

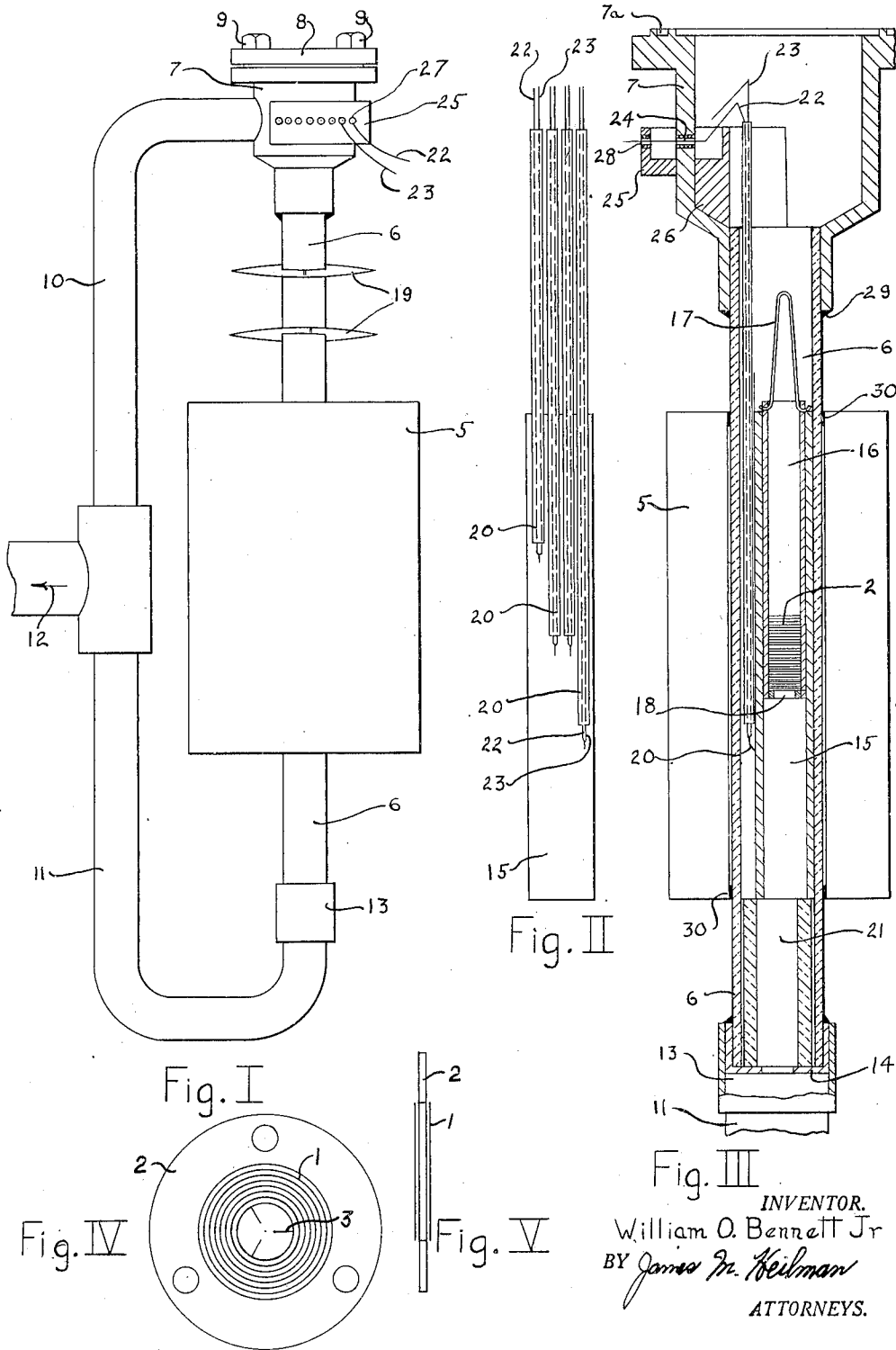
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HEAT TREATING DEVICE

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HEAT TREATING DEVICE

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This invention relates to improved means and method of heat treating metals.

