Atmos Clock: Replacement of Old Bellows

The bellows in an Atmos clock consists of a metal capsule that is designed to expand and contract easily, which makes it possible to wind the mainspring of the clock when the temperature or atmospheric pressure changes. Expansion and contraction take place between about 60 and 75° Fahrenheit because the capsule contains a small amount of ethyl chloride, which condenses to a liquid when it cools, causing the capsule to contract. Similarly, the ethyl chloride becomes a gas when it gets warmer, causing the capsule to expand. If the capsule develops a pin hole leak, the ethyl chloride escapes and the capsule collapses, so the bellows must be replaced.

Replacing the bellows in a newer Atmos clock is easy because the housing comes apart easily and contains a separate bellow assembly: simply push in and turn the front cover counterclockwise until it is released. The new bellows is installed by placing it in the freezer for about two minutes until it contracts and then immediately place it inside the housing with the retaining spring placed in the center of it and screw the front cover back on (clockwise, in the opposite manner than it had been removed). Re-assembly must be done immediately before the cold bellows becomes warmer and has a chance to expand. If it expands, it must be placed in the freezer again until it contracts in order to make installation possible. Replacing the new bellows is easy enough, but the early Atmos bellows were soldered together in the housing as a one piece assembly, providing no straightforward way to replace the bellows if it becomes flat.

The procedure outlined here was developed and performed by Dan Henderson, a mechanical engineer at 3M, here in Austin, Texas. My rôle was that of curious horologist armed with a camera.

In old Atmos clocks, the bellows were integral to the housing, and conventional replacement would require unsoldering of the assembly. The heat needed to unsolder and resolder the assembly would change the appearance of the housing and may be sufficient to damage the new bellows. Since the new replacement bellows is slightly smaller in diameter than the housing, it is possible to cut an opening in the end of the housing, remove the existing bellows, and install a new bellows. Since a cover plate is used on this surface, the appearance of this surface need not be flawless. The challenge was to develop a method by which this could be done and re-assembled without the need for complicated fastening systems. A method of using two half-washers and the bellows' own spring force provided the necessary solution to the re-assembly problem.

Step 1 - Removal of the existing bellows:

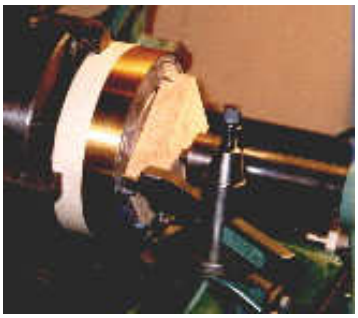
Here is the bellows with the front cover on, after wrapping the back part with three layers of

masking tape (for protection when it is installed into a four-jaw chuck):

...and after removing the front cover:

Here is a rear view, showing the masking tape:

The bellows has been installed in the four-jaw chuck of Dan's large machinists' lathe. The bellows must be centered, of course, and tightened into position enough to enable him to perform the operation but not so tight that the brass housing would be dented: snug, but not really tight. There is a wooden block pressed against the front of the bellows by a live (rotating) center on the tail stock. The wooden block is pressed snugly, but not too tight. The block stabilizes the housing by holding it against the chuck and, as the housing is cut, it prevents the spring force from causing the center of the housing to "pop out" unexpectedly. Here you see the cutting graver in position, set to a diameter just slightly larger than that of the new bellows (by approximately 1/8"):



Rotating the bellows at about 150 revolutions per minute, the cutter is plunged very slowly into the housing until the cut is complete. The dangerous part of this procedure occurs when the cutting is almost finished because the graver tends to get caught on the spot where it begins to cut through. Dan adjusted the belt of his lathe loosely so that it was just tight enough to rotate and cut but loose enough to enable the belt to slip when the graver got stuck. Otherwise the bellows could be forced out of the chuck, resulting in dents and scratches. So be very careful. This is a front view after cutting. The cutting on the lathe has been completed.

The rest of the cutting is performed by hand with a hobby knife:

The inner part and the outer part are cut and the top is removed:

The rest of the bellows is removed with pliers:

Step 2 - Fabrication of the Retaining Washers:

The retaining washers used to re-assemble the housing are fabricated from a piece of tempered sheet metal (0.010" or 0.25mm. shim stock was used). The shape is scribed on the sheet metal. The outside diameter should be just slightly smaller than the inside diameter of the housing. Clearance holes are needed for the mounting studs from the removed plate and also for the center bellows opening (I regret the next photo does not appear sharp, so the markings are not visible):

The parts from the bellows housing are deburred with a file to remove sharp corners and edges that could cut your hands.

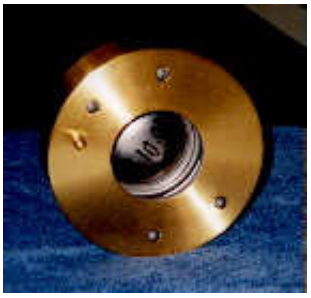
Step3 - Re-assembly:

The new bellows (which is smaller than the original) is placed in the freezer:

...and removed about two minutes later, after it has contracted:

The new bellows is installed immediately (while still cold), the retaining spring placed inside, the front cover (that had been cut out) placed on top, and the two pieces of sheet metal placed on top of the front cover, such that the drilled holes align with the protruding bolts and the outer edges of the sheet metal are wedged inside the outer cover:

Finally, the brass cover is placed into position and the completed bellows replacement is installed onto the back of the Atmos clock as it had been before it was removed. The four nuts are placed snugly to hold the bellows into position, but must not be tightened very tightly because of this repair, so the nuts can be prevented from loosening themselves by applying small quantities of threadlocker (blue Locktite).



As with any other Atmos-related repair, be aware that any repair incorrectly performed could easily result in permanent damage to the clock: do not attempt this repair unless you understand every detail in this procedure. Do this at your own risk!

Thanks, Dan.

(19 December, 1999.)

Mark Headrick