Master Watchmaking

MODERN SHOP METHODS

LESSON

32 PART II

PRACTICAL JOB METHODS

CHICAGO SCHOOL OF WATCHMAKING
Founded 1908 by THOMAS B. SWEAZEY

(This chart is for use with Modern Shop Methods Estimate and Check List)

In order to speed up the estimating of repairs necessary to put a watch in first class order the most common repairs are listed below, preceded by a number and followed by letters which designate special work. Estimate job carefully and enter by number or number and letter in space for estimate on check list. Example: Demagnetize-Mainspring (17 jewel)-Clean, Oil and Regulate would be entered 19, 23-B, 4.

1. PIVOTS
   - A. Polish
   - B. Straighten

2. HAIRSPRING
   - A. True in round
   - B. True in flat
   - C. Center
   - D. Level
   - E. Overcoil

3. BALANCE WHEEL
   - A. True
   - B. Poise

4. CLEAN, OIL, REGULATE

5. WATCH GLASS
   - A. Round
   - B. Fancy
   - C. Military Bend

6. NO-BREAK
   - A. Round
   - B. Fancy

7. SPECIAL CRYSTAL
   - A. Color
   - B. Extra Heavy
   - C. Special

8. BALANCE STAFF

9. DIAL
   - A. Refinish
   - B. Replace

10. SPRING BARS

11. CORD

12. STRAP

13. HAND
   - A. Plain
   - B. Luminous
   - C. Seconds
   - D. Sweep Seconds

14. HANDS - Pair
   - A. Plain
   - B. Luminous

15. CROWN
   - A. Regular
   - B. Waterproof
   - C. Snap

16. STEM
   - A. Regular
   - B. Oversize
   - C. Snap

17. SLEEVE

18. CROWN AND STEM
   - A. Regular
   - B. Special

19. DEMAGNETIZE

20. CASE
   - A. Joint
   - B. Catch
   - C. Lugs

21. REMOVE RUST

22. CLICK SPRING

23. MAINSPRING
   - A. 7 to 15 jewel
   - B. 17 to 19 jewel
   - C. 21 to 23 jewel

24. JEWELS
   - A. Cap
   - B. Balance
   - C. Roller
   - D. Train
   - E. Center
   - F. Pallet

25. WINDING PINION

26. MAINWHEEL

27. HAIRSPRING, New
   - A. Flat
   - B. Overcoil

28. SETTING SPRING

29. WHEELS
   - A. Center
   - B. 3rd
   - C. 4th
   - D. Escape
   - E. Balance

30. BOW
   - A. White
   - B. Yellow

31. CLUTCH

32. SHIPPER SPRING

33. SET LEVER SCREW

34. CANNON PINION

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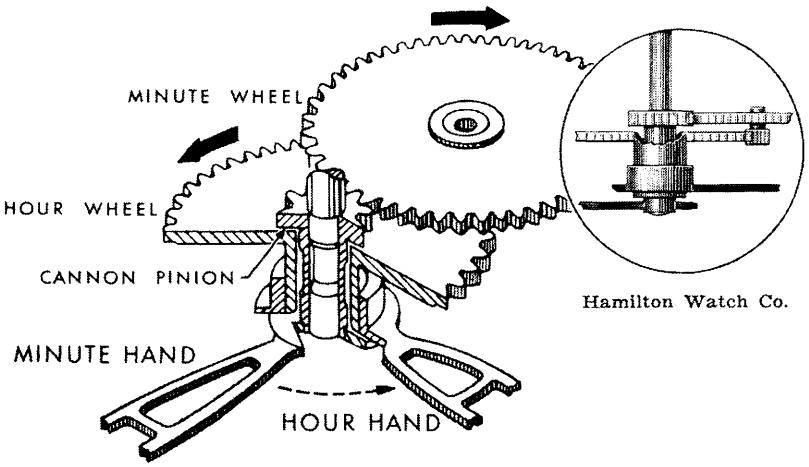
SEC. 561 - Calculating Dial Trains



The cannon pinion, minute wheel, hour wheel, and minute wheel pinion are known as the dial train.

