watches in the chart shown at left.

	MECHANICAL (1660)	HAMILTON ELECTRIC (1957)	BULOVA ELEC- TRONIC ACCUTRON (1960)	HATTORI SEIKO QUARTZ (1969)
POWER SOURCE	Mainspring	Battery	Battery	Battery
OSCILLATOR	Balance Wheel	Balance Wheel	Tuning Fork	Quartz Crystal
INDEX SYSTEM	Gear Train	Oscillator/Motor*	Improved Oscillator/ Motor**	Integrated Circuit with Microchip
	Escapement Set. Mechanism Dial & Hands	Gear Train Set. Mechanism Dial & Hands	Gear Train Set. Mechanism Dial & Hands	Step Motor (3)*** Set. Mechanism Dial & Hands

* Oscillator/Motor — with an electrical make-break contact switch

** Improved Oscillator/Motor — with a transistorized electronic switch

*** Step Motor — first attempt; was later improved

(Continued on page 49)

Novice Watchmaker

James Adams, CMW, CMBHI



ON AMERICAN TIME ELGIN NATIONAL WATCH CO. 1864-1964

John Adams of Chicago and Nelson P. Stratton of Waltham, Massachusetts met to consider a watch factory in the midwest to service the western states. P.S. Bartlett and Ira Blake also met to discuss the watch factory idea. In 1864 the idea became reality, and at Elgin, Illinois the National Watch Company became incorporated. After its reorganization in 1865, the National Watch Company's first president was the former mayor of Chicago, Benjamin W. Raymond.

The first movement introduced was an 18 size full plate model dubbed "B.W. Raymond." This was introduced in 1867. As mentioned, this was an 18 size keywind, single roller, 15 jewel model that was called the "B.W. Raymond" and was retailed out at \$117.00 without a case. It was a common practice to sell movements and cases separately. The retailing jeweler, at the customer's request, would combine case and movement. Somewhere I have one of the containers these movements came in.

As time passed, the B.W. Raymond gained favor as a railroad grade pocket watch that retailed at \$50.00 cased. The story of the railroad watch is of some interest and will be discussed at a later time. By 1874 the company's name was changed to the Elgin National Watch Company. It was, by far, the largest watch producer of quality movements, totaling well over 50 million timepieces.

Some of the popular models of the Elgin National Watch Company were:

H.L. Culver	18 & 16 sizes
Father Time	18 size
Veritas	18 size
G.M. Wheeler	18 size
Lord Elgin	16 size
B.W. Raymond	18 & 16 sizes

Elgin also used numbers to designate various movements. For instance:

#1	18 size keywind full plate
#2-4	18 size lever set full plate
#5	18 size pendant set full plate
#6	18 size $\frac{3}{4}$ pendant set and so on.
	16 size movements were $\frac{3}{4}$ plates and
	pocket watches were made also in 12 size,
	10 size, 6 size and 0 size.

American watches used their own unique system of movement measurement. This was the Lancashire Gauge. It was introduced by the Waltham Watch Co. and adopted by the other watch producing firms.

The American Movement size or Lancashire Gauge was based on 1 inch plus $\frac{5}{30}$ inch for drop. The bridge plate size was made smaller than the pillar plate to allow the movement to drop into case position. So, 1- $\frac{5}{30}$ inch became 0 size, this being the base movement size. Each size increment then was measured from 0 size.

POCKET MOVEMENTS

0 size	1- $\frac{5}{30}$ inch
12 size	1- $\frac{17}{30}$ inch
16 size	1- $\frac{21}{30}$ inch
18 size	1- $\frac{23}{30}$ inch

SMALLER WRIST MOVEMENTS

5/0 size	1- $\frac{1}{30}$ inch
8/0 size	28/30 inch
14/0 size	22/30 inch
18/0 size	18/30 inch

The American Movement size or Lancashire Gauge is truly strange, but that's the way it is.

BALL WATCH COMPANY

The intriguing story of the Ball Watch Company is the story of the American railroad grade pocket watch. From early in the 1800s through the early 1900s, the United States was in a frenzy of railroad building from coast to coast, Canada to Mexico. As the industrial revolution erupted, the rail network (of necessity) started to crisscross our country. In most of the track mileage, trains going in either direction used the same track! This, coupled with the early practice of "local" time zones, created havoc. As the rail system became more and more sophisticated, a system of railroad time was introduced. This railroad time system unified most of our country from a chaotic rural society to a more industrial urban society.

A control of train passage along crowded trackage was required. This control was in the form of "track time allotment," meaning the train HAD to be in a given location at a give time. PERIOD. Train crews carried timepieces to meet these time requirements. Unfortunately, all kinds of time telling devices were used—quality pocket watches, cheap dollar watches, and alarm clocks of all parentage. This system of haphazard time control was an accident waiting to happen. AND IT DID! In 1891, on the Lake Shore and Michigan Southern Railroad, a fast mail train collided with a slower moving train. This occurred near Kipton, Ohio. This terrible accident moved railroad officials to seek out Webb C. Ball of Cleveland, Ohio to investigate and organize a time standard for railroad timepieces and also put in place a system for inspection and servicing these timepieces. Mr. Ball did, indeed, set standards of timekeeping along with the necessary inspection and servicing standards. Mr. Ball, because of his success along these lines, became the General Time Inspector for a number of railroads headquartered in Chicago, Cleveland, San Francisco, and also in Canada. The Ball firm, as such, was paid by the railroads to set up and supervise local watchmaker inspectors along the respective railroad lines. The inspectors were not Ball employees, but independent watchmakers who received their income from sales and service of timepieces required of railroad employees.

The general standards Mr. Ball decreed were:

American-made 18 size or 16 size

Lever set

Time rate adjusted within 30 seconds per week

Adjusted to temperature and isochronism to

five positions

At least 17 working jewels

Lever escapement with double roller

Overcoil hairspring and micrometer regulator

Open face and stem at 12 o'clock position

A tight dust-free case

Plain Arabic dial

Temperature adjusted from 30 to 95 degrees F

The railroad pocket watch was also to be cleaned and adjusted once a year and inspected every two weeks, with this information duly noted on an official card carried by the railroad employee.