An object of this invention is to provide new and improved means and method of heat treating and handling timepiece springs;

Another object is to provide means and method of controlling the surface condition of a metal during heat treatment of that metal;

Another object is to provide means and method of so heat treating a resilient metal member as to avoid oxidation and/or scale thereon and consequent introduction of variation in uniformity of the structure and of the resilience of the member.

Another object is to provide means and method for heat treating a corrosion resistant iron-nickel-chromium alloy without discoloring its surface;

Another object is to provide means for so heat treating an iron-nickel-chromium alloy as to set and harden it in form without discoloration of its surface insofar as the most careful scrutiny can determine;

Another object is to provide means and method of heat treating an iron-nickel-chromium alloy in a vacuum;

Another object is to provide means for heat treating timepiece springs in a vacuum;

Another object is to provide means for heat treating a group of timepiece springs together in one heat without discoloring the surfaces thereof; and

Another object is to provide an improvement in vacuum furnaces.

Other and further objects will be clearly apparent from the following specification and from the drawing.

Referring to the drawing:

Fig. I is an elevation of the vacuum furnace embodying this invention;

Fig. II is a partial detail of the furnace structure, illustrating the structure and positions of the thermocouples;

Fig. III is a vertical central section of the furnace of Fig. I, showing the vacuum chamber and tube with work holders therein;

Fig. IV is an enlarged plan view of a work holder showing springs mounted therein; and

Fig. V is a side elevation of Fig. IV.

It has been found extremely difficult to heat treat some metals without causing oxidation, scale or discoloration of the metal. In treating resilient members, such as springs, it is particularly important to keep the metal free from such

undesirable changes since they introduce a variation in structural uniformity and in resilience.

The slippage of the surface layers in the flexing of a spring loses in uniformity if the surface is broken up by oxidized patches or scale and the resilience of the spring consequently loses in uniformity. This is a great disadvantage in timepiece springs, where uniformity of resilience is a very important factor in the achievement of accurate timekeeping.

The appearance of timepiece springs is important, and it is for this reason that hairsprings have been treated to give them a blue color. This treatment has been necessary to cover the surface imperfections resulting from heat treatment.

In watch hairsprings made of an iron-nickel-chromium alloy it has been particularly difficult to maintain the metal surface free from scale and discoloration during a heat treating process to harden and set to form. One method has been to heat treat the springs in a gaseous atmosphere and since it is difficult to obtain a gas which is free from impurities such as oxygen or moisture or others, the result has been that the springs are discolored and given a very undesirable appearance.

Such heat treating of watch hairsprings has been relatively expensive due to the difficulty of properly loading and unloading the furnace and to the relatively small number of springs which could be handled in one furnace in a single heat due to the nature and construction of the furnace and the spring holders.

The device and method of this invention obviate the difficulties of the prior art in that the metal or watch hairsprings may be heat treated without surface discoloration, oxidation, or the formation of scale and consequent variation in structure and resilience and in that means is provided which is such as to make the loading and unloading of the furnace easy and simple and to make it possible to heat treat a large number of springs in one furnace in a single heat.

This is accomplished mainly by heat treating the springs in a vacuum and by using spring holders and furnace loading containers which permit the assembly of a great many springs in a small space.

The temperature used in heat treating hairsprings in this device is preferably from 1100° to 1250° F. and the vacuum achieved, through the use of a combination of a diffusion pump and a mechanical fore pump may be expressed

as less than 10^{-4} mm. of mercury. Different temperatures and degrees of vacuum are obtainable if desired.

More uniform heat treatment may be obtained by the use of the vacuum furnace of this invention rather than the prior art gaseous furnace since the heat is entirely radiated and there are no gases present which might form such paths of conduction or convection as would unevenly distribute the heat throughout the work enclosing chamber.

The purpose of this invention is also to provide a vacuum furnace in which the furnace loading head and opening is located in a section of the vacuum system which is insulated from the furnace heat.

The watch hairsprings 1, as illustrated in Figs. IV and V, are mounted in the opening of a perforated disc 2 which is designed for ease and efficiency of handling and furnace loading and for uniform and efficient presentation of the spring surface to the furnace atmosphere.

More than two springs may be mounted in a single disc of a thickness approximating the width of a single spring by intercoiling the springs so that their coils are overlappingly spiraled in a single plane.