The center staff or arbor makes one revolution in one hour. The cannon pinion is attached by friction to the center arbor and likewise makes one revolution per hour.

The cannon pinion drives the minute wheel. The pinion attached to the minute wheel is known as the minute wheel pinion and drives the hour wheel.

The teeth of the hour wheel multiplied by the teeth in the minute wheel equals the number of leaves in the cannon pinion multiplied by the number of leaves in the minute wheel pinion multiplied by 12.

The following formula is used to prove the correctness of a 12 hour dial train:

$$\frac{\text{Teeth in minute wheel x teeth in hour wheel}}{\text{Leaves in cannon pinion x leaves in minute wheel pinion x 12}} = 1$$

Substituting:

$$\frac{40 \times 36}{10 \times 12 \times 12} = \frac{1440}{1440} = 1$$

If the dial train is correct, the result will always be 1

$$\frac{\text{Leaves in cannon pinion x leaves in minute wheel pinion x 12}}{\text{Teeth in minute wheel}}$$ equals teeth in hour wheel

$$\frac{\text{Teeth in hour wheel x teeth in minute wheel}}{\text{Leaves in minute wheel pinion x 12}}$$ equals leaves in cannon pinion

$$\frac{\text{Teeth in hour wheel x teeth in minute wheel}}{\text{Leaves in cannon pinion x 12}}$$ equals leaves in minute wheel pinion

$$\frac{\text{Leaves in cannon pinion x leaves in minute wheel pinion x 12}}{\text{teeth in hour wheel}}$$ equals teeth in minute wheel

SEC. 562 - Practical Job Methods

The term "Watchmaker" has come down through the years to mean one who makes watches. But in the true sense of the word, the watchmaker of today is a repairman, one who has the ability to repair watches no matter who made them. He is judged by his customers on his ability to make their watches keep accurate time, the kind of time his customers can depend on.

A watchmaker can be considered a master only when he is able to make all of his watches keep time.

From now on, in your career in watch repairing, you know that you must not neglect any repairs necessary to put the train, the balance and hairspring, and the escapement in first class condition but you must also see that the watch keeps time.

In this lesson, we want to show you how to make your repairs in a systematic manner. System makes for better work and increased profits. The methods outlined here have been used profitably by many watchmakers. If you will follow them, you will shortly develop an efficient system of handling repairs that will become second nature.

SEC. 563 - Estimating

The first important step when you have taken in a watch for repair is to estimate what needs to be done. Try to have the customer leave the repair job in order that you can make an accurate estimate. When you estimate, you figure the material and the time it takes to make the necessary repairs. You base your charges upon your estimate. Therefore, it is very important that you check carefully each one of the following steps and make a note of the repairs required together with the material needed. Add to this the time it takes and you have an idea of how much to charge.

1. Check crystal. (Lesson #3)

2. Check crown, stem, sleeve, bow, etc. (Lesson #2)

3. Check hands. (Lessons #8 and #11)

4. Condition of dial. (Lesson #8)

5. Check cannon pinion. (Lessons #8 and #11)

6. Check hairspring. (Lessons #18, #19, #20 and #32)

7. Check balance staff. (Lesson #15)

8. Check roller jewel. (Lesson #13)

9. Check balance jewels. (Lesson #13)

10. Check pallets and escapement. (Lesson #26)

11. Check mainspring. (Lessons #5 and #6)

12. Check the train. (Lessons #8 and #10)

13. Observe general condition of oil, screws, etc. (Lesson #10)

SEC. 564 - Making Repairs

When making repairs on a watch, doesn't it seem wise to do your repairs first and then clean, assemble, oil and bring the watch to time? Don't get into the habit of cleaning the watch first and then taking it apart again to repair it.

The order of steps which follows has proven very practical when making repairs. In looking over the watch for mechanical troubles, follow these steps in the order given. Make your repairs as soon as you find the trouble. For example, if the watch is magnetized (step #5), demagnetize it right away. When you check the roller jewel (step #21) and find it loose, reset it properly at this time. As you use this sequence time after time, you'll find it develops speed in repairing and saves you doubling back to fix something you should have taken care of earlier.

