

Isochronism (1): As a Keyword of Japanese Mechanical Horology

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This paper is an English version of the first technical lecture that has been serialized four times since 2000 in the Journal of the Horological Institute of Japan. Twenty years after the original publication, the reason why I created the English version is to tell the world that the attitude toward «isochronism» shows the uniqueness of Japanese watch engineers. I think that the reason why they emphasized «isochronism» in the theory of mechanical watches is that «isochronism» has evolved independently in Japan and has achieved good results. And, through all four technical lectures, I would like to convey what kind of content is being educated to engineers and further applied to precision adjustment by watchmakers.

本稿は、日本時計学会誌に2000年から4回連載された技術講義1)2)3)4)の第1回を英語版として発行するものである。オリジナルの発行から、20年を経て、私が英語版を作成した背景としては、「等時性」に対する姿勢が日本の時計技術者のユニークさを示すものだと世界に伝えるためである。彼らが機械式時計理論の中でも「等時性」を重要視した理由として、「等時性」が日本で独自に進化し、成果を上げてきたからだとは私は考えている。そして、全4回の技術講義を通じて、私はどのような内容が技術者へ教育され、さらに、時計師による精度調整に応用されているのかを伝えていきたい。

Abstract

In this chapter 1, the fundamental equation of vibration for the free damped case and its power consumption are described. The consumption power of the balance-spring system should be regarded as the solid friction resistance of the pivot of the balance staff and the viscous resistance of balance wheel rotating in the air. Moreover, the relationship between the Q value which represents the goodness of the vibration system and the frequency of vibration, effect of high vibration frequency and the improvement of wearing accuracy are described. In chapter 2 in the next book, basic theory of isochronism, the nonlinearity portion of hairspring action. In chapter 3, explanation of isochronism of horizontal positions, mainly based from the outer end fixation of hairspring. In chapter 4, explanation of the isochronism of vertical positions based on the unbalance moment of inertia of balance wheel and the inner terminal fixation of hairspring. Weighing method of middle place of hairspring is explained here.

第1章(本稿)においてはテンプひげ系の振動系の基本的な表現を自由減衰振動とそれに要するエネルギー、および振動系の良さ Q に関しても学ぶ。さらに、次回、第2章においては等時性の基本、主としてひげの内外端の影響の扱い方を学び、外端の影響の詳細に関して学ぶ。第3章ではひげぜんまいの外端、第4章では姿勢差に関する理論、ひげ内端のテンワの片重りの影響、およびひげの重り付けの理論について解説した。

1. Characteristics of the balance-spring system

Since the balance-spring system is a speed regulator for the watch, the constant vibration period is the main purpose and the main characteristic. Especially the isochronism that means mainly the relations with amplitude of the balance spring system and vibration period is the main problem for explanation here, but first, we overview the various characteristics of the vibration system. The various characteristics are listed below.

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