This invention relates to improvements in and relating to the heat-treatment of metal objects, particularly pressed metal parts or stampings, such as, for example, pressure measuring elements, instrument springs, current-carrying springs, spring components and other parts of precision equipment.

When metal objects, such as pressed metal parts or stampings are heat-treated, subsequent to manufacture, for the purpose of precipitation hardening, tempering or stress-relieving, distortion of the objects is liable to occur due to the relief of residual stresses. In order to prevent, or minimize as far as possible, such undesirable distortion, it is usual to embed the objects to be treated in fine sand or to clamp them in metal jigs, specially made for the purpose, before introducing them into the heat-treatment furnace.

It has been found, however, that, for various reasons, neither of these procedures provides a really satisfactory answer to the problem. If the objects be embedded in sand, distortion cannot be entirely prevented owing to the fact that the sand does not provide a sufficiently rigid support or abutment for the objects, but allows a limited displacement of the metal to take place. Whilst the provision of jigs is effective to prevent such displacement and consequent distortion, the manufacture of such jigs, which have to be accurately made to close limits of tolerance, is itself expensive and considerably increases the cost of manufacture of the metal objects. Moreover, as the jigs themselves are of necessity of bulky section, considerable heat must be expended in raising them to the temperature of the heat-treatment furnace, which further adds to the cost.

The principal object of this invention is to overcome the above disadvantages and to provide a simple and efficient method of supporting and locating metal objects to be heat-treated, so as to prevent distortion thereof during taking place during such treatment. Another object of the invention is to provide an improved method for the heat-treatment of metal objects, which is more economical both from the point of view of the cost of operation and the avoidance of waste than are existing methods.

According to one feature of the invention, there is provided a method of pre-treating a metal object or metal objects, such as pressed metal parts or stampings, so as to prevent distortion thereof during subsequent heat-treatment, which comprises investing the said object or objects with a liquid slurry of cement-like refractory material which is hardenable in situ and allowing said slurry to set or harden to form a rigid coating around the said object or objects. According to another feature of the invention, there is provided a method of heat-treating metal objects, such as pressed metal parts or stampings, which comprises investing the said objects with a liquid slurry of cement-like refractory material, which is hardenable in situ, allowing the slurry to set or harden to form around the objects a rigid coating which prevents distortion thereof during heat-treatment, subjecting the so-invested objects to heat-treatment as required and subsequently removing the investment material from the heat-treated objects.

The metal objects to be invested are preferably placed in a suitable container, such as a metal tray or canister, depending on the size and type of objects in question, and a liquid slurry of investment material is then poured into the tray or canister so as to cover the objects and to fill out the intervening space between the said objects and the sides of the tray or the wall of the canister, as the case may be. The slurry is then allowed to dry and set to a solid condition, whereby the metal objects are immovably located and confined to an area defined by their own surface area by solidified investment material which tightly grips the said objects on all sides and effectively prevents distortion of the objects during subsequent heat-treatment thereof.

If desired, instead of using a tray or canister for supporting the metal objects, the latter may be placed in a mesh basket, for example of stainless steel, which is enclosed within a bag of impermeable material, such as polyethylene, or like plastic material, or waxed paper, which bag is a more or less tight fit around the basket. The investment material is then poured into the basket and, after the material has set, the basket is removed from the container, before the heat-treatment step. The use of such a form of container will be found greatly to facilitate the subsequent removal of the investment material and allow of the final operation of washing and pickling of the objects to be carried out without the necessity of handling them.

In carrying out heat-treatment of metal objects pre-treated in accordance with the invention, the container or basket, housing the invested objects, is placed in a suitable heat-treatment furnace, or other heating device, such as an oil bath or a bath of molten metal, wherein the objects are subjected to any predetermined required heat-treatment. After the treatment has been carried out, the container or basket is removed from the furnace and quenched in cold water, whereby the solidified investment material is fluidized and the object or objects free therefrom.

The heat-treated metal objects are now removed from the container or basket and subjected to vigorous washing and pickling so as to free them entirely of the investment material.

Any suitable refractory material, such as is commonly employed as investment material in "lost wax" casting processes may be used in carrying out the invention.

For example, a material composed mainly of plaster of Paris to which, if desired, may be added some silica in the form of cristoballite, such as a mixture of 30% plaster of Paris and 70% silica powder, will be found suitable for the purpose of the invention.

As will be readily appreciated, by means of the invention, there is provided a simple and efficient method of pre-treating and of heat-treating metal objects, which effectively ensures that no distortion of the objects shall take place during the heat-treatment and which is more economical than are existing methods.

I claim:

1. The method of heat-treating a plurality of metal objects, which comprises investing the said objects with a liquid slurry of an investment material composed of a mixture of plaster of Paris and silica, allowing said slurry to set and harden prior to the heat-treatment to form around said plurality of objects a single coating whereby said objects are immovably located and confined to an area defined by their own surface area by solidified investment material which tightly grips said objects on all sides and prevents distortion thereof during heat treatment, heat-treating the so-invested objects, and subsequently quenching such heat-treated objects in cold water to cause the said investment material to break away from the metal objects and soften to a wet slurry thereby effecting removal of the said material.

2. The method of heat-treating a plurality of metal
objects, which comprises placing the objects in a container, pouring a liquid slurry of an investment material composed of a mixture of plaster of Paris and silica into said container so as to cover said objects and to fill out the intervening space between the objects and the sides of the container, allowing said slurry to set and harden prior to the heat-treatment to form around said plurality of objects a single rigid body whereby said objects are immovably located and confined to an area defined by their own surface area by solidified investment material which tightly grips said objects on all sides and prevents distortion thereof during heat-treating the so-invested objects, quenching such heat-treated objects in cold water to cause the said investment material to break away from the container and from the metal objects therein and soften to a wet slurry, and then withdrawing said objects from said slurry.

3. The method of heat-treating a plurality of metal objects, which comprises placing the objects in a mesh basket, enclosing the basket within a bag of impermeable material, pouring a liquid slurry of an investment material composed of a mixture of plaster of Paris and silica into said bag so as to cover said objects and to fill out the intervening space between the objects and the sides of the bag, allowing said slurry to set and harden prior to the heat-treatment to form around said plurality of objects a single rigid body whereby said objects are immovably located and confined to an area defined by their own surface area by solidified investment material which tightly grips said objects on all sides and prevents distortion thereof during heat-treatment, removing said bag from said rigid body, heat-treating the objects invested in said body, quenching such heat-treated objects in cold water to cause the said investment material to break away from the said mesh basket and from the metal objects therein and soften to a wet slurry, and then withdrawing said objects from said slurry.

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