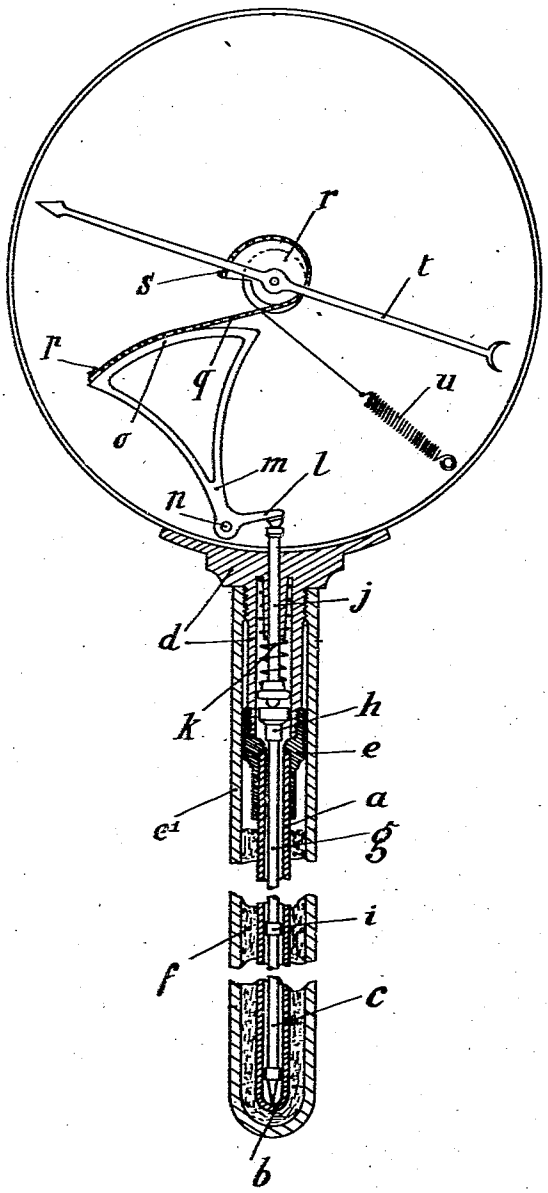
April 1, 1924. 1,489,116

P. CHEVENARD

ALLOY FOR STANDARDS EMPLOYED IN EXPANSION MEASUREMENTS AND THE APPLICATIONS THEREOF TO MEASURING INSTRUMENTS

Filed Aug. 16, 1921 2 Sheets-Sheet 1

Fig. 1



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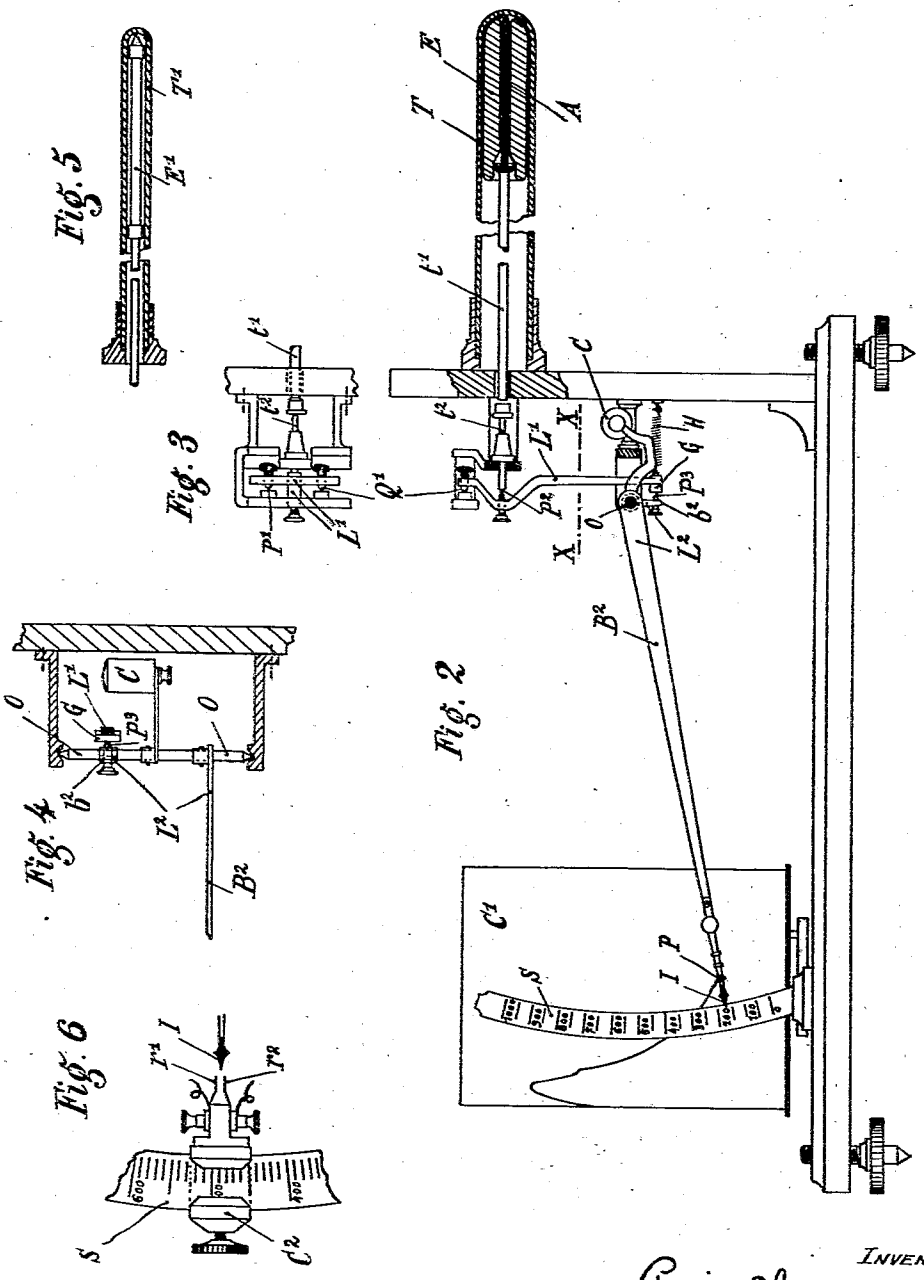
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UNITED STATES PATENT OFFICE.

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ALLOY FOR STANDARDS EMPLOYED IN EXPANSION MEASUREMENTS AND THE APPLICATIONS THEREOF TO MEASURING INSTRUMENTS.

Application filed August 16, 1921. Serial No. 492,786.

To all whom it may concern:

Be it known that I, PIERRE CHEVENARD, a citizen of the Republic of France, residing in Imphy, Nievre, France, have invented new and useful Improvements in Alloys for Standards Employed in Expansion Measurements and the Applications Thereof to Measuring Instruments (for which I have applied for a patent in France February 10, 1920), which is fully set forth in the following specification.

It is a recognized fact that the pyrometers of the expansion type, or dial pyrometers which were formerly used for the measurement of high temperatures, possessed in spite of their obvious qualities such as simple construction, solidity, and the like, a capital drawback which led to the complete disuse of the said apparatus. This result was due to the improper choice of the substances whose relative expansion was employed to effect the measurement of the temperature. Metals were employed which were subject to oxidation and were obviously viscous when heated, and were subject to polymorphic transformations—always affected by hysteresis—or were susceptible of undergoing when submitted to the prolonged action of high temperatures, a physico-chemical modification of a continuous nature which caused a considerable change in their expansion values.

As a result of numerous experiments, the applicant has succeeded in producing an alloy which possesses the following essential properties such as are necessary for all pyrometric standards.