1. Test winding and setting. (Lessons #2 and #9)

2. Remove watch from case. (Lesson #1)

3. Make all necessary repairs such as crowns, stems, sleeves, bows, and crystals. (Lessons #2 and #3)

4. Polish and clean case. Assemble and put to one side. (Lessons #1 and #10)

5. Check for magnetism. (Lessons #11)

6. Check loose cannon pinion with pegwood pushed against minute hand. (Lessons #8 and #11)

7. Remove hands and dial, and tighten dial screws. Replace screws if necessary. (Lessons #2 and #8)

8. Check dial and dial feet. (Lessons #8 and #29)

9. Fit new hands if necessary. (Lesson #11)

10. Check teeth in hour wheel. (Lessons #8, #10 and #11)

11. Remove cannon pinion - tighten if necessary. (Lessons #8 and #11)

12. Check hairspring for center. Place regulator in center of index. (Lesson #32)

13. Check hairspring for level. (Lesson #32)

14. Release stud screw. (Lesson #8)

15. Remove balance cock and separate balance from cock. (Lesson #8) Tighten stud screw.

16. Check regulator pins, adjust or replace. (Lessons #11 and #32)

17. Place balance in truing caliper and check hairspring in round and flat. (Lesson #18)

18. Remove hairspring. (Lesson #15)

19. Replace hairspring in balance cock and recheck for center and level. Check outside terminal coil to see if it is circled correctly. (Lessons #8 and #32)

20. Remove hairspring from bridge and tighten stud screw.

21. Check roller jewel. (Lesson #13)

22. Check for broken balance or cap jewels. Replace if necessary. (Lessons #13, #14 and #30)

23. Burnish and polish balance pivots. (Lesson #31) Fit new balance staff if necessary. (Lesson #15) When polishing the upper balance pivot, it is permissible to catch the balance up on impulse roller. Use a chuck of proper size and make certain the staff runs true before endeavoring to polish the pivot. If roller will not hold, remove

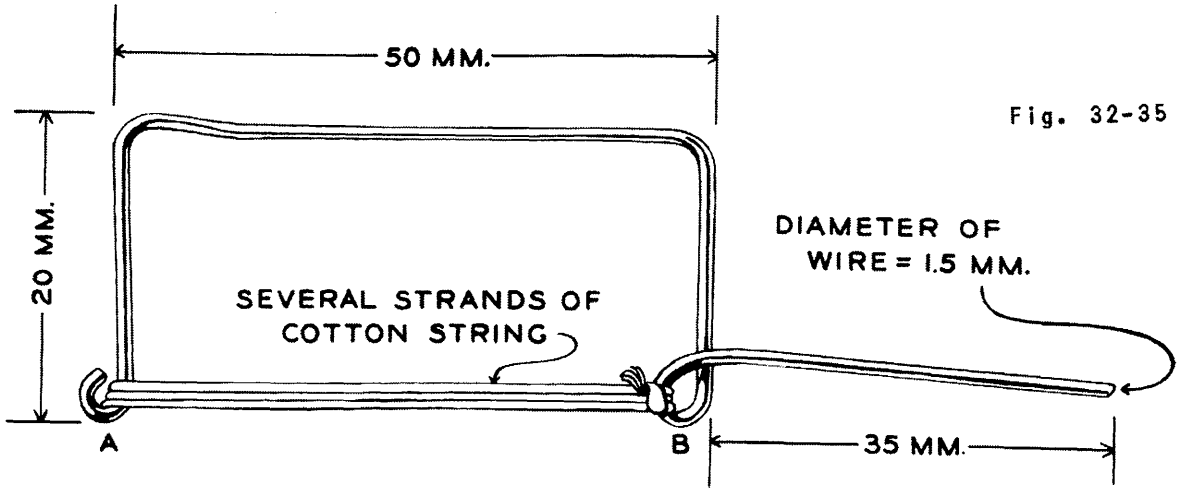


Fig. 32-35

roller (Lesson #15) and catch up on roller post. To polish lower pivot, catch up on collet post. In either case, if the pivots do not run true, it is best to use a pivot polisher as shown in figure 31-24, Lesson #31. Burnish end of every balance pivot lightly with smooth pivot burnisher, grind with grinding slip if necessary, and polish with boxwood slip and diamontine.

