

# **The Repair and Replacement of an American Strip Recoil Escapement**

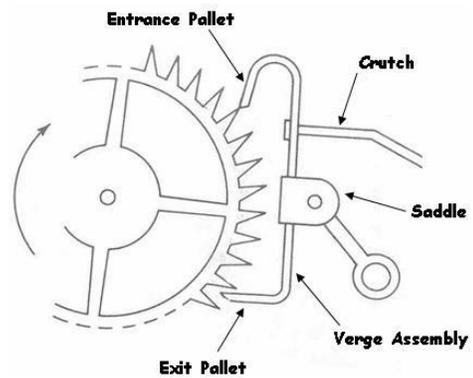
This two day course will cover the repair and replacement of recoil strip escapement components normally found in the American open spring clocks

# Course Outline

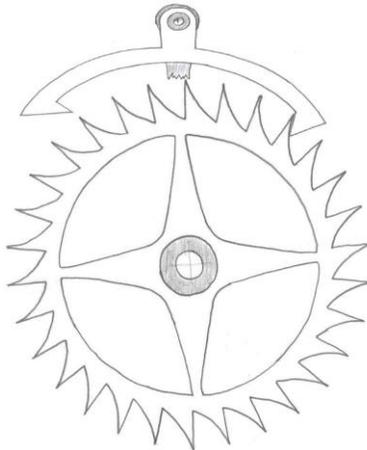
## A. Background

a) Recoil escapements can be classified in three basic configurations

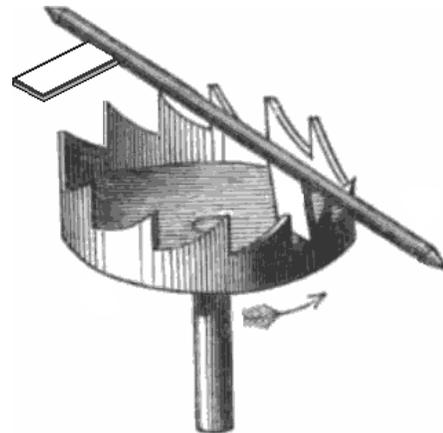
1. Strip which will be covered in this two-day class. The verge assembly consists of the entrance & exit pallet, the saddle, and the crutch. (Not to be confused with the Verge Escapement, see below)



2. Anchor of solid



3. Crown Wheel or Verge Escapement



b) Scope of Course: This course will cover the recoil strip escapement generally used in the American open spring and some European clocks.

1. Since this course is a repair course, recoil escapement design or theory will not be discussed. For the student interested in those details, there is a reference list of books that covers the material nicely.
2. This course will cover three subjects
  - i. The repair of an existing escapement
  - ii. How to make a verge assembly by using the escape wheel teeth span method
  - iii. How to make a verge assembly from a calculate dimensions method

**B. Repair Existing Escapement** If is virtually impossible to properly adjust a worn escapement, so it is very important to repair escape wheel and all bushings before proceeding with adjustments.

**IMPORTANT: It is recommended that the student replace the escape wheel bushing even if slightly worn before attending this class.**

a) The Escape wheel.

1. The instructor will present a slide show of how to repair an escape wheel on a lathe.
  - i. Remove wobble
  - ii. Straighten teeth
  - iii. Top the teeth to make the wheel concentric
2. Check for out-of-round or wobbling escape wheel
  - i. If there is excessive wobble in the wheel, correct by spinning between plates and straighten.
3. Check for bent teeth; two ways to straighten teeth
  - i. Pliers; use a small smooth jaw pliers
  - ii. Webster tooth straighter, available from clock tool & part vendors