Fig. IV illustrates the holder 2 having three springs intercoiled and mounted therein as evidenced by the three inner terminals 3.

The vacuum furnace of this invention includes a furnace housing 5, a vacuum chamber housing 6 having a central portion lying within the furnace and a portion extending beyond the furnace at each end thereof, a loading head 7 having a removable cover 8 held on the loading head 7 in vacuum tight relation therewith by bolts 9, and vacuum leads 10 and 11 made preferably of seamless tubing. The cover 8 has circular depressions therein to match circular raised portions 7a on the loading head 7, with rubber inserts in the depressions, in order to produce a vacuum seal between the head 7 and cover 8, or other suitable vacuum seal producing means may be used.

The vacuum is created by drawing simultaneously from both ends of the vacuum chamber housing 6 through the vacuum leads 10 and 11 and to a diffusion pump and a mechanical force pump as indicated by the arrow 12.

The furnace housing 5 is cylindrical in shape with a standard furnace heating unit surrounding a central longitudinal opening therein and the vacuum housing 6 is in the form of a hollow cylinder lying within the central opening of the furnace housing.

The vacuum housing 6 is preferably made of a material which is vacuum tight at high temperatures and a poor conductor of heat, such as fused silica. The material must be such as to retard the passage of heat by conduction to the loading head 7 and vacuum leads 10 and 11. The heat retardation is aided by lightweight relatively thin cooling fins 19 mounted on the furnace housing 6 between the furnace and the loading head 7. The fins 19 also protect the loading head 7 from heat of radiation and convection of the furnace.

With this arrangement an important advantage is accomplished in that the vacuum leads 10 and 11, as well as the vacuum pumps and their supports and all of the joints and connections between the furnace and the pumps and around the pumps, may be made with regard only to the characteristics necessary to

produce the vacuum and with disregard of the problem of heat.

Also the furnace of this invention has the advantage that its loading head 7 is insulated from the heat of the furnace and is consequently not subject to the difficulties of maintaining a vacuum seal during expansion and contraction of the separate parts. A good vacuum seal is obtainable between the loading head 7 and its cover 8 mainly because the head 7 is insulated against conducted heat by the heat retarding member 6 and against heat of radiation and convection by the cooling fins 19.

With this arrangement, the loading head may be conveniently opened and closed indefinitely without varying the efficiency of the vacuum seal.

The lower vacuum lead 11, at its juncture with the vacuum housing 6 has a collar 13 with a bracket sleeve 14 therein on which the lower end of the quartz vacuum housing 6 is rested, and the housing 6 is vacuum sealed to the collar 13 with "dekhotinsky" or other low vapor pressure cement which may be applied by heating.

A container 15 is positioned within and at least partly spaced from the vacuum housing 6 to provide room for thermocouples 20 and is supported on a ceramic insulating supporting sleeve 21 which in turn rests on the bracket sleeve 14 as a support. The container 15 uniformly absorbs and distributes the heat from the surrounding heating unit. The container 15 must be of a material no component of which will sublime, and which is a relatively good conductor of heat, not subject to oxidation and generally resistant to vacuum furnace conditions. The material preferably used in the device of this invention is nickel although other suitable materials generally resistant to heat in a vacuum may be used.

The work holding rings 2 are held in vertical alignment with each other within the furnace by a work tube 16, which is a relatively thin sleeve formed preferably of nickel or other material of the characteristics required for the container 15 and fitting closely within the container 15 and readily removable therefrom. The work tube 16 is suspended within the furnace by the bearing of the ends of a lifter wire 17 on the top edge of the container 15. The diameter of the work holding rings 2 is such that the rings lie horizontally flat and have a relatively close fit inside of the work tube 16.

The work holding rings are held in the work tube 16 by the action of their own weight against an annular stop ring 18 secured to the inner wall of the work tube 16 adjacent its lower end. The dimensions of the work holding ring 2 and the stop ring 18 are such that no part of the springs 1 comes in contact with the stop ring 18.

Consequently when a group of the work holding rings 2 are assembled in the work tube 16 as shown in Fig. III, the springs 1 are all in vertical alignment with no support or other foreign object between them and there is a direct and continuous opening extending centrally through the group because of the central openings in the spring windings illustrated in Fig. IV as that opening into which the inner terminals 3 of the hairsprings extend.