24. Replace balance, check endshake and sideshake. (Lesson #13)

25. Check guard action. (Lesson #26)

26. Remove cap jewels, replace balance jewels, and jewel screws. (Lesson #10)

27. Polish balance wheel rim if necessary. To polish between the screws of a balance wheel, make a small bow of brass wire. Approximate dimensions are given in figure 32-35. Wind two or three loops of cotton store string from A to B, keeping it taut. Wet the string with alcohol and rub across a stick of rouge. Balance screws and rim of wheel are then polished as in figure 32-36. Brush balance with cleaning solution to remove all rouge.

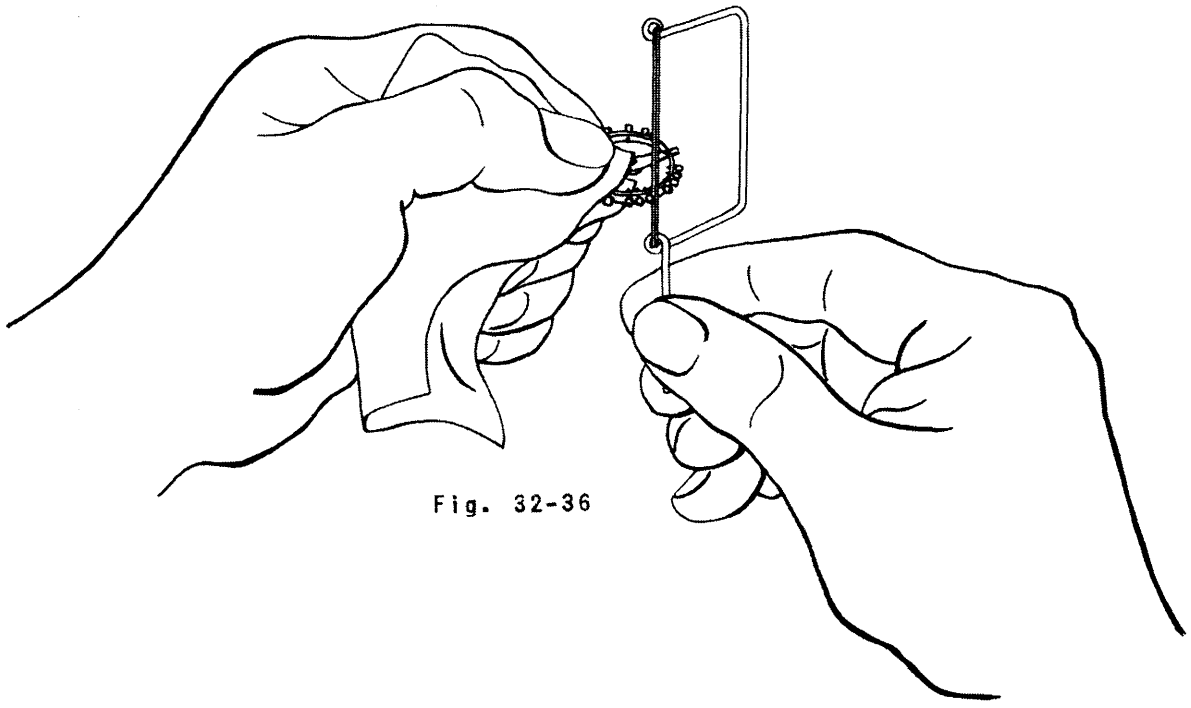


Fig. 32-36

28. True and poise balance wheel. (Lessons #16 and #17)

29. Check lock, drop and slide; also, sideshake of pallet arbor. (Lesson #26)

30. Let down power. (Lesson #5)

31. Remove fork and examine pallet stones and guard dart. (Lesson #26) Polish pallet arbor pivots if necessary. (Lesson #31) Make necessary escapement adjustments. (Lesson #26)