b) The Verge Assembly

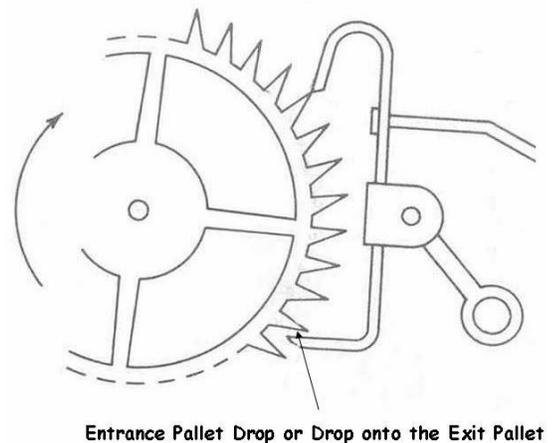
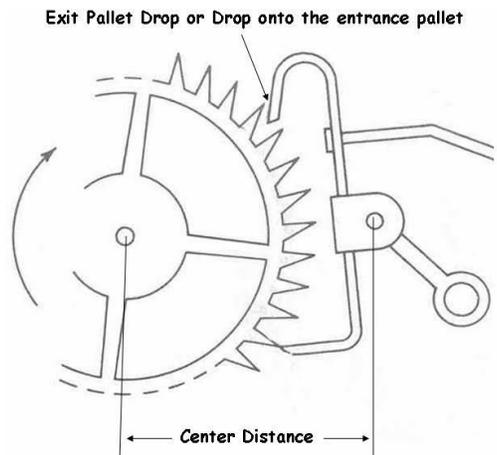
1. Tighten loose crutch
  - i. Hold in vise and brad with ball peen hammer
  - ii. Hold in special tool to repair (supplied by instructor) Tighten loose saddle
  - iii. Use vise
  - iv. Use special tool supplied by instructor
2. Repair effect of loose verge pin holes
  - i. Replace pin
  - ii. Bush worn hole or close
  - iii. Replace saddle
3. Entrance / Exit Pallets
  - i. Repair grooved pallets

- (a) Measure distance between pallet faces
- (b) Stone or file out grooves and polish pallet surfaces to a high sheen
- (c) Return verge to original dimensions by opening or closing

### C. Adjust the Escapement

#### 1. Escapement Drop

- i. The escapement DROP is the sudden rotation of the escape wheel that takes place when a tooth slides off a pallet. The larger the DROP the more power is wasted...so the DROP should be set as small as possible and still be safe not to hang-up the escapement on a tooth. The DROP can be seen in a running clock by looking between a pallet and the entering or exiting of an escape wheel tooth.
- ii. When a tooth drops off the exit pallet the drop is seen at the entrance pallet and is called exit pallet drop (also called drop onto entrance pallet).
- iii. Similarly, when a tooth drops off the entrance pallet the drop is seen at the exit pallet and is called entrance pallet drop (also called drop onto the exit pallet).
- iv. Visually measure the DROP relative to the distance between the teeth. On American clocks a good guideline for drop is  $\frac{1}{4}$  the tooth spacing.
- v. **Set the Drop Small:** any drop is wasted power, but there must be some to operate and to keep from locking the escapement on a tooth.
- vi. **Set the Drop Safe:** sufficient not to lock on a tooth.....ever, ever.
- vii. **Set the Drop Equal:** drop off entry and exit pallet must be equal for each tooth.



#### 2. Drop Adjustment

- i. **IMPORTANT:** It is virtually impossible to properly adjust a worn escapement, so before the drop is adjusted complete Paragraph B above.
- ii. Use the center distance adjustment (arm holding the verge) to set the DROP onto the entrance pallet. Close center distance to close drop onto the entrance pallet. Open center distance to open drop onto the entrance pallet.
- iii. The center distance can change the drop onto the exit a small amount too.

- iv. After adjusting the drop onto the entrance pallet, if the drop onto the entrance, and exit pallets are unequal, then the strap verge must be opened or closed to correct the situation.
- v. Close the pallet (bend in center where verge is mounted to saddle and metal is ductile) to close the drop onto the exit pallet. Open the pallet to open drop onto the exit pallet.
- vi. The center distance may need to be re-adjusted after bending the verge.

