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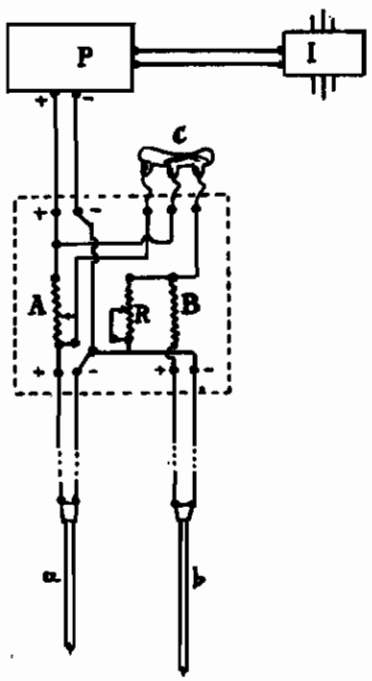


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# ALIEN PROPERTY CUSTODIAN

## DEVICES FOR REGULATING THE TEMPERATURE OF ELECTRIC FURNACES OF THE RESISTANCE TYPE

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In the electric furnaces of the resistance type, use is generally made of devices adapted for automatically cutting off the current from the heating devices when the desired temperature is attained at a given point in the furnace, and for again supplying the current when the temperature at this point again becomes reduced.

The arrangement which consists in selecting the place for taking the temperature at a point near the pieces or objects which are to be heated in the furnace at a given temperature, is well known and in current use, but although the temperature of the pieces is thus exactly regulated, the temperature of the heating devices is fixed only between this lower limit and an upper limit which depends upon the conditions of transmission of heat in the furnace between the heating devices and the pieces to be heated.

For this reason, the temperature variations of the heating devices of the furnace may often reach considerable values, and chiefly, for instance, when a protecting screen of refractory ceramic material is placed between the pieces to be heated and the heating devices of the furnace.

When the temperature is very high and is near the maximum admissible limit for a given alloy of which the heating devices of the furnace are made, any great and frequent changes of temperature will hasten the oxidizing of the alloy, and this latter will also be damaged.

In order to obviate this drawback, the place of taking the regulating temperature is sometimes selected at a point near the heating devices, whose operating temperature is thus fixed in a definite manner. This arrangement will provide for the maximum life of the heating devices, but it will not give any exact indication of the temperature of the pieces or objects to be heated, and the condition of thermal equilibrium between these pieces and the heating devices of the furnace requires a long time to establish. Accordingly, this method is only used in practice for continuous furnaces or for furnaces whose temperature is to be kept up for a long time.

The object of the apparatus according to the invention is to obviate the above-mentioned drawbacks.

For this purpose, and in conformity to the invention, use is made of two devices for taking the temperature, such as pyro-electric couples, one of which is placed near the pieces to be heated, and the other near the heating devices, as well as an external apparatus which is adapted to reduce, according to the temperature of the pieces and according to a predetermined formula, the maximum temperature which can be attained by the heating devices of the furnace, and the regulating of the temperature of the furnace is effected upon these latter.

This will provide for a very small temperature variation in the heating devices, and this will practically depend only upon the sensitiveness of the regulating pyrometer, while the difference of temperature between the heating devices and the pieces to be heated, which is a maximum at the start, will tend towards zero according as the pieces become heated.

According to one feature of the invention, use is made of two pyro-electric couples which take the temperature respectively at the heating devices and at the pieces to be heated, and which act upon two separate pyrometers, which might in fact be assembled in a single instrument. The furnace is regulated by the pyrometer used for the heating devices, which is arranged as a regulator. The pyrometer for the pieces to be heated will modify, by mechanical means acting upon the regulating part of the pyrometer for the heating devices, the temperature for which the temperature regulator comes into action, according to a predetermined formula, depending upon the measured temperature of the pieces.