The stop ring 18 is also centrally open as are both ends of the work, heating, and vacuum housing tubes 16, 15, and 6, so that all of the springs 1 are centrally and directly in the vacuum atmosphere with no interfering objects. Consequently uniformity of heat treatment is

accomplished to a high degree, particularly since the stop ring 18 is so located as to hold the work rings 2 in the vertically central portion of the furnace where the heat is designed to be most uniformly distributed and constant. The actual heating conditions are readily checked by the thermocouples 20.

The springs 1 may be dimensioned with respect to and positioned in the ring 2 in any desired relation to the thickness dimension of the ring. They may be flush with, below, or above the top and bottom surfaces of the ring, as desired. In Fig. V the springs extend above and below. In some instances it is desirable to mount several groups of interwound springs, such as the group of three shown in Fig. IV, in aligned relation with each other within a single ring, much in the same manner that the rings themselves are mounted in the ring tube 16 of Fig. III, and this may readily be done without affecting the efficiency of the furnace or the uniformity of the heat treatment.

The ring tube 16 may readily be removed from the furnace by removing the loader head cover 8 and pulling the tube out by the lifter wire 17. The rings 2 are loaded in the ring tube 16 outside of the furnace.

The rings are put into the furnace and the cover 8 vacuum sealed and the air pumped out until a high degree of vacuum exists in the housing 6. The furnace is then heated and the pumping continued until the further desired degree of vacuum is achieved, and the heating is thereafter continued until the springs are properly heated, after which the furnace is allowed to cool before the springs are removed.

When the springs are ready to be removed from the furnace, the cover 8 is forced off by jack screws or similar suitable means.

Prior to the heat treatment the springs and their holders are carefully cleaned so as to avoid introducing impurities into the vacuum chamber. After the springs have been removed, the cover 8 is immediately replaced and a partial vacuum retained preparatory to heat treating the next group of springs.

The nature and arrangement of the spring holders, springs, and the furnace is such that upwards of 3000 watch hairsprings may be simultaneously heat treated without loss of efficiency or quality and uniformity of the heat treatment. The furnace is preferably about two feet long and the central ten inches is the section in which the springs are preferably located for most uniform heat treatment.

As illustrated in Figs. II and III, thermocouples 20 are positioned within the vacuum chamber housing 6 and outside of the container 15. Since the furnace is so designed as to provide the most uniform heat in the central vertical section of the furnace the thermocouples 20 are located at the extreme and intermediate portions of that central section to provide a check on the actual furnace heat at any given time.

The thermocouples each consist of a pair of wires 22 and 23 held separated and insulated by a ceramic lead 24. At their lower ends, the wires are joined and placed in contact with the container 15 and at their upper ends are separately insulated and led through the wall of the loading head 7 to their temperature indicating instruments.

The insulator leads of the thermocouples 20 terminate within the loading head 7 and the

wires 22 and 23 are provided with free portions beyond the end of the insulator to allow for expansion and contraction.

An opening is provided in the wall of the loading head 7 for each of the wires 22 and 23 and each wire is embedded in a glass insert 24 which is held in its opening by "dekhotinsky" or other suitable vacuum cement. In order to firmly hold each wire in place and to provide positive insulation of the thermocouple wires from the loading head 7 an angle piece 25 is mounted on the outside and a similar angle piece 26 is mounted on the inside of the loading head 7.

The outer angle piece 25 has an opening 27 in its vertical wall for each of the thermocouple wires, with each wire being embedded in a glass insulator 28 held in the opening 27 by "dekhotinsky" or other suitable cement.

The recesses formed by the angle pieces 25 and 26 with the wall of the loading head 7 are loaded with "dekhotinsky" cement and the thermocouple wires are embedded in this cement before and after they pass through the wall of the loading head 7. The thermocouple wires may be thus held in the head 7 because it is insulated and remains cool during the furnace operation. This arrangement permits a ready check on the furnace temperature without disturbing the vacuum of the furnace or breaking the vacuum seal of the cover 8 to the loading head 7, and also provides positive insulation of the thermocouple wires from the loading head 7 and means for holding the wires in position while providing leeway for expansion and contraction of the wires and thermocouple leads during the operation of the furnace.