1. The curve of expansion is absolutely reversible being entirely exempt from anomalous features and is therefore susceptible of being expressed by a simple algebraic formula.

2. Absence of thermal reaction effects.

3. The alloy is not subject to chemical change and it possesses a great mechanical rigidity at high temperatures.

4. Exact preservation of the initial physical properties after a long exposure to high temperatures.

The alloy according to this invention which possesses all the above-mentioned qualities has the following composition:

	Per cent.		
Nickel or cobalt	90	to	70
Chromium	10	to	25
Tungsten	0	to	5
Carbon	0.2	to	0.6
Manganese	1	to	3

If necessary, the tungsten may be replaced by an equivalent quantity of molybdenum, and the said alloy may if required have added thereto: vanadium 0 to 1%; titanium 0 to 5%; uranium 0 to 0.5%; boron 0 to 0.5%; zirconium 0 to 0.5%, for the purpose of facilitating the metallurgical elaboration.

By the combined action of the chromium, manganese, carbon and if required, tungsten, etc. the point of transformation of the nickel or cobalt is reduced considerably below the ordinary temperature, whereby the alloy is entirely exempt from thermic anomalies. The expansion curve is quite reversible and may be expressed with the greatest exactness by a parabolic formula. The chromium and the tungsten confer upon the alloy a great resistance to oxidation and a considerable rigidity, even at a red heat. On the other hand, as shown by numerous tests, the initial expansion value of the alloy remains unchanged after several thousand heating operations at 1000° to 1100°.

Concerning the various interesting applications of the alloy according to this invention, the following may be given by way of example: the use of the said alloy either in the pyrometers employing the expansion principle and of the dial type, or of the recording type, the said pyrometers comprising an amplifying mechanism which constitutes one of the particular features of this invention; the use of the alloy for limiting the effects of heat or in a thermostatic regulator adapted to act automatically by reason of a special contact device.

The following description, together with the accompanying drawings which are given by way of example, sets forth various applications of this invention.

Fig. 1 a front view, partially in section,

of the dial pyrometer constructed according to this invention. Fig. 2 is a side view, partially in section, of a recording pyrometer of the expansion type. Fig. 3 is a plan view of the amplifying mechanism. Fig. 4 is a section on the line X—X Fig. 2. Fig. 5 is a section of a device adapted to be combined with the said amplifying mechanism in order to constitute a thermic recorder. Fig. 6 is a detail of a modified form of the recording apparatus in order to enable the same to act as a heat limiting device or a thermostatic regulator.

The measuring apparatus which comprise the use of a standard constituted by the above-mentioned alloy possess the advantage of the small expansibility and the mechanical rigidity of melted silica when in the hot state, and on the other hand the dilatometric qualities of the said alloy.

The apparatus comprise in general the following essential parts:

A tube formed of silica and closed at one end.

A standard rod of the special alloy which is disposed within the said silica tube and enters in contact with the end of the same.

A silica rod which is disposed within the tube and is held pressed against the standard piece by a spring.

An amplifying device.

Upon introducing the closed end of the tube into the heated region, the silica rod undergoes, with reference to the outer tube a displacement which is equal to the thermic expansion of the standard as compared with that of melted silica, and this displacement, which is amplified by a suitable device, serves to measure the temperature which is reached by the standard. When provided with the above-described device, the former pyrometer of the dial type will now constitute a measuring apparatus of substantial construction, not subject to change, inexpensive, and possessing a remarkable exactness and reliability throughout the whole range of temperatures below 1100°.