#### **D. Make a new Recoil Escapement Verge**

##### a) Method #1, by escape wheel tooth span

1. Background of tooth span. Escape wheel tooth span is derived from Arc of Circumference, however the tooth span is independent of arc of circumference because tooth pitch is not a constant in clock design. Even so, there are authors that use both arc of circumference (Saunier) and tooth span (Tigner & Conover) in the design of escapement verges.
  - i. Arc of Circumference. Larger verge arcs produce less lift angle, less recoil, give less pallet wear and are better time keepers.
    - (a) Precision regulators typically have 90 to 120 degrees of arc span
    - (b) English anchor escapements run 69 to 90 degree span
    - (c) Ordinary small anchor span 40 to 60 degree.
    - (d) American strip escapements span about 72 degrees.
  - ii. Tooth Span. This class will use tooth span of approximately 20% of the escape wheel (or 72 degrees) in making a new verge assembly.
2. Crutch Length. A good rule of thumb based on best practices is to use a mean crutch length of  $\frac{1}{4}$  to  $\frac{1}{3}$  the pendulum length.
3. Use Verge-Fits-All Blank (Timesaver # 12503 or equivalent)
  - i. Use a file to test the verge softness.
  - ii. To soften, heat to cherry red and allow it to cool very slowly.
  - iii. Broach the saddle holes on the verge (from both sides) to fit the verge pin, use a smoothing broach to finish the inside of the holes. If the saddle is too wide it can be bent to fit the verge pin length.
  - iv. Place verge on pivot pins. Position the crutch on the side that clears any interfering front plate post or arbors.
  - v. Count number of teeth on escape wheel and find the teeth the verge will span from the table below.
 

(a) 30 to 39	7 teeth embraced
(b) 40 to 43	8 teeth embraced
(c) 44 to 46	9 teeth embraced

- vi. Mark escape wheel tooth that's in a straight line with the verge pivot point and the escape wheel pivot.
- vii. Pivot the verge to be perpendicular to a line through the verge & escape wheel pivot points. Use Play-Doh or Rodico to hold escape wheel and verge in a fixed position.
- viii. Count  $\frac{1}{2}$  the tooth span from the marked tooth toward the exit pallet and mark the exit pallet tooth.

- ix. Extend a perpendicular line from the verge to the exit pallet tooth and place a mark on the verge for the exit pallet bend.

- x. Count back from the exit pallet tooth the span number plus two teeth and mark that tooth for the entrance pallet bend position.

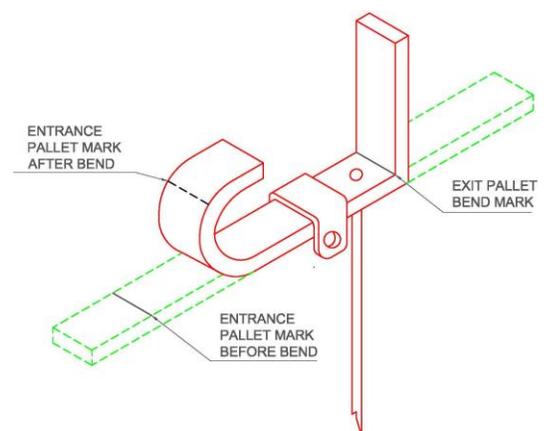
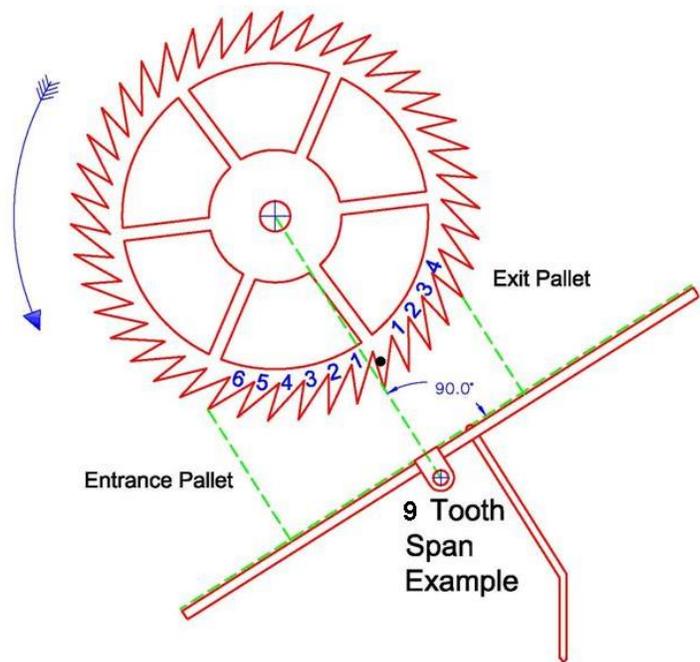
- xi. Extend a perpendicular line from verge to the tooth that is the entrance-bend tooth and place a mark on the verge for the entrance pallet bend.