32. Check train wheels to see if they run true. Check lower 4th pivot for trueness.

33. Disassemble movement. (Lesson #8)

34. Dip each wheel and pinion in benzine or carbon tetrachloride and push leaves and pivots into pithwood.

35. Remove rust from pinion leaves. (Lesson #10)

36. Polish or burnish pivots if necessary. (Lesson #31) When polishing train pivots, place arbor or pinion leaves in chuck, making certain that the pivot runs true. If impossible to catch on arbor or pinion leaves, place wheel in a wheel chuck or cement to a flat face cement chuck, which has been hollowed out, making certain that the pivot runs true. Never place a pivot in a chuck as it will mar or distort the shape of the pivot. Lightly brush the ends of the pivot with a smooth pivot burnisher. Grind pivot with grinding slip, if necessary, and polish with boxwood slip and diamontine.

37. Check and peg out all pivot holes. Close holes if necessary. (Lesson #17) Replace broken jewels. (Lessons #12, #14 and #30)

38. Check endshake in barrel arbor. (Lesson #5)

39. Clean teeth in mainspring barrel using a stiff brush. (Lesson #10)

40. Remove mainspring, replace if necessary, check hook in barrel, and on barrel arbor. Polish bearing surfaces on arbor, barrel and cap if necessary. (Lessons #5 and #6)

41. Check and repair winding and setting parts. (Lesson #9)

42. Fit all new material. All repairs should have been completed by now.

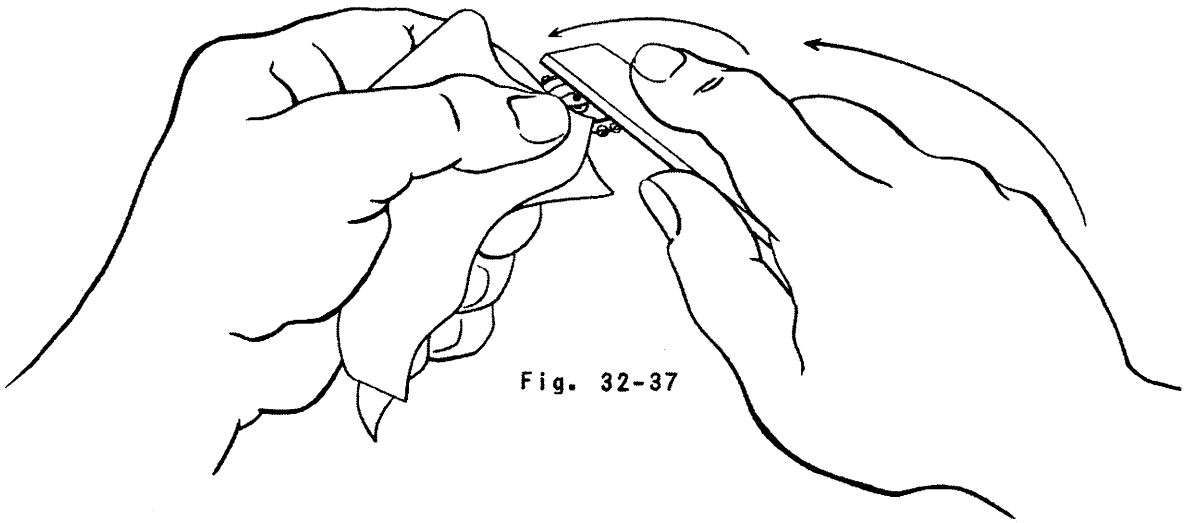


Fig. 32-37

43. Clean and dry all parts of watch. (Lesson #10) Repolish top of balance rim using small chamois buff and rouge. After the balance has been thoroughly cleaned and dried, polish the upper side of rim with a circular motion as in figure 32-37. The buff can be either chamois or leather and the wheel should be held between the fingers with watch paper. Do not use any pressure. Remove traces of rouge with soft dry brush.