The purpose of all this was to insure all railway personnel were operating on the same time standard of exact-

ness, be he working in Maine, Minnesota, Georgia, Oregon, and all points in between.

The major watch companies produced railroad grade pocket watches in their name and also on contract to Ball under the name Ball Watch Company. The same rigid standards applied to ALL pocket watches accepted by Mr. Ball to be certified as official Railroad Timepieces.

The following major firms produced railroad grade pocket watches. The notation after the company indicates those firms producing railroad grade pocket watches for the Ball Watch Company.

Waltham	also contracted to Ball Company
Elgin	" " " " "
Hampden	" " " " "
Illinois	" " " " "
Howard	" " " " "
Hamilton	" " " " "
South Bend	
Columbus	

It has been estimated about 50,000 pocket watches were produced under the Ball Watch Company brand alone.

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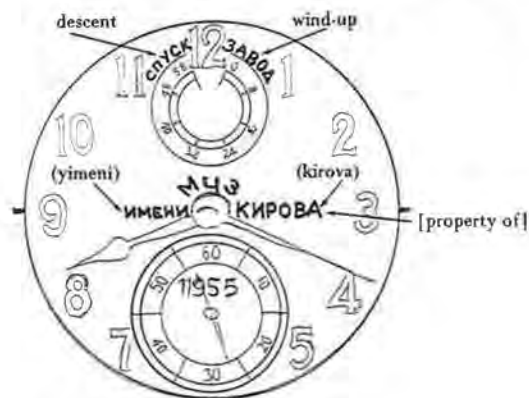
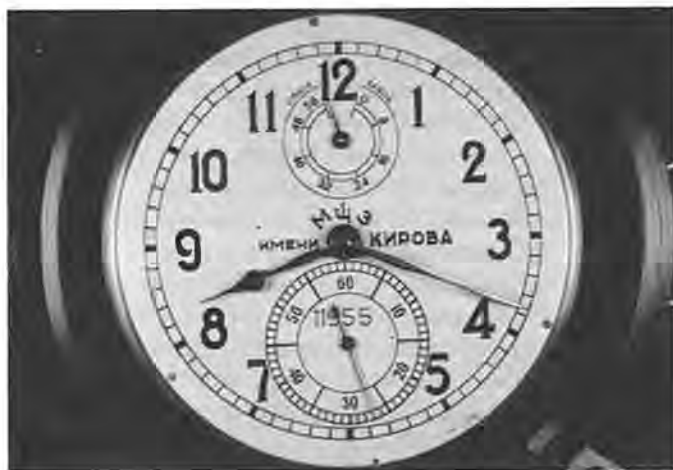
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More on Russian Watch- and Clockmakers

By

Henry B. Fried
CMW, CMC, FAWI, FBHI, ★FNAWCC



In last month's article on the horological tour of Russia, we reported our various conversations with watch factory officials and the many repairmen we met throughout our 22-day tour. We were told that there were no professional horological associations or guilds in that country. While that must be so, the history of pre-revolutionary Russia reveals quite an active watch and clock community through that vast country.

Benjamin Mellenhoff, a president of the Horological Society of New York and head of Tiffany's watch department, would like to recount his achievements and special diploma as a prize student and graduate of the St. Petersburg Academy of Arts and Sciences. While at Tiffany's, he made a watch with the bridges showing the logo and theme of the 1938 New York World's Fair.

However, much information of Russian watchmakers is contained in the 64-page book *Watch and Clockmakers in Russia, 1400-1850* by Valentin I. Chenakal of Leningrad's Academy of Sciences of the USSR, translated by W.F. Ryan in 1972. This was reviewed by me in 1973. In this book, the author has compiled a list of about 600 makers; some were emigrants from western Europe who settled there. Many Russian watch- and clockmakers came from the Baltic countries, others later were their descendants who changed their names or adapted them to the Russian alphabetical soundings and spellings. Furthermore, in the history of the Russian Empire, many Baltic countries became part of expansionistic Russia. These included at one time or another Poland, Armenia, the Ukraine, Siberia, Odessa, Crimea, and the Caucasus. Baillie's monumental list of *Watch and Clockmakers of the World* fails to list any of these Eastern makers.

In Chenakal's book, the earliest is dated as 1404 for a turret clock constructed by a monk with the improbable name of Lazar in Moscow.

By the 16th century, Moscow had a district termed "clock court," where many watch- and clockmakers operated for an active trade. They catered to both the military as well as the private sector. Attempts to set up "factories" mainly in the mid-18th century did not result in any long-lasting enterprises of (then) St. Petersburg.

By 1850 the main source of timepieces of all types available were the products of the small clock and watch shops and their apprentices as well as the strong inroads of the imported Swiss, English, and French machine-made timepieces.

Repairers as such are not included because no references appear from which to gather this information. However, these repairers must have been members of the various guilds throughout the empire.

Cities such as Moscow, St. Petersburg, Vilna, Cracow, Tiflis, and the other regions noted earlier have listings in the Chenakal book. These artisans also worked for the military, public works offices, and scientific laboratories. Records of these makers also exist in tax reports. For example: "Nikifor Nikitin took care of the clock in the Kremlin (1613-1615) and Kirill Samoilov made the clock for the Frolansk Tower in the Kremlin (1626)."

Other entries show that Moise Terent of Moscow made a watch set into a ring for the Tsar and even before Harrison submitted his No. 4, "a proposal for a marine chronometer driven by four springs was submitted by Lamonosov, an eminent scientist in 1754."

Also, "an extremely complex egg-shaped watch



Photos courtesy of T. Wm. Schroeder, Chicago, IL.

(1764) was presented to Catherine II by Ivan Kulibin." At that time some clock- and watchmakers are recorded as having produced odometers for carriages which recorded distances traveled.

One of the first "factories" (probably a building with many journeymen and apprentices making handmade parts) was founded by Brazillier at St. Petersburg between 1744-1777.

Christopher Winberg, b. 1755 in Sweden, d. 1818 in St. Petersburg, directed the clockmaking class at the St. Petersburg Academy of Arts and Sciences. Some Russian clockmakers and watchmakers (Chisov, 1767) traveled to London to hone their skills before returning to their native country. One, I.N. Druzhinin, made marine chronometers, and in 1840 set up a successful watch factory in Kharkov.

One of a family of famous horologists in Russia was Benjamin Hynman of St. Petersburg who also was sent to London in 1765 to study clockmaking. Upon his return he became clockmaker to the Imperial Court at St. Petersburg. His father was of English origin and was equally famous and honored.

To overcome a noticeable shortage, the St. Petersburg Academy of Arts and Sciences started a special class in 1757 which turned out craftsmen until 1799. This was headed by famed horologists Nordstein, Winberg, and Glodky. From those graduating their apprentices and workers, all types of timepieces were produced. By the advent of the 19th century, the influx of foreign artisans as well as their own craftsmen and apprentices produced a considerable number of watch- and clockmakers.

Such trade guilds existed by the start of the 18th century and these flourished in a number of cities. The guilds provided protection as well as skill improvement.

The guilds in most cities were classified and restrictive. Konstantin Iosifovich Berkle is listed as an assessor of the Vilna Christian Clockmakers Guild 1848-57, and at the same time Aron Ioselevich Danislovsky (1828-54) is noted as being an assessor of the Vilna Jewish Clockmakers Guild. In 1850 he also is noted as being "a master of the highest class."

Prize-winning watch- and clockmakers are listed with their achievements in the late 18th and 19th centuries.

In the 19th century there were still makers of sundials but also makers of railroad timepieces. One, Ego Ovtzyn in 1811, invented a clock rotating on an inclined glass plane which was acclaimed as the only one of its kind, for which he was awarded an annual pension of 1000 rubles. Another, Andrei Filipponovich, though trained in Russia, achieved fame as an assistant to the famous Schwilgue who restored the famous, still-existing clock in the Strasbourg Cathedral. He also worked for Louis Antoine Breguet before returning to Russia.

As early as 1829 exhibitions of the watch- and clockmakers' art were held in Moscow as well as in St. Petersburg. These included table clocks, longcase clocks, as well as watches and even complicated sundials.

Chenakal ends his listing in 1850 as stating that after that time there were no "makers." Books on clockmaking by well-known Russian craftsmen were published. These mirror the usual books on horological history—yet, strangely, none that this writer has seen picture any Russian-made watches. Those illustrated are typical French, English, and Swiss. Depending on the law of averages, it would appear that a considerable number of watches and clocks of Russian origin should have survived, including the period of the terrible revolution and later the ravages of Nazi German devastation, not considering tower and public clocks.

In the watch factory museums, the only typical Russian watches shown were those unusual wooden-cased and wooden movement watches. Furthermore, in the visit to the Hermitage museum and in the purchasing of postcard collections showing some of their timepieces, no native watches or clocks were included.

Over the years, we have at times observed some fine watches that had Russian engravings and markings but looked like Swiss or French watches. These could conceivably be Russian, but were produced along the continental technology of each period. It is well-known that Swiss, French, and English "ebauches" were available early in the 18th century through to the 20th. Thus, these might have been finished by Russian craftsmen and the many French, English, Swedish, and Norwegian watchmakers who settled there.

That very many Russian texts on horology exist is evident, having acquired a few during my visit there. One of these is a fine, 280-illustration book of 496 pages, entitled *History of Timepieces* by C. Drevneyshich Vremen (my transliteration), published by the Academy of Natural and Technical Sciences, Natchka, Moscow, 1982. There are 14 pages devoted to an extensive horological bibliography from all (language) sources. Six of these pages are of Russian references and texts. These who are well versed in the technology of the pendulum will be familiar with the work of Fedechenko, who many consider to be the world's leading pendulum authority.

It is hoped that this short report may bring to light further facts of interest on this segment of horological history.

Henry B. Fried

TWO-TRAIN WESTMINSTER CHIME MOVEMENT

PART II

By Leo A. Jaroslaw ©1989
Drawings and photos by the author.
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Hamburg Amerikanische Uhrenfabrik - (HAU)
Two Train Westminster Chime Movement Clock

In Part I we discussed two-train chime movements, including "cheaters." The movement we are describing is one of the "better cheaters," where the Westminster chime is played correctly through the first three quarters, then striking the hour.

OPERATION (Continued)

SHIFTING FROM CHIME TO STRIKE (See Figures 1 and 3)

As the clock approaches the hour, the lifting pin on the minute wheel contacts the cam on the lower end of the strike/chime shift lever. It should reach maximum shift just as the strike unlocking lever is released. The motion is trans-

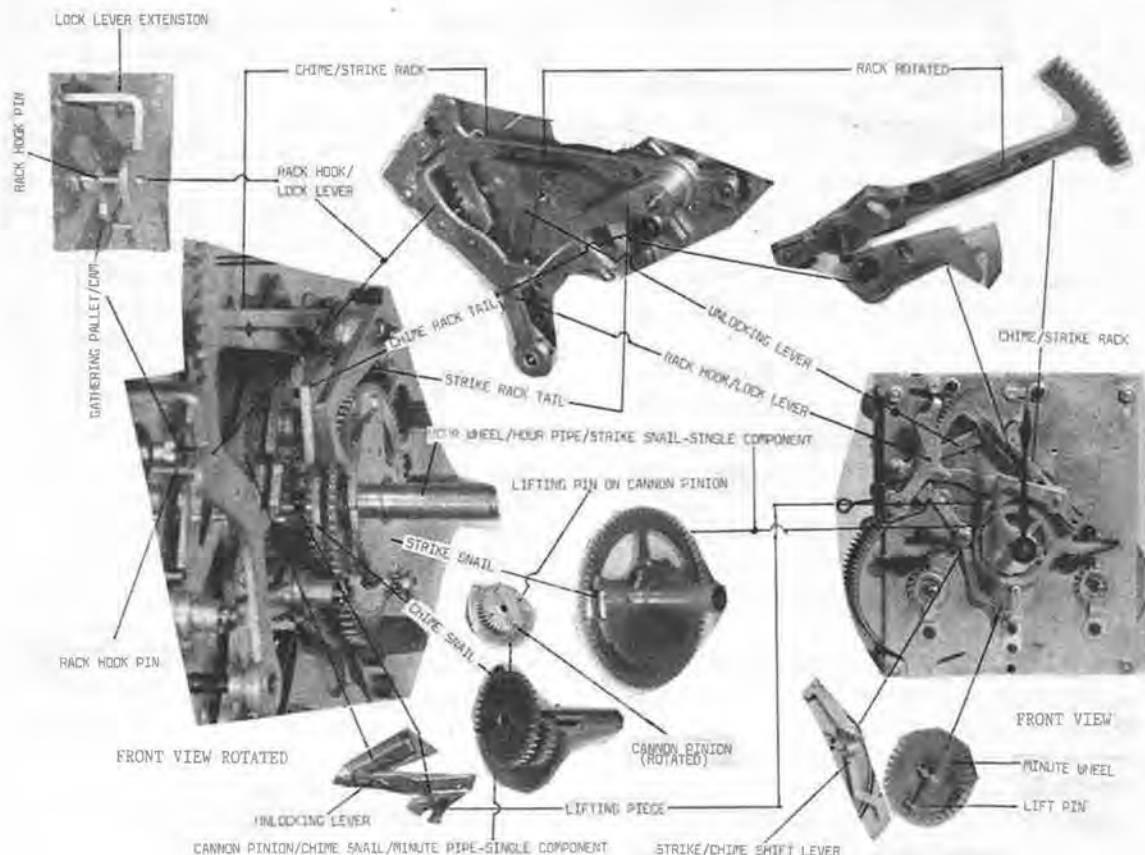


FIG.1 - HAU 2 TRAIN CHIME - COMPONENTS IN FRONT OF PLATE

formed into a lift of the shift pin #1, which in turn lifts shift pin #2, causing the shifter arbor to rotate. The rotating arbor raises shift pin #3, rotating the transfer lever. That motion is transferred into a shift motion of the operating components from the chime to the strike mode.

The shift is accomplished by a pin in the transfer lever riding in a groove of the hammer arbor transfer hub. The hammer arbor moves the hammer tail assembly from its chime position between the starwheel and the strike third wheel onto alignment with the starwheel. Simultaneously, a pin extending from the hammer arbor transfer hub contacts the pin barrel shifter plate. This action shifts the open-ended lantern pinion out of engagement with the second wheel, at the same time shifting the pin barrel out of alignment with the chime hammer levers, and inserting the locking pin in a hole to prevent rotation of the pin barrel. The system is now set up

to strike on the hour. Details of the strike system's unusual components will be discussed in Part III.

SHIFT FROM STRIKE TO CHIME

On completion of the strike, the minute wheel continues to rotate. The lifting pin comes off the cam on the strike/chime shift lever. The spring which is under tension with the chime pin barrel arbor shifts the system back to the chime mode. The operational sequence of all of the components is the reverse of that occurring from chime to strike.

This concludes the operational discussion of this unusual movement.

CONTINUED IN PART III.

TIMES

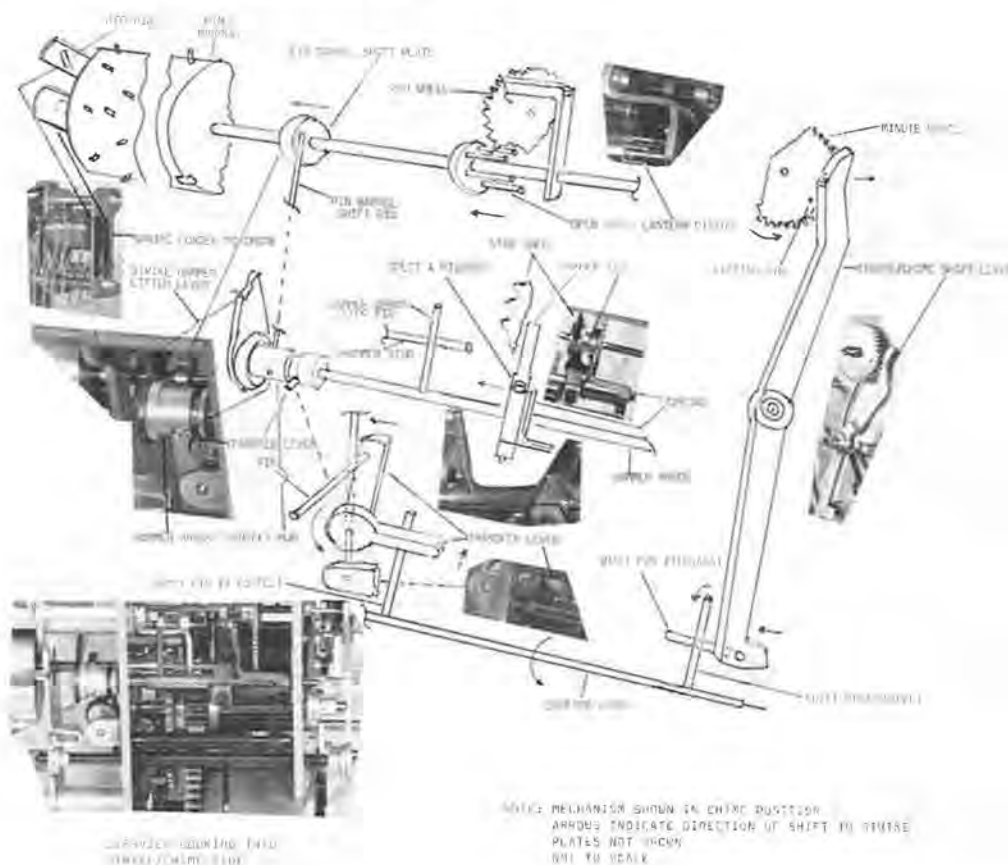


FIG. 3- HAMILTON 2 TRAIN CHIME - SCHEMATIC - STRIKE/CHIME SHIFTER MECHANISM

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SCHOLASTICALLY SPEAKING

Jim Lubic



Schools of Horology

Here is a list of all the known horological schools in the United States and Canada, plus one in Switzerland. Tell a high school counselor about the one nearest you. If you know of one not on the list, please write or call AWI. If you are an instructor at one of these schools you should be thinking about REC's annual meetings next June and taking advantage of AWI's new policy on reimbursing you \$200 for travel to the annual meeting.

ALABAMA

Mobile

Southwest State College (public)
925 Dauphin Island Parkway
Mobile, AL 36605
(205) 471-4828

COLORADO

Denver

Emily Griffith Opportunity School (public)
1250 Welton Street
Denver, CO 80219
(303) 572-8218

ILLINOIS

Champaign

Parkland College (public)
2400 W. Bradley Avenue
Champaign, IL 61820
(217) 351-2288

Quincy

Gem City College School of Horology (private)
7th and State Streets
P.O. Box 179
Quincy, IL 62306
(217) 222-0391

MICHIGAN

Plainwell

State Technical Institute & Rehab Center
Rt. 3 - Pine Lake
Alber Drive
Plainwell, MI 49080
(616) 664-4461

Sterling Heights

Career Prep Center
12200 Fifteen Mile Road
Sterling Heights, MI 48077
(313) 979-6510

CALIFORNIA

San Francisco

John O'Connell Community College
118 Bartlett Street
San Francisco, CA 94110
(415) 282-3100

DISTRICT OF COLUMBIA

Washington

Chamberlain Vocational High School
1345 Potomac Avenue S.E.
Washington, DC 20003
(301) 589-2343

MONTANA

Great Falls

Great Falls Voc-Tech Center
2100 16th Avenue South
Great Falls, MT 59405
(406) 791-2100

MISSISSIPPI

Ellisville

Jones County Junior College
Ellisville, MI 39437
(601) 477-9311

NEW YORK

Brooklyn

Geo. Westinghouse Vocational and Technical
High School
105 Johnson Street
Brooklyn, NY 11201
(212) 625-6130

Woodside

Joseph Bulova School of Watchmaking
40-24 62nd Street
Woodside, NY 11377
(212) 424-2929

OHIO

Cincinnati

Ohio Valley Watchmaking Institute
10600 Springfield Pike
Cincinnati, OH 45215
(513) 771-4800

PENNSYLVANIA

Lancaster

Bowman Technical School
220 West King Street
Lancaster, PA 17603
(717) 397-7484

HISTORY OF THE QUARTZ WATCH

(Continued from page 41)

Paradoxically, the extraordinary technologically advanced Seiko watch is, judged by today's quartz standards, embryonic, primitive, and crude. This was also true of many other quartz watches produced by a number of other companies in 1970 and 1971. The principal weakness of all these models was due to their inferior motors.

Seiko's first quartz watch, the Astron, which used a stepper motor, was inefficient and was quickly withdrawn. The same fate awaited a model produced, some time later, by Ricoh.

In Seiko's next attempt, models 03SQ and 39SQ, it used an awkward pallet/escape wheel type of motor. It, too, was short-lived.

In other versions, by various companies, the energized quartz crystal acted as a master oscillator which activated an inferior slave oscillator. Examples of these are:

In the Swiss Beta, the slave oscillator was a reed.

In the Bulova version, the slave oscillator was a tuning fork.

In the Timex version, the slave oscillator was a balance wheel.

In the Longines version, the slave oscillator was a bar-motor.

A review of these first quartz watches follows:

THE QUARTZ WATCH BETWEEN 1969 and 1972			
MANUFACTURER	MODEL	COUNTRY	TYPE OF MOTOR
Hattori Seiko (1969)	Astron model 35	Japan	Ill-designed stepper motor
Eta (1970)	Beta 21*	Switzerland	Slave oscillator — vibrating reed
Ricoh		Japan	Ill-designed stepper motor
Longines	Ultra-Quartz	Switzerland	Slave oscillator — vibrating bar-motor
Timex		USA	Slave oscillator — balance wheel
Bulova	Accuquartz	USA	Slave oscillator — tuning fork
Hattori Seiko	03SQ and 39SQ	Japan	Type of pallet/escape wheel motor**

* Marketed by Omega and Bulova.

** Because of the first unsuccessful stepper motor, Hattori Seiko produced this version.

TIMES

Johnstown

Hiram C. Andrews Center
727 Goucher Street
Johnstown, PA 15915

TEXAS

El Paso

Conley's Watch & Jewelry Repair
9128 Oyer Street
El Paso, TX 79924
(915) 751-8380

Houston

Houston Technical College
1301 Waugh Drive
Houston, TX 77019
(713) 529-8143

Kilgore

Kilgore College
1100 Broadway Blvd.
Kilgore, TX 75662
(214) 984-8531

Paris

Paris Junior College
2400 Clarksville Street
Paris, TX 75460
(214) 785-7661, ext. 116

OKLAHOMA

Okmulgee
Oklahoma State University of
Technical Training
Okmulgee, OK 74447

WASHINGTON

Seattle
North Seattle Community College
9600 College Way North
Seattle, WA 98103
(206) 634-4410

CANADA

Trois-Rivieres, Quebec
Polyvalente ste-Ursule
1725 Boul. du Carmel
Trois-Rivieres, Quebec
Canada G8Z 3R8
(819) 379-3644

SWITZERLAND

Neuchatel

WOSTEP — Watchmakers of Switzerland
Technical & Educational Program
Case Postale 118
2006 Neuchatel, Switzerland

TIMES

Affiliate Chapter Column

Paul D. Wadsworth



Important AWI Awards

One of the things that takes place at the Annual Affiliate Chapters Meeting that never seems to be highlighted is the Annual Affiliate Chapters Award. Each year this award is given to the chapter that best exemplifies service to its members and the community, and which serves to further the art of horology. Some of the things taken into consideration are the membership status, annual convention, the number of meetings held per year, the dues schedule, and the number of workshops and bench courses held. You should consider these items in your annual report, since the only way the committee can choose the winner is from the reports. Having been on this committee, I can strongly recommend that the annual report should be an important part of each chapter's activities. This is one more reason to choose the next delegate as early in the year as possible. That way he or she will have more time to become familiar with the workings of the affiliate chapters and prepare for the annual meeting. It is very hard to choose a chapter that has only a partially completed report form.

While I am on the topic of awards, we should remember the Battery Reclamation Committee. They have been at work with the label program, and the report is that AWI received a lot of watch cells this year. Each year the ELM Trust has given recognition to the affiliate chapter for the most cells collected during the year. This total is from the cells that are sent in during the year and those that are brought in at the annual meeting. For several years there has been a weigh-in and lots of fun trying to find out which chapter had the most pounds of watch cells. Watch cell recycling is the main source of income for the Trust. All of the chapters that participate receive at least an honorable mention ribbon to display with their affiliate chapter banner. Which reminds me, to those of you that haven't been to the annual meeting yet, all the chapters bring their banners and hang them around the room. This makes for quite a display and gives others some ideas to take back to their local meetings. Perhaps you could ask your representative to take some pictures for a report to the chapter on his return. This should be a good topic for a

meeting when the new representative is chosen. Perhaps it could be a working meeting to fill out the chapter's annual report and discuss the things that you want your representative to bring before the annual meeting.

As I was thinking out loud about this article, I said: "What shall I write about this month?" . . . and I heard the word 'coupons.' At first this thought went away, but it returned again as I was typing, and here it is. How many of you use coupons in your grocery shopping? I'll bet most of you do. Next, how many of you use coupons when you buy other things—such as rebates on oil for your car or household items? Some of us do. Why not use coupons for watch repair? It seems that the average housewife saves coupons for almost everything else. Why not watch repair coupons? We could have a coupon for a free estimate on repairs. Or another one for free installation of a new cell with any purchase from the diamond department. With the Holiday Season coming on, I'm sure that the ideas for coupons are almost unlimited. How about one for a free watch band with every third watch purchase?

My mail this month came in the form of a verbal note from Henry Frystak of New Jersey. Henry would like to see all the local affiliate chapter representatives' names and addresses published in the HT. On discussing this with Milt Stevens, it was decided that I will write and ask permission first in case they don't want their address published—the thought being that there are many members of AWI that don't know whom to contact in their own local area. This might result in an increase in the membership. As we all know, that wouldn't hurt any of our chapters.

This month's travels took me to Lancaster, PA for a meeting of the committee to put together the Northeast Technical Conclave. We had a good meeting with representatives from New York, Pennsylvania, New Jersey, Virginia, Maryland, and AWI. Keep the first weekend in May 1990 open. More about the final plans after the committee gets them all confirmed.



ASSOCIATION NEWS

ARIZONA

The Arizona Clockmakers & Watchmakers Guild held their annual kick-off dinner meeting on September 19, 1989 at Denny's Dunlap Avenue Restaurant in Phoenix. The program, the third in spousal presentations given annually, was a demonstration of watercolor painting by Hildegard Erkert. Mrs. Erkert showed various techniques she has used, including painting with a credit card. She urged the audience to dare to try new techniques and use one's imagination. All felt that this approach could be applied to our profession.

On a more somber note, one guild member reported a new scam. This is the way it works. A thief will obtain a list of merchants with good credit ratings. When the merchant is closed for vacation, for example, merchandise will be ordered in the merchant's name for delivery to his store. The delivery person leaves a note saying "unable to deliver." The thief then picks up the note and goes to the delivery service office and picks up the merchandise. Fortunately, the local police apprehended the thief and our member did not suffer loss.

At the meeting, officers for 1989-90 were sworn in as follows: Robert Macomber, president; Walter Steffen, vice president; Bernard Guhin, treasurer; Sal DiStefano, secretary; and Robert Miller, Joseph Baier and Thomas Bulfer, directors.

NEW JERSEY

The Watchmakers Association of New Jersey featured speaker, Henry Fried, who spoke about the Patek Philippe Watch "89". Mr. Fried, who has been linked to the WANJ for the past 50 years, showed slides and explained the many functions of Patek Philippe's complicated mechanical timepiece. Here is some technical data he gave: case weight is 600 grams (18kt gold), movement diameter is 71 mm, 1 main-spring, 184 wheels, 126 jewels, 24 hands, built on 4 levels to show time, calendar, chronograph and chimes. Over 50 members were in attendance at the meeting, and learned much more about the "89" as well as the history of Patek Philippe.

NEW YORK

On Tuesday, September 6, 1989, at the Novotel in New York City, Harry Blair, engineer and member of the New Jersey Watchmakers Association, AWI and NAWCC, addressed the Horological Society of New York. He had recently returned from the tour of the watch factories in the Soviet Union which was led by Mr. Henry B. Fried. Mr. Blair, equipped with slides, live Soviet watches, and Soviet horological literature, gave a vivid report of his experiences in the land of Glasnost and Perestroika.

Mr. Blair's delivery was friendly, warm and personal. Yet, with great skill, he interspersed into his talk a great number of statistics, technical details, and a wide range of interesting facts. The audience was fascinated by his presentation.

UPCOMING EVENTS

*Missouri Jewelers & Watchmakers Association
Annual Convention
April 27-29, 1990
Holiday Inn - Lake Ozark, MO*

*Kansas Jewelers Association Annual Convention
June 1-3, 1990
Holiday Inn - Olathe, KS*

A few of Mr. Blair's observations were as follows:

1. The Soviets produce 60 million watches per year.
2. Two million of these are quartz. The rest are mechanical.
3. Soviets export to 30 countries.
4. There are about 6,000 repair shops (some employ as many as 20 people).
5. Tools and equipment are very primitive (few lathes, cleaning, or timing machines).

An active question and answer period concluded an enjoyable, informative evening.

TEXAS

The Watchmaker's Association of the Houston Area held their annual barbeque on October 1. The new Time-O-Print 4500 by Vibrograf was on display. This is a new timing machine that times mechanical watches. The rate is displayed on the screen by digital and also by graph. It figures out the beat of the watch for you if it is not known.

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News in the Trade

CLOCKS OF THE SUSQUEHANNA VALLEY, 1750-1910 EXHIBIT

An exhibit of Susquehanna River Valley clockmakers, sponsored by the Packwood House Museum in Lewisburg, PA, will travel to Columbia, PA for its grand opening at the Watch & Clock Museum of the NAWCC. The exhibit will be featured in Columbia from October 3, 1989 through January 6, 1990. The geographical area covered by this exhibit includes the counties which border the Susquehanna River from Lycoming County to the Maryland-Pennsylvania state border.

This exhibit displays examples of clocks and watches made by craftsmen of the Susquehanna Valley. Tall clocks, shelf clocks, pocket watches, and early twentieth century electric clocks can be examined. In addition to the timepieces, photographs and drawings of clocks in period settings and images of clocks appearing on fraktur are featured.

The "Clocks of the Susquehanna Valley, 1750-1910" exhibit is funded in part by a grant from the Museum Assistance Grant Program of the Pennsylvania Historical and Museum Commission. A catalogue to accompany the exhibit can be purchased at the museum during the time of the event.

The Watch & Clock Museum of the NAWCC is open Tuesday through Saturday, 9 AM to 4 PM; closed holidays. An admission fee is charged. Guided group tours at a discount rate are available by appointment.

For more information, contact: **NAWCC, 514 Poplar St., Columbia, PA 17512-2130; (717) 684-8261.**

**EXHIBITION OF CARTIER
MYSTERY CLOCKS AT
SAN DIEGO MUSEUM OF ART**
Five of the famous Cartier Mystery Clocks will be shown during the exhibition "Reflections of Elegance: Cartier Jewels From the

Lindemann Collection" at the San Diego Museum of Art November 18-December 31, 1989.

The exhibition features the Model A Mystery Clock; Ecran Mystery Clock; Inkwell; the Jade Duck Mystery Clock; and the Portico Mystery Clock. The clocks are considered to be supreme achievements of Cartier. The exhibition surveys the entire range of Cartier's work, world renowned for its innovative designs and exquisite workmanship. Also included in the exhibition will be jewelry, desk objects, cigarette and cigar boxes, frames, fantasy objects, and purses.

The San Diego Museum of Art is open Tuesday through Sunday from 10 AM to 4:30 PM. An admission price is charged.

For more information, contact: **San Diego Museum of Art, Balboa Park, P.O. Box 2107, San Diego, CA 92112-9956; (619) 232-7931, ext. 170 or 172.**

SEIKO OFFICIAL TIMER OF 1989 U.S. OPEN

Celebrating its fourth consecutive year as official timer and major sponsor of the U.S. Open Tennis, Seiko welcomed both retailers and press to the tournament when it hosted a "Night of Tennis" for more than 200 authorized retailers and "Seiko Non-Invitational Doubles Tournament" for Open-accredited press during the prestigious tennis event.

Seiko invited dealers and spouses to a buffet dinner held in the corporation's VIP tent at the National Tennis Center, and to watch Ivan Lendl and Tim Mayotte quarter final feature match on the stadium court. The tennis night was hosted by Shigeho Kurashina, Seiko Time President, and other key company executives.

On the morning of the final day of the tournament, the company sponsored its popular "Seiko Non-Invitational Doubles Press Tournament," giving mem-

bers of the international press covering the Open the opportunity to compete for Seiko quartz mantel clocks. Bud Collins, noted tennis columnist and broadcaster, was tournament director. A record 50 U.S. Open-accredited journalists, representing print, TV, radio, and photographic media from around the world, participated in Seiko's

press tournament.

The U.S. Open is one of many top international sports events for which Seiko is official timer. Through the years these have included the summer and winter Olympics, National Horse Show, World Cup Football, America's Cup, and the New York City Marathon.



Winning team in category 'A' of the Seiko Non-Invitational Doubles Press Tournament" at the U.S. Open (left to right): winner Mitch Rustad, Sun Tennis, Phoenix, AZ; tennis columnist/broadcaster Bud Collins, press tournament director; co-winner Lou Brodersen, The Hour, Norwalk, CT; David Strousse, Assistant to the President, Hattori Corp. of America; and Hal Wilensky, Executive Vice President, Seiko Time.



Winners in category 'B' of the tournament: David Strousse, Assistant to the President, Hattori Corp. of America; winner Mike Zeigfinger, Inside Tennis Newspaper, Belair, TX; Bud Collins; co-winner Philip Boroff, Crains, NY; and Hal Wilensky, Seiko Time.

Classified Ads

REGULATIONS AND RATES

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Classified Ads

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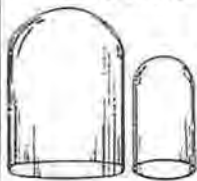
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Dates to Remember

Ad Index

NOVEMBER 1989

- 6-10—Introduction to Clock Repair Bench Course (AWI); Waco, TX.*
- 11-12—Repair of the Atmos Clock Bench Course (AWI); St. Louis, MO.*
- 11-13—Introduction to the Watchmakers Lathe Bench Course (AWI); Sacramento, CA.*
- 12—Useful Techniques: Mechanical Watch Repair Bench Course (AWI); Tampa, FL.*

DECEMBER 1989

- 2-3—Repair of the Atmos Clock Bench Course (AWI); Milwaukee, WI.*

JANUARY 1990

- 9-11—Jewelry Showcase 90, the Israeli Jewelry Week; Jerusalem. For more information: Israel Export Institute, 29 Hamered St., P.O. Box 50084, Tel-Aviv 61500, Israel.
- 14—AWI Southeast Regional Seminar; Orlando, FL.*
- 20-21—Repair of the Atmos Clock Bench Course (AWI); Dallas, TX.*
- 20-21—Advanced Quartz Watch Repair Bench Course (AWI); Tampa, FL.*

FEBRUARY 1990

- 5-9—Introduction to Clock Repair Bench Course (AWI); San Jose, CA.*
- 9-13—Inhorgenta 90, Munich Trade Fair Center, Munich, Germany. For information contact: Gerald G. Kallman, President, Kallman Associates, Five Maple Court, Ridgewood, NJ 07450-4431; phone (201) 652-7070.
- 11—Retrofitting & Casing Bench Course (AWI); Phoenix, AZ.*

- 12-16—Introduction to Clock Repair Bench Course (AWI); Riverside, CA.*

- 17-18—Repair of the Atmos Clock Bench Course (AWI); Pensacola, FL.*

- 24-25—Repair of the Atmos Clock Bench Course (AWI); Orlando, FL.*

MARCH 1990

- 11—Retrofitting & Casing Bench Course (AWI); St. Louis, MO.*
- 24-25—Repair of the Atmos Clock Bench Course (AWI); Greensboro, NC.*
- 31-1—Repair of the Atmos Clock Bench Course (AWI); Alexandria, VA.*

APRIL 1990

- 8—Retrofitting & Casing Bench Course (AWI); Philadelphia, PA.*
- 21-22—Wonderful World of Gems; Veterans Memorial, 300 W. Broad St., Columbus, OH. Information: Robert Kell, 3848 Norbrook Dr., Columbus, OH 43220; (614) 457-1838.
- 27-29—Missouri Jewelers & Watchmakers Association Annual Convention; Holiday Inn, Lake Ozark, MO. For more information contact Sharon Blair, (913) 661-0084.

JUNE 1990

- 1-3—Kansas Jewelers Association Annual Convention; Holiday Inn, Olathe, KS. For more information contact Sharon Blair, (913) 661-0084.

*For more information on AWI Bench Courses contact AWI CENTRAL, 3700 Harrison Ave., P.O. Box 11011, Cincinnati, OH 45211.

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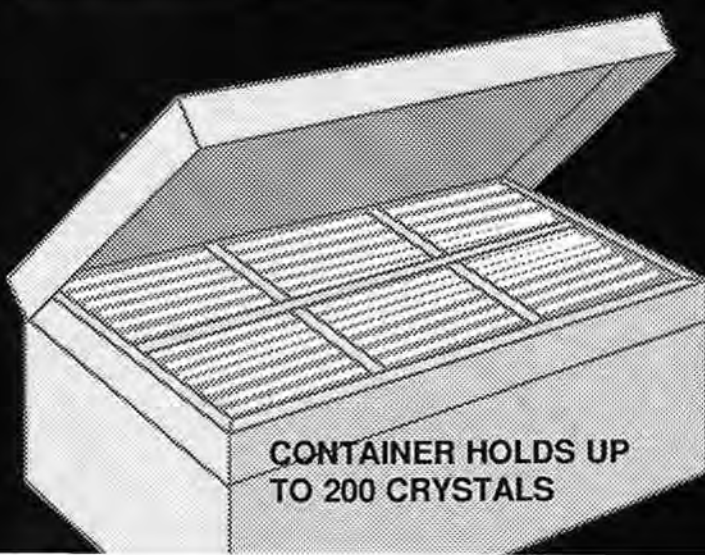
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- * Retrofitting & Casing
- * Introduction to Clock Repair
- * Advanced Clock Repair
- * Repair of the Atmos Clock
- * Useful Techniques: Mechanical Watch Repair
- * Introduction to the Watchmakers Lathe

Here is a listing of the seminars scheduled to be held during the remainder of this year and the beginning of 1990, and their locations.

If you are interested in information regarding any of these courses, write to: **AWI Bench Courses, P.O. Box 11011, Cincinnati, Ohio 45211.** The information will be sent to you as soon as it is available.

1989

NOVEMBER

- 5 Introduction to Quartz Watch Repair Dallas, TX
5 Retrofitting & Casing Kansas City, MO
6-10 Introduction to Clock Repair Waco, TX
11-12 Repair of the Atmos Clock St. Louis, MO
12 Useful Techniques: Mechanical Watch Repair .Tampa, FL
11-13 Introduction to the Watchmakers Lathe Sacramento, CA

DECEMBER

- 2-3 Repair of the Atmos Clock Milwaukee, WI

1990

JANUARY

- 14 **AWI Southeast Regional Seminar** Orlando, FL
20-21 Repair of the Atmos Clock Dallas, TX
20-21 Advanced Quartz Watch Repair Tampa, FL

FEBRUARY

- 5-9 Introduction to Clock Repair San Jose, CA
11 Retrofitting & Casing Phoenix, AZ
12-16 Introduction to Clock Repair Riverside, CA
17-18 Repair of the Atmos Clock Pensacola, FL
24-25 Repair of the Atmos Clock Orlando, FL

MARCH

- 11 Retrofitting & Casing St. Louis, MO
24-25 Repair of the Atmos Clock Greensboro, NC
31-1 Repair of the Atmos Clock Alexandria, VA

APRIL

- 8 Retrofitting & Casing Philadelphia, PA