- xii. Remove the verge blank and bend an exit pallet 90 degrees outside the mark (see drawing below).

- xiii. Bend an entrance pallet with the entrance pallet mark inside the pallet radius (see drawing below).

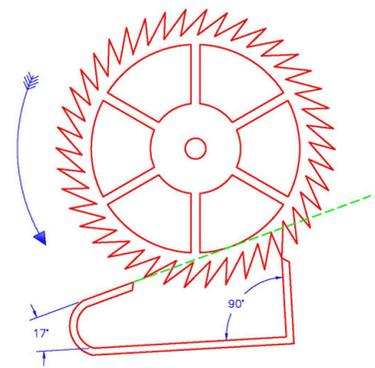
- xiv. Place verge on pivots pins with exit pallet on the exit tooth and shape the entrance pallet to form a tangent line with inner circle of escape wheel that has an angle of 17 degrees (see drawing below). At this point, both pallets will probably be too long.

- xv. With the verge in the tangent position described, cut off both the exit and entrance pallets to cover the proper tooth span. Since some minor adjustment will



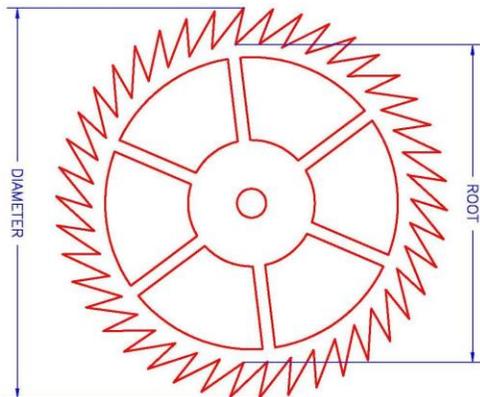
probably have to be made to obtain equal drops, it is advisable to make the pallets a little long.

- xvi. Adjust the exit and entrance drops as described above. The pallets may need to be trimmed
- xvii. Cut about a 65 degree relief on the tips of the exit and entrance pallets. See picture below.
- xviii. Test completed escapement in clock
- xix. Polish both pallets to a high sheen
- xx. Harden and temper both pallets to straw color. Use an anti-oxidant agent to prevent the metal from burning.
- xxi. Re-polished hardened pallets.
- xxii. Test completed escapement in clock



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b) New Verge Method #2, by calculations of verge dimensions



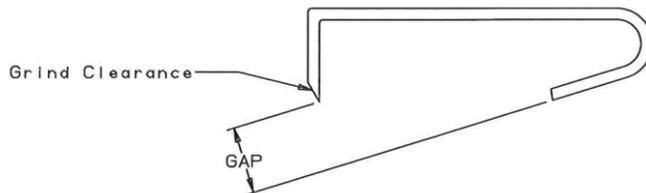
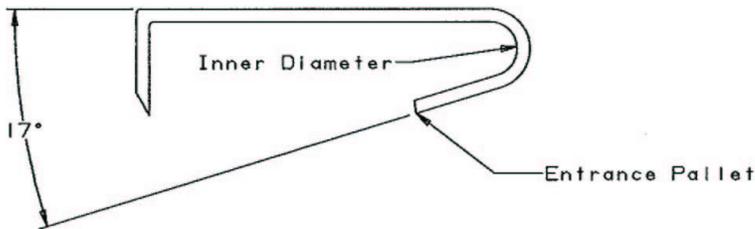
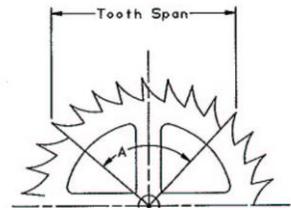
1. Use provided EXCEL work sheet or formulas in this outline to calculate verge dimensions
  - i. Measure diameter of escape wheel (DIA)
  - ii. Measure teeth root diameter. (ROOT)
  - iii. Count number of teeth in escape wheel (N)

- iv. Calculate tooth pitch:  $P=(DIA*3.14/N)$
- v. Calculate 20% of teeth for tooth span and round up:  
 $n=N*20\%$
- vi. Since the span is 20%, the angle of teeth spanned is:  
 $A=360^{\circ}*20\% = 72^{\circ}$
- vii. Calculate tooth span cord length:  $L=DIA*\sin(A/2)$
- viii. Calculate entrance pallet inner diameter:  $IDIA= (DIA-ROOT)*0.75$
- ix. Calculate  $GAP=P*75\%$
- x. Calculate distance between pallets:  $D=L+0.2P$



2. Use Verge-Fits-All Blank (Timesaver # 12503 or equivalent)
  - i. Use a file to test the verge softness.

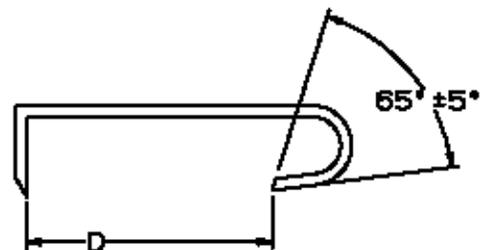
- ii. To soften, heat to cherry red and allow it to cool very slowly.
- iii. Broach the saddle holes on the verge from both sides to fit the verge pin, use a smoothing broach to finish the inside of the holes. If the saddle is too wide it can be bent to fit the verge pin length.



- iv. Place verge on pivot points. Position the crutch on the side that clears any interfering post from front plate.
- v. Make verge using dimensions just calculated
- vi. First bend the

pallet that is on the crutch side of verge blank.

- vii. If the exit pallet is on the crutch side, bend a 90 degree pallet near the crutch. Then bend an entrance pallet with a radius of IDIA and an angle of 17 degrees. Set the entrance pallet on a flat surface and measures the gap thickness with a feeler gauge and cut the exit pallet the length shown in the accompanying picture.
- viii. Cut the entrance pallet to give distance D between the pallets.
- ix. If the entrance pallet is on the crutch side, bend an entrance pallet near the crutch with a radius of IDIA and an angle of 17 degrees. Bend a 90 degree exit pallet. Cut the entrance and exit pallets as described above.
- x. Adjust the exit and entrance drops as described in previous section.
- xi. Cut about a 65 degree relief on the tips of the exit and entrance pallets.
- xii. Test completed escapement in clock
- xiii. Polish both pallets to a high sheen



- xiv. Harden and temper both pallets to straw color. Use an anti-oxidant agent to prevent the metal from burning.
- xv. Re-polished hardened pallets.
- xvi. Test completed escapement in clock

### Student tool list for Recoil Escapement Class

1. All tools needed to disassemble and assemble an open spring American clock.
2. Cutting Broaches
3. Smoothing Broaches
4. Jewelers Saw
5. Jewelers Saw Blades
6. Small Set of Jewelers Files
7. 6" Flat File
8. Digital Caliper
9. Small Hammer
10. Flat Punches
11. Assortment of Different Pliers
12. Eye Loop or Optivisor
13. Sharpie Marker (Fine Point)
14. Small Bench Vise
15. Rodico or Play-Doh
16. Polish Stones
  - a. Msc # 78197423 or equivalent
  - b. Msc # 78197431 or equivalent
  - c. Msc # 78197449 or equivalent
17. Feeler Gauge
  - a. Msc # 01471077 or equivalent
18. Recoil movement with outside escape wheel, cleaned, oiled, and properly bushed.

## Reference Book List

Treatise on Modern Horology	Claudius Saunier
Practical Clock Escapements	Laurie Penman
Clock and Watch Escapements	W. J. Gazeley
Clock Repair Skills	Steven G. Conover
Clock Repair Basics	Steven G. Conover
Questions and Answers	James L. Tigner
Modern Clocks	Ward L. Goodrich
This Old Clock	David S. Goodman