As shown in Fig. 1, the dial pyrometer essentially comprises a silica tube *a* closed at one end *b* and containing the standard rod *c* formed of the above-mentioned alloy which enters in contact with the end *b* of the silica tube. The tube *a* is connected with the frame *d* of the instrument by a sleeve *e* of invar metal, for instance, and is protected against shocks by an outer or inclosing tube e^1 of non-rusting metal which is sufficiently rigid in the hot state, the annular interval between the inclosing tube e^1 and the silica tube *a* being filled with carded asbestos *f* which however is but slightly packed. A silica rod *g* disposed in the lower part of the silica tube *a* is terminated by a tempered steel cap *h* which bears against the plane end surface *i* of the standard *c*. Against the cap *h* is caused to bear the impelling rod *j* which is driven downwardly by the spring *k* thereby maintaining the contact between the said rod and the cap *h*.

The other end of the rod *j* enters in contact with the arm *l* of a bell-crank lever pivoted at *n* whose other arm *m* ends in a quadrant *o*. About the latter is disposed the chain *q* whereof one end is secured at *p* to the said quadrant, the chain being wound about the spiraloid drum *r* to which the said chain is secured at *s*. The axle of the drum *r* carries the indicating pointer *t*. When the outer tube of the pyrometer is introduced into the region whose temperature is to be measured, the expansion of the standard piece causes the lever *l m* to pivot upon its axle *n*, and this movement is transmitted to the pointer *t* by the chain *q*; the shape of the drum *r* is such that the expansion of the standard, which is a quadratic function of the temperature, shall produce an angular displacement of the pointer which is proportional to the variations of temperature. The contact between the small arm of the lever *l* and the end of the rod *j* is afforded by a spring *u* which acts for instance upon a drum *v* secured to the said pointer, by means of a chain or flexible wire.

Another use of the alloy according to this invention consists in the application thereof to apparatus for thermic analysis. The apparatus of this class hitherto in use for investigation of the transformations of alloys have been rudimentary instruments which will indicate only the most apparent critical points, or laboratory apparatus of a complex and expensive nature which require a special installation and careful use by highly skilled persons.

This invention relates to an apparatus for thermic analysis of a simple and substantial character and reliable operation, which may be installed in a summary manner and which even if placed in the hands of persons of ordinary skill will afford the most satisfactory results. By reason of the simple construction of the device, it may be produced at a moderate cost. Owing to the above-mentioned qualities, the new apparatus is suitable for exact researches carried out in testing or instruction laboratories as well as for industrial determinations whose principal object is to afford a guide for tempering operations by a continuous observation of the thermic properties of the metals under treatment.

The said apparatus will automatically record the curves of the variation of temperature with reference to the time, during the heating or cooling of a specimen of metal. The thermic phenomena which accompany these allotropic transformations are shown upon the curves by straight por-

tions or at least by an abnormal appearance. All other conditions being equal, these abnormal appearances will be made more evident, and the method is consequently more sensitive, when the record is of a clearer nature. By reason of the use of a pyrometer of the expansion type whose standard is constituted by the above-described alloy, the apparatus which will be set forth hereunder is entirely insensible to jarring or vibrations, and will furnish records of the greatest regularity, wherein the smallest anomalies of a thermic nature are put in evidence in the most positive manner.

The specimen under investigation, E, Fig. 2, consists of a cylinder having formed therein, upon the axis, a narrow cylindrical passage wherein is engaged with easy friction the pyrometric standard A which is made of the special alloy. The said standard has the form of a fine needle having at one end a flat head and at the other a rounded point. The specimen E is disposed within a tube formed of melted silica T; the point of the needle A enters in contact with the end of the said tube. If the temperature of the sample E is caused to vary by means of a suitable source of heat, the needle A by reason of its small mass will participate in all the thermic fluctuations of the metal block wherein it is situated.