SEC. 565 - Review of Cleaning Methods

A. Cyanide, soap, alcohol, and sawdust. (Lesson #10, Section 237)

B. Modern 7 Jar Method. (Lesson #10, Sections 238 through 247)

C. Machine Cleaning Methods:

The modern method is to use the 7 jar cleaning method as described in Lesson #10. Section 239. To use this method with the machine requires 7 jars plus the heat dryer unit. Label the jars from 1 to 7. A common type of cleaning basket is illustrated in figure 32-38. Put bridges, plates, and barrel into the largest Compartment C. Place all screws, levers, train wheels, etc. which you know will not slip through basket in Compartment B. Place pallet fork and balance in Compartment A.

Precaution: Clean hairspring separately.

Place cover on basket and place in cleaning machine. Run slowly in Solution #1 for approximately 60 seconds. Spin off surplus solution in upper half of jar #1. Rinse quickly in solution #2 and spin off surplus. Run very, very slowly in solution #3 for approximately 15 to 30 seconds. This solution is used to brighten parts so do not let it remain for over 30 seconds. Spin off surplus

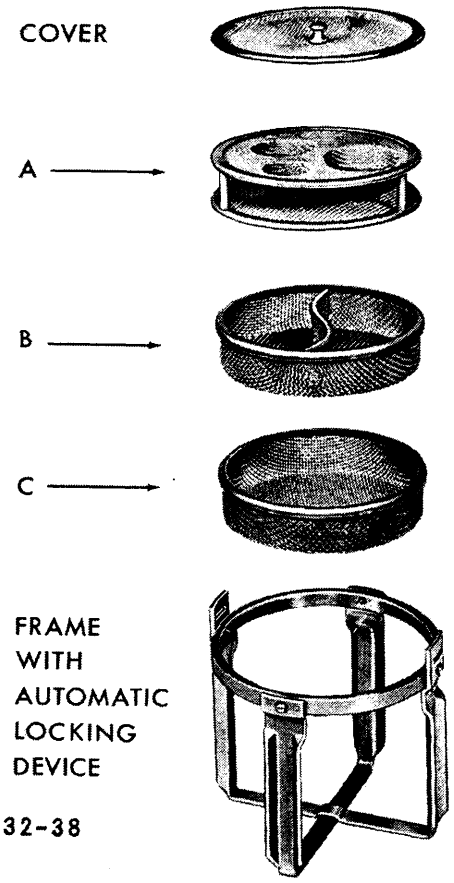


Fig. 32-38

Rinse quickly in solutions #4, #5, #6, and #7 and dry thoroughly over heater on cleaning machine.

3 Jar Cleaning Method: Although the 7 jar method is superior, there are a great many shops which use the 3 jar method with heater. This method of cleaning requires that all parts of a watch be brushed thoroughly with naphtha or benzine before putting in the cleaning machine. Assemble parts in cleaning basket as outlined in Lesson #10, Section 258, and run in solution #1, which is the cleaning solution, not to exceed 30 seconds. This will keep the parts from turning dull and it should not require any more time than this if the old oil has been thoroughly loosened before cleaning. Quickly rinse in solutions #2 and #3 and dry parts over heater.

Clean the hairspring separately. A small jar with an airtight screw top containing naphtha or benzine should be

kept handy for cleaning the hairspring. Dry with soft watch brush or blower. It is a good idea to warm the hairspring slightly to make certain that all the cleaning solution has been evaporated.

SEC. 566 - Assembling

1. Replace mainspring, oil barrel arbor and mainspring. (Lessons #5 and #6)

2. Replace winding and setting parts, and oil. (Lessons #9 and #10)

3. Replace and oil all balance hole and cap jewel combinations. (Lesson #10)

4. Replace train wheels and oil pivots. (Lessons #8 and #10)

5. Check the train carefully by winding the mainspring, and in most cases the train wheels will run down and the escape wheel will come to a stop and then reverse its direction. This is called train recoil and generally speaking, the train is in top notch condition if this recoil takes place. (Lesson #8)

6. Place balance in watch with pallet bridge in place and place movement dial down.

7. With a small brush or pointed piece of pegwood, test balance by flicking it with brush. Not fast. Carefully observe the reaction. The balance should revolve freely and slow down gradually!

