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INDUCTION HEATING METHOD

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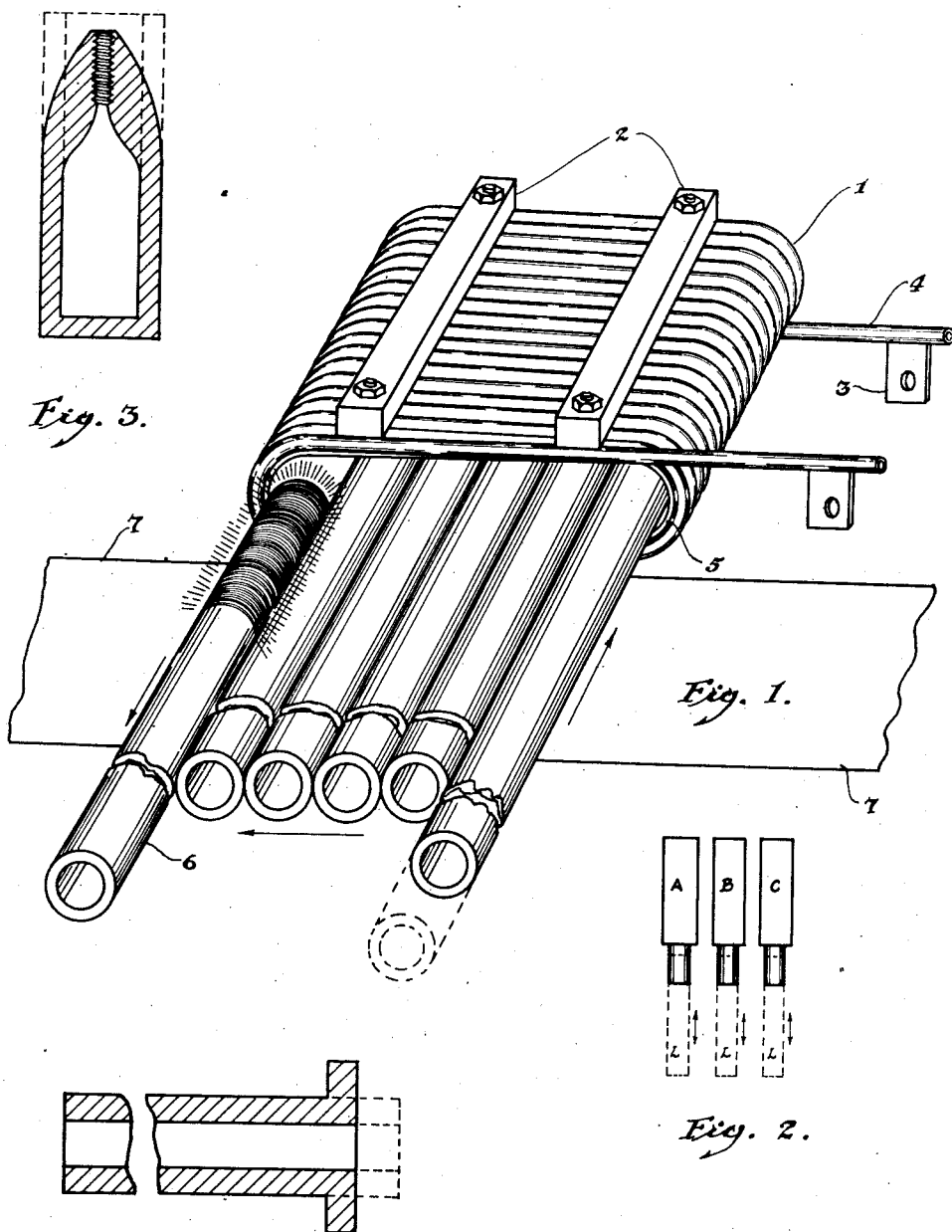


Fig. 4.

Fig. 2.

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INDUCTION HEATING METHOD

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2 Claims. (Cl. 219—13)

This invention deals with induction heating and has to do with methods and mechanisms useful in that art.

A purpose of the invention is to provide a method and apparatus for heating the ends of tubes, rods, bars or like charges for forging or for other purposes.

A further purpose is to provide a relatively simple method and apparatus for uniformly inductively heating the ends of attenuated or bulky charges with a minimum of handling effort.

Further purposes will appear in or be evident from the specification and the claims.

Four figures have been used to illustrate the invention.

Figure 1 is a perspective view showing one form of applicants' invention as applied to the heating of the ends of tubes.

Figure 2 is a diagrammatic view showing how tubes, as in Figure 1, have been heated heretofore by induction.

Figures 3 and 4 are cross-sectional views of an ordnance shell and a section of pipe shown as examples of charges that might be heated by the method described.

Heating of the ends of tubes, rods or like charges by induction has been accomplished heretofore and although the methods are successful and efficient the handling of the charge pieces is sometimes troublesome. In most such instances individual coils having good coupling with the charge pieces are used. The charge pieces are inserted in these and are heated to the desired temperature after which they are removed for working. Since the heating time required for a single charge is generally too long to fit into usual production schedules several coils are required, and the charge pieces are inserted and taken out of these in rotation to maintain the desired production speed. To effect such a continuous cