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UNITED STATES PATENT OFFICE.

CHARLES EDOUARD GUILLAUME, OF SEVRES, FRANCE, ASSIGNOR TO SOCIETÉ DES FABRIQUES DE SPIRAUX RÉUNIES, OF PETIT-SACONNEX, SWITZERLAND.

COMPENSATING BALANCE SPRING FOR CHRONOMETERS AND WATCHES.

No Drawing. Application filed December 22, 1920. Serial No. 432,608.

To all whom it may concern:

Be it known that I, CHARLES EDOUARD GUILLAUME, a citizen of the Swiss Republic, and resident of Sevres, Seine-et-Oise, France, have invented new and useful Improvements in Compensating Balance Springs for Chronometers and Watches, of which the following is a full, clear, and exact specification.

In the specification of my United States Letters Patent No. 1,106,206 and No. 1,106,207, dated August 4, 1914, I have described a compensating balance or hair-spring which, when associated with a continuous or unsplit balance, give to watches fitted therewith a partial compensation for variations of temperature to the extent that, in the case of successful castings or tappings, such watches possess the same rate of movement at two temperatures, for example 0° and 30°, but at intermediate temperatures gain to a degree which may attain from 20 to 25 seconds per day. Furthermore, in the specification of my United States Letters Patent No. 1,313,291, dated August 19, 1919, it is shewn that it is possible, by using an alloy sensibly different from that described in the earlier specification, to obtain balance springs which ensure that watches fitted therewith shall have the same rate of movement not only at two temperatures, but at all temperatures comprised within considerable limits, thereby eliminating the so-called "secondary error" inherent in chronometers. The alloys which enable these two results to be obtained belong to the same category of products of which the base consists of iron and nickel admixed, in the first case, with foreign bodies (manganese, chromium, tungsten, vanadium, carbon, etc.), indispensable both for their metallurgical treatment and for obtaining an elastic limit sufficient to ensure that balance springs made therefrom shall remain, during use, within the limits of their elastic deformation. In the second case the basic metals are admixed with heavy proportions (10 to 20%) of at least one metal capable of alloying in all proportions with the ferro-nickels.

Now it has been found, that it is possible to adapt the compensating capacity of balance hair springs to the range of temperatures principally available in practice, and to reduce sufficiently the secondary error of watches and chronometers, within the said range of temperatures, when the addition of chromium to the alloys of iron and nickel employed to the manufacture of hair springs (balance springs) and containing 27 to 45% nickel is reduced to 4 to 8%. The said alloys contain advantageously small additions of substances capable of raising their limits of elasticity, as for instance, tungsten, carbon, manganese, silicium and vanadium.

For example the alloy of a balance spring may have the following composition:

	Parts.
Iron	45 to 65
Nickel	30 to 38
Chromium	4 to 8
Tungsten	1 to 3
Carbon	0.5 to 1
Manganese and silicon together	0.5 to 2

In this composition for the 0.5 to 2 parts of manganese and silicon together there can be substituted 0.2 to 2 parts of vanadium or 0.5 to 3 parts of manganese, vanadium and silicon together.

The following shews a particularly advantageons composition for balance springs:

	Parts.
Nickel	33 to 35
Iron	53 to 61
Chromium	4 to 5
Tungsten	1 to 3
Carbon	0.5 to 1
Manganese and silicon	0.5 to 2

What I claim is:—

1. A compensating balance spring for chronometers and watches which has a compensating capacity adapted to the range of temperatures principally available in practice and reduces sufficiently the secondary error within the said range of temperatures, when employed with a continous balance, and is composed of an alloy of iron and nickel (the latter in the proportion of from 25 to 45 per cent) containing from 4 to 8 per cent of chromium.

2. A compensating balance spring for chronometers and watches which has a compensating capacity adapted to the range of temperatures principally available in practice and reduces sufficiently the secondary error, within the said range of temperatures, when employed with a continuous balance, and is composed of an alloy of iron and nickel (the latter in the proportion of from 25 to 45 per cent) containing from 4 to 8 per cent of chromium, 1 to 3 per cent

of tungsten, 0.5 to 1 per cent of carbon and 0.5 to 2 per cent of manganese and silicon (taken together).

3. A compensating balance spring for chronometers and watches which has a compensating capacity adapted to the range of temperatures principally available in practice and reduces sufficiently the secondary error, within the said range of temperatures, when employed with a continuous balance, and is composed of an alloy of iron and nickel (the latter in the proportion of from 25 to 45 per cent) containing from 4 to 8 per cent of chromium, 1 to 3 per cent of tungsten, 0.5 to 1 per cent of carbon and 0.2 to 2 per cent of vanadium.

4. A compensating balance spring for chronometers and watches which has a compensating capacity adapted to the range of temperatures principally available in practice and reduces sufficiently the secondary error within the said range of temperatures, when employed with a continuous balance, and is composed of an alloy of iron and nickel (the latter in the proportion of from 25 to 45 per cent) containing from 4 to 8 per cent of chromium, 1 to 3 per cent of tungsten, 0.5 to 1 per cent of carbon and 0.5 to 3 per cent of manganese, vanadium and silicon (taken together).

5. A compensating balance spring composed of an alloy consisting of from 45 to 65 parts of iron, 30 to 38 parts of nickel, 4 to 8 parts of chromium, 1 to 3 parts of tungsten, 0.5 to 1 part of carbon and 0.5 to 2 parts of manganese and silicon (taken together).

6. A compensating balance spring composed of an alloy consisting of from 45 to 65 parts of iron, 30 to 38 parts of nickel, 4 to 8 parts of chromium, 1 to 3 parts of tungsten, 0.5 to 1 part of carbon and 0.2 to 2 parts of vanadium.

7. A compensating balance spring composed of an alloy consisting of from 45 to 65 parts of iron, 30 to 38 parts of nickel, 4 to 8 parts of chromium, 1 to 3 parts of tungsten, 0.5 to 1 part of carbon and 0.5 to 3 parts of manganese, vanadium and silicon (taken together).

8. A compensating balance spring composed of an alloy consisting of from 33 to 35 parts of nickel, 53 to 61 parts of iron, 4 to 5 parts of chromium, 1 to 3 parts of tungsten, 0.5 to 1 part of carbon and 0.5 to 2 parts of manganese and silicon (taken together).

In witness whereof I have hereunto signed my name this 1st day of December, 1920, in the presence of two subscribing witnesses.

CHARLES EDOUARD GUILLAUME.

Witnesses:

JEAN BAPTISTE AMAND RITTER,

JOSEPH HÜTTERLI.