In another feature of the invention, the two pyrometers are quite independent from a mechanical point of view, and the pyrometer for the pieces will modify the regulating of a potentiometer whose difference of potential is determined according to a given formula, depending upon the temperature of the pieces. The couple which shows, in units of electromotive force, the temperature of the parts, is connected in series with this potentiometer, and the regulating pyrometer measured the sum of these two values.

According to another feature of the invention, only a single pyrometer is employed, using as the formula for the temperature variations of the heating devices, the formula for the variations of the electromotive force of the couple showing the temperature of the pieces to be heated. These two couples, having the same characteristics, are connected in series, and the regulator measures the sum of the electromotive forces of these two couples.

According to another feature of the invention, the above-mentioned device is completed by a pyrometer for temperature regulation which is separately controlled by the couple showing the temperature of the pieces to be heated, in such manner that for a given temperature of said pieces, the regulation made upon the two couples

is cut off, and then restored if the temperature of the pieces becomes lowered. This is carried out by a series connection between two controlling contacts actuated by the two regulators, and the current supplied to the heating devices will depend upon the closing of these two contacts.

For the better understanding of the manner in which the invention may be carried into effect, reference is made to the accompanying drawing which shows a constructional form of a pyrometric device comprising two pyro-élevtric couples connectes in parallel.

The two couples *a* and *b* are located respectively near the pieces and the heating devices.

The said couples are connected in parallel through two resistances A and B, for a given position of the hand-operated or automatic switch C.

A leakage resistance R is connected to the terminals of the combination of the couple *b* and the resistance B.

The pyro-electric regulator P measures the difference of potential at the terminals of the resistance R, or at the terminals of the couple *a* alone, according to the position of the switch C, and when it operates, it opens or closes the circuit of the heating devices by its action upon the distant-control switch I.

The operating point of the regulator corresponds to the measurement, by the pyrometer, of the electromotive force produced by the couple *a* alone when the pieces are at the proper temperature, i. e., when the regulating pointer is placed, on the pyrometer scale, at the proper temperature to be obtained for the pieces.

The different ohmic resistances of the parts of the circuit are such that the regulator will operate, during the measurement made upon the two coupled together, when the temperature of the heating devices attains the maximum determined by the chosen regulating formula, while the regulating pointer remains in the position above mentioned.

If E and E′ are the electromotive forces produced by the respective couples *a* and *b*, and $E_1$ the electromotive force of the couple *a* corresponding to the adjustment of the regulator, the formula for regulation has the form:

$$E' = E_1 + KE_1 + p(E_1 - E)$$

The values of the two factors *p* and K depend upon the ohmic resistances of certain parts of the circuit, and they can be adjusted independently of one another by regulating the ohmic resistances in question.

When the charge in the furnace is being heated up, any possible overheating of the heating devices is determined at each instant by the product of the factor *p* and the difference of temperature between the maximum specified for the pieces and the actual temperature of these latter at the time of the control by the regulator, but taking due account of the formula for the action of the couples.

During the maintenance of the pieces at the proper temperature, the amplitude of the variations of temperature of the heating devices cannot exceed the fraction K of the temperature of the pieces, for instance 2% of this temperature.

In normal action, the switch C is in the position herein represented, and the measurement is made on the two couples together. When the said switch is placed in the other position, the pyrometer will show the temperature of the pieces.

The switch C may be operated:

*a*—Manually, in order to control the temperature of the pieces at all times;

*b*—Periodically, in order to provide successively for the regulation of the furnace according to the two coupled together, and then according to the couple used for the pieces, taken separately;

c—At the same time as the operating of the switch I, for the supply of the furnace, in order to put the heating devices out of use on the combination of the two couples, and to put them in use according to the sole temperature of the pieces.

*d*—Independently by the regulator, in such way that when it takes the position which is not shown, it will serve at the same time to put the heating devices out of use, and when it returns to the position indicated, this movement will put the heating devices in use after a certain time which is sufficient to allow a control by the regulating pyrometer to take place in the meantime on the combination of the two couples, thus acting for or against the order in which the heating devices of the furnace are again put in use.

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