The thermic expansion of the said needle which is communicated to the exterior of the tube T by a silica rod t^1 extended by a steel sliding or impelling member t^2 is transmitted by the lever L^1 to a bent lever L^2 which serves to amplify the same. The lever L^1 is a lever of the second class and is movable about a horizontal axis which is determined by the two points P^1 Q^1—coinciding in projection in Fig. 2—and the outer end of the lever is provided with a small disk of tempered steel G whose highly polished surface is situated in the plane of the points P^1, Q^1, P^2. The bent lever L^2 which is formed by the arms B^2, b^2 is movable about the horizontal axle O. The rounded point P^3 situated at the end of the small arm b^2 is caused to bear upon the plane surface of the small disk G. The recording pen P is disposed at the end of the large arm B^2, whose weight is partially balanced by a counterweight C. The weight of this latter is such that the pressure of the point P^3 upon the small disk G shall not exceed 50 grammes. The proper contact of the points P^1, Q^1, P^2 is maintained by a spring H.

The expansion of the pyrometric needle which is transmitted by the rod t^2 to the point P^2, produces a movement from right to left of the small disk G and consequently a rotation of the bent lever L^2 about the axle O, whereby the said record pen is caused to rise. By the combination of the two levers L^1, L^2, the said pen is given a displacement which is a hundred times that of the said needle. The long arm B^2 of the lever which is pivoted at O, carries a pen P as well as a pointer I.

The said pen produces the record upon a sheet of curve paper which is wrapped about a chronographic cylinder C^1. The curves showing the temperature with reference to the time are produced by the combined movements of the pen and the cylinder. When compared with the forces which enter into action in the phenomena of expansion, the inertia of the amplifying devices is absolutely negligible, and for this reason the variations of temperature, even the most rapid, are recorded in an instantaneous manner. The shocks or jarring movements, often of a violent nature, which are of frequent occurrence in metallurgical establishments, are absolutely without effect upon the operation of the apparatus. In fact, the device is found to work in the normal manner when situated at a short distance from a steam hammer under full operation. The pointer I moves before a quadrant S provided with a thermometric graduation which is calculated according to the expansion formula of the alloy constituting the pyrometric standard, or it may be empirically established. This device affords a means of ascertaining at each instant the temperature of the said specimen and therefore of checking the operation of the apparatus. The quadrant S will also supply the place of curve sheets provided with a special graduation.

The heating apparatus may be either an electric furnace or a set of burners employing gas, gasoline, heavy oil or the like. In order to obtain in this latter case a uniform temperature throughout the entire mass of the test specimen, it is advisable to dispose a metal muffle about the silica tube, for instance a muffle of nickel.

Aside from its use for the thermic analysis of metals, the apparatus hereinbefore described with reference to Figs. 2, 3 and 4 may be employed to record with reference to the time, the variation of temperature of any desired region. In this case the silica tube T is replaced by a narrower tube T^1 of the same substance as and similar to the tube b of the dial pyrometer Fig. 1. The tube T^1 contains a pyrometric standard E^1 formed of the special alloy above described and of the same character as the standard c Fig. 1. The apparatus is so disposed that the closed end of the tube T^1 shall be engaged in the region whose temperature is to be determined. The extent to which the device is inserted may be as desired, provided the standard shall be situated in a region which is uniformly heated. The length of the tube T^1 may reach 1 to 2 meters without inconvenience, but in this case it is essential to protect the same

mechanically by means of an inclosing tube of a special alloy which is rigid and is not subject to oxidation at high temperatures, as indicated for the dial pyrometer described with reference to Fig. 1.

Different degrees of sensitiveness may be obtained by the use of a set of tubes T^1 and of standards of different lengths. The entire height of the cylinder may for instance be made to correspond to a small range of temperature about a mean temperature which is previously determined. By reason of the sharpness of the record, thermic fluctuations of very small amplitude such as 1 or 2 degrees may be determined. For the purpose of increasing the number of scientific and industrial applications of the apparatus, the construction may be modified in such manner as to provide a tube T^1 which may be vertical, horizontal or inclined.

By the use of an additional operative member, the above-mentioned apparatus is susceptible either of automatically stopping the heating action at a previously determined point, thus constituting a limiting device for heating effects, or of maintaining the temperature of a given space within narrow limits, thus constituting a thermostatic regulator as shown in Fig. 6.

A slide C^2 is moved along the graduated quadrant S and is adapted to be secured at any desired point. The said slide has disposed thereon one or two flexible contact strips r^1, r^2, which are electrically insulated from the main body of the apparatus and are so disposed as to enter in contact with the pointer I which is provided at the end of the large arm B^2 of the lever L^2 during the movement of the latter. It is evident that the contacts r^1, r^2 may be employed to close the circuit of an electric current through a device used to cut off the heating effect or to modify the value of the same. When the apparatus is operated as a thermostat, the temperature varies between the limits corresponding to the position of the contact strips r^1, r^2, and may therefore be maintained at a constant value within a few degrees.

The forces of expansion being considerable, a relatively high pressure of contact may be used without causing any disturbance in the operation of the pyrometer. Electric contacts are thus absolutely sharp, and may be employed for currents of considerable value which are susceptible of operating various regulating devices of a certain power without intermediate relays. The apparatus for thermic analysis provided with a temperature limiting device is adapted to operate in an entirely automatic manner—heating to a determined temperature and then cooling at a determined speed—and without any attention, this being an essential advantage for an industrial apparatus for temperature control. The temperature recording apparatus, provided with a thermostatic regulator will render important services in laboratory research as well as in industrial operations, for instance in the chemical industries, for thermic treatment, and the like.

It is understood that this application is not limited to the hereinbefore described devices, and that these are susceptible of all required modifications, and particularly as concerns the amplification of the expansion displacements resulting from the heat, without departing from the spirit of this invention.

Having thus described the nature of my said invention and the best means I know of carrying the same into effect, I claim:—

1. An expansion measuring device comprising a silica tube closed at one end thereof, an alloy rod constituting a pyrometric standard having as its special properties a perfectly reversible expansion exempt from anomalous features and an absence of thermal reaction effects, said rod being positioned in said tube and having one end thereof in engagement with the closed end of said tube, a silica rod having a portion thereof extending within said tube, means for maintaining said silica rod in contact with the standard rod, means for transmitting to the exterior of said tube, and amplifying, the relative displacements of the silica rod produced by the expansion of the standard rod with reference to the silica tube when the same is heated.

2. A registering expansion measuring apparatus as set forth in claim 1 in which the expansion of the alloy rod is indicated at the end of the tube by means of two bent levers.

3. A registering expansion measuring apparatus as set forth in claim 2 in which the lever receiving the movement of the rod to be studied is a lever of the second class movable around a horizontal axis.

4. A recording expansion measuring device as set forth in claim 3 in which the free end of the first bent lever carries a disk of tempered steel.

5. A registering expansion measuring device as set forth in claim 4 in which the second amplifying lever is movable around a horizontal axis and consists of two arms, namely, a large arm and a small arm.

6. A registering expansion measuring apparatus as set forth in claim 5 in which the large arm carries a registering pen and is partially balanced by a counterweight.

7. A registering expansion measuring apparatus as set forth in claim 6 in which the large arm of the lever also carries an index pointer.

8. A registering expansion measuring ap-

paratus as set forth in claim 7 comprising a spring for controlling the movements of the first amplifying lever.

9. A registering expansion measuring apparatus as set forth in claim 8 in which the indications of a needle are recorded on a sheet of paper surrounding a chronographical cylinder.

10. A device of the class described comprising, in combination, a tube having one end thereof closed, a pyrometric standard positioned in said tube and having one end thereof in engagement with the closed end of said tube, a rod having engagement at one end thereof with the opposite end of said standard interiorly of said tube, a second-class lever movably mounted adjacent the open end of said tube operatively engaging the outer end of said rod, a second counterweighted lever operatively engaging said first-named lever, and recording means positioned for engagement with said second lever.

In testimony whereof I have signed this specification.

PIERRE CHEVENARD.