It is to be understood that in all instances herein of reference to the use of "dekhotinsky" cement, any other suitable low vapor pressure cement which may be applied by heating, may be used.

Such cement is used to vacuum seal the housing 6 to the loading head 7, as at 29, and furnace cement is used to heat seal the furnace housing 5 to the housing 6 as at 30. The latter seal is necessary since the central opening of the furnace housing 5 is purposely made sufficiently larger than the housing 6 to permit expansion and contraction of both mentioned housings during the furnace operation, and to keep furnace convection currents down and maintain the efficiency of the furnace.

The furnace of this invention is particularly designed for precipitation hardening of time-piece springs made from age hardenable material of the type which will satisfactorily set and harden in desired form under the process of slow heat rise, steady application and slow cooling within the furnace.

The use of "dekhotinsky" cement at the various cold joints throughout the apparatus provides an important advantage in the matter of repairs or replacements, since it is a simple matter to heat the cement and separate the joined parts.

An important feature of this invention is that corresponding parts of the several springs are uniformly heat treated, and that watch hairsprings maintain their natural fine, silver-like finish throughout the heat treatment to such an extent that the closest scrutiny cannot detect a difference.

What I claim is:

1. In a furnace for heat treating watch springs, a fused silica vacuum chamber housing extending

through and beyond the furnace, a container within the vacuum chamber housing formed of a material no component of which will sublime and holding means adapted to so position said springs within said container as to present a direct and continuous opening through the springs, the container, and the vacuum chamber housing.

2. In a furnace for heat treating watch springs, a fused silica vacuum chamber housing extending through and beyond the furnace, a nickel container within the vacuum chamber housing, and support means within said container adapted to so maintain a group of spring holders therein as to present a direct and continuous opening through the springs, the container and the vacuum chamber housing.

3. In a furnace for heat treating watch springs in a vacuum, a vacuum chamber housing of heat retarding material extending through and beyond the furnace and supported by a vacuum lead of heat conducting material a member of heat retarding material in said vacuum chamber housing, and a container within said vacuum chamber housing and supported by said member.

4. In a furnace for heat treating watch springs in a vacuum, a vacuum chamber housing of heat retarding material extending through and beyond the furnace and supported by a vacuum lead of heat conducting material, a container within said vacuum chamber housing and supported by a member of heat retarding material located within said vacuum chamber housing, and support means within said container adapted to so maintain a group of spring holders therein as to present a direct and continuous opening through the springs, the container and the vacuum chamber housing.

5. In a furnace for heat treating delicate metallic objects, a fused silica vacuum chamber housing extending through and substantially beyond opposing faces of said furnace, a nickel container tube lying within said housing coextensive

with said furnace and a vacuum tight loading head secured to one of the outer ends of said housing.

6. In a device of the character described, a cylinder-like furnace, a fused silica vacuum housing extending longitudinally through the body of said furnace and outwardly beyond each end thereof, a tubular fused silica supporting member lying within one of the outwardly extending portions of said housing, a tubular nickel container lying within said housing, supported by said supporting member and coextensive with said furnace body, a tubular nickel work holder adapted to lie within said container and to be supported thereby, a metal vacuum lead operably joined to each of said outwardly extending housing portions, a loading head in one of said leads adapted to provide an opening in alignment with said container through which said work holder may be placed within or removed from said container, thermo-couple lead openings in a wall of said loading head, and a cementing trough adjacent said openings and on each side of said wall.

7. In a furnace for heat treating watch springs, a fused silica vacuum chamber housing extending through and beyond the furnace, a container within the vacuum chamber housing formed of a material no component of which will sublime, a tube receivable in said container and spring holding rings stacked in said tube to present a direct and continuous opening through said springs.

8. In a furnace for heat treating watch springs, a fused silica vacuum chamber housing extending through and beyond the furnace, a container within the vacuum chamber housing formed of a material no component of which will sublime, a tube receivable in said container, holding rings, each retaining a plurality of watch springs stacked in said tube to present a direct and continuous opening through said springs.

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