NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS.

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EFFECT OF TEMPERATURE AND PRESSURE ON WATCHES AND CHRONOMETERS.

By Mr. Leroy,
Manufacturer of chronometers and Member of the
"Bureau des Longitudes".

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During the war, aviators recognized the necessity of carrying watches capable of withstanding low temperatures. In fact, the compensated balance wheel of chronometers is appreciably distorted below -5°C and when the temperature reaches 25 or 30° below zero (which was not rare during the winters of 1915-17), its distortion becomes so great that it does not regain its original form.

Guynemer once experienced a temperature of -32°C at 2000 meters and his watch, (which was in a leather pocket attached to a strut of his airplane) stopped. An examination, the same day, showed that the balance wheel was so distorted that it struck against the case.

In order to remedy this serious disadvantage, it seemed best to expose to such temperatures only chronometers with monometal balance wheels, like the new balances of Charles Guillaume, coupled with spiral automatic compensators. Though not giving nearly so good results, they answered well enough for keeping the time on airplanes.

There remained to be determined the effect of the <u>barometric pressure</u> on the running of chronometers at high altitudes.

Interesting experiments have just been made at the Besancon Observatory on 50 Leroy and Company chronometers and on 12 chronometers of precision.

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1. The 50 chronometers were subjected to pressures of 735 and 35 mm at 15°C. The average daily variation for 700 mm was 10.94 seconds, or 0.0156 sec. per mm.

2. The 12 precision chronometers were observed at three temperatures: 0°C, 15°, 30°. At each temperature, they were subjected to the two extreme pressures of 735 and 35 mm. These experiments demonstrated that the variation in running, due to pressure, increases with the lowering of the temperature. The mean variation in passing from

15°	to	0°	was	2.84	sec.	or 1° = 0.19 sec.
30	"	15	"	0.09	"	" 1 = 0.006
30	"	0	"	2.93	"	" 1 = 0.09

24 chronometers were then observed at 15° and subjected to successive pressure increases of 100 mm. The mean variations in running, corresponding to a variation of 100 mm in pressure, were:

Between	35	and 135 mm	1.92 sec
	135	" 235	1.86
	235	" 335	1.93
	335	" 435	1.82
	435	" 535	1.69
	535	" 635	1.46
	635	" 735	0.97

We find that the variation in running is proportional only for low pressures, or 0.019 sec per mm between 35 and 435 mm.

Since the running is accelerated from 0.97 to 1.69 sec. in 24

hours in passing from 735 to 435 mm (or an altitude of about 4800 meters), the correction to be made in the running of the chronometer is much smaller for the pressure than for the temperature.

It is therefore absolutely necessary in using chronometers on aircraft to protect them from temperatures much below $0^{\circ}C$ either by some special warning device or by carrying them on the body, protected from the outside air.

These tests were made with the greatest care at the "Observatoire National de Besancon" by Mr. Hérique and constitute a valuable contribution to the study of the effect of temperature and barometric pressure on chronometers of precision.

Translated by the National Advisory Committee for Aeronautics.