8. Repeat this operation Dial Up position. When you are certain that the action is free in both positions, the balance is in good order.

9. Turn balance pendant up and test. In most cases, the balance will slow down more rapidly in this position than in the D U (Dial Up) or D D (Dial Down).

10. Replace pallet fork (remember to oil escape wheel teeth) and wind the stem 5 or 6 turns. Test lock, drop, draw, slide and endshake. (Lesson #26)

11. Replace balance without hairspring and check roller and safety action. (Lesson #26) Many of the high grade pocket watches will run on half time. When the balance (without a hairspring) continues to oscillate from impulses imparted to the roller jewel by the fork, it is referred to as running on "half time". A watch capable of running on "half time" in the Dial Down position should also run on "half time" in the Dial Up position or vice versa.

If all of the above conditions have been met, the watch can be adjudged to be in good condition.

12. Replace hairspring (Lesson #32) and put watch in beat (Lesson #26)

13. Check motion. (Lesson #11, Sec. 269)

14. Replace cannon pinion, hour wheel, dial and hands.

15. Check motion.

SEC. 567 - Timing and Regulation

Rating is the observation and comparison of the daily rate of a watch when it is being adjusted.

Timing is the operation required to bring a watch to time after it has been repaired and rated.

Regulation refers to the regulator adjustment of a watch to its owner's personal routine and habits.

This lesson could be extended into volumes if we were to consider all the theories advanced and operations required in temperature and position adjusting. In this lesson, we will consider three positions first as these three positions are most important in the majority of watches in use today. Facts, theories, and problems regarding temperature and position adjusting are contained in many good books and the student should endeavor to do a certain amount of study and practice from recommended books.

SEC. 568 - Limits of Accuracy

First, we, as watch repairmen, have to consider that the factory which made the watch has made the necessary adjustments regarding temperature and position errors and we, therefore, are only expected to repair the watch as well as it was when it left the factory. Consequently, we are primarily interested in:

1. Putting the watch in first class shape.

2. Making the watch keep accurate time within certain limits i.e., a railroad watch of 21 or 23 jewels must keep time within 30 seconds per week. This is the maximum error allowed by the watch Inspector. With careful regulation you should get greater accuracy. This is also possible with 7J, 15J, 17J and 19J watches in good order.

Average wrist watches should keep time within 90 seconds per week more or less. The principal factors to consider before endeavoring to adjust and time a watch are:

a. The train must be free, cleaned, and oiled properly.

b. The escapement must be free and have snap.

c. The balance must be in first class condition.

d. Hairspring - true and centered. Regulator pins adjusted properly.

e. Pivots polished.

f. Endshakes and sideshakes at a minimum.

g. Wheel true and poised.

If these conditions have been met, we should have good motion.

3. Dial Up and Dial Down the motion should be the same, 1-1/2 turns. (Lesson #11)

4. Pendant Up the motion should be about 1-1/4 plus turns. (Lesson #11)

In watches with a Breguet hairspring, the regulator pins should be parallel and be adjusted with a minimum amount of play. (Lesson #32) This is also true with flat hairsprings but the amount of clearance is greater in most cases than the Breguet Spring, (Lesson #32)

SEC. 569 - Rating and Timing Records

When all of the above conditions have been met, we will make three preliminary tests and keep a record of each test. Set the second hand of the watch you are timing with a regulator having a known rate. Of course, the best possible regulator is a short wave radio set which sends time signals on differ-

ent wave lengths 24 hours per day. Other methods include regular radio tone beats, chronometers, clocks, etc.

Set the second hand on your watch to correspond exactly with the second hand on your regulator and place your watch in a Dial Up position. All rates are based on a 24 hour period. Wind the watch fully. It isn't necessary for us to let the watch run the full 24 hours before making further checks as that slows down the process of adjusting. For example: Let us say we let our watch run for 3 hours in the Dial Up position. At the end of this 3 hour period, calculate the loss or gain over a 24 hour period and make a note of it. Place watch in Dial Down position and calculate the loss or gain over a 24 hour period, and make a note of it. Now run watch in Pendant Up position and calculate the loss or gain over a 24 hour period and make a note of it. The Dial Up and Dial Down position should be the same. The Pendant Up may vary some but should be within a reasonable amount of loss or gain. When these calculations have been made and found to be correct, it is only a matter of adding weight to or subtracting weight from the balance wheel in order to bring the watch to time.

If we are timing a pocket watch, we will make the adjustment necessary to bring the watch to time in the Pendant UP position as this is the position in which the customer will carry his watch in the greater portion of time he will wear it. A wrist watch is brought to time in the Pendant Down position for the same reason.

It is better to have pocket watches gain from 5 to 10 seconds per day average and then have the customer return for regulating to his personal habits.

A wrist watch should have about 10 to 15 seconds per average day gain for the same reason.

For final check, compare rate a full 24 hours in each position. Regulating a watch when the rate is known can be accomplished by the meantime screws. (Lesson #11). Turning them in will cause the watch to gain: turning them out will cause the watch to lose. Adding timing washers will cause the watch to lose and removing washers or weight from balance wheel will cause it to gain.

SEC. 570 - Timing Machines

By now you should be able to put a watch in good running order and bring it to time properly. Of course, you may be slow, but speed comes only with practice.

At this point in his training, the average student becomes intrigued with the recently developed electronic timing devices. In his enthusiasm, he is often led to believe that the machine will make his repair analysis for him and is a "cure-all" for watch troubles. Actually, the machine is nothing more than a check on his craftsmanship and not a substitute for it.

Before the watch is placed in the machine, it must be in good running order. This means that all repairs have been made. By following the modern shop outline, the good craftsman locates and corrects the trouble as he checks each part. The machine does not make repairs nor is it a short cut to making repairs. It tests the job that has been done and shows up work that may have been slighted. If you have properly repaired the watch according to the Modern Shop outline, it is unlikely that the machine will ever indicate errors

such as dirty balance jewels, magnetism, loose roller jewels, bent regulator pins, wheels out of poise and so forth. The good watchmaker will have already found and corrected these errors. He does not need a machine for this purpose.

The main advantage of an electronic timing machine is a saving in time for the watchmaker when rating, timing and adjusting. With it he can bring watches to time more quickly than without it. This means better service for his customer. But depending on the machine to show up errors in workmanship encourages slip-shod repair habits. There is then less saving as the repair work must be done over before the watch can be brought to time.

The average man uses a timing machine very briefly for rating or timing -- from 30 to 60 seconds with the watch half wound or fully wound. Some feel the rate they get from the machine tape is accurate for the entire 24 hour period. A true rate is possible only when the watch has run for a full 24-hour period in any one position. Many students have failed examinations because of this failure to test their watches over a 24 hour period.

Be a good watchmaker. This means to use all modern equipment available that will help you increase your income, save time and give greater service to your customers. But these devices must be used with understanding. The machine is only as good as the man who operates it.

WHAT IS A WATCH ???

"An ordinary sixteen-size watch of the present day is composed of about 217 parts. Making 18,000 beats or vibrations per hour, it has to make 432,000 per day, or 157,680,000 per year. The balance wheel travels 1.43 inches with each vibration which is equal to 9.75 miles in twenty-four hours; 292.50 miles in thirty days, or 3,558.75 miles in one year."

"Among the many who own and carry watches, how few ever stop to think of the amount of brain power that has been expended upon its construction or the repairs necessary to bring it back to its original factory condition. The number of its parts and the difficulties attendant upon the assembling of all these delicate parts into one harmonious whole so when completed it shall run continuously for a period of months at least, and always indicate the correct time without even a moment's rest."

-- Anonymous

note:

(No job sheets are associated with Lesson 32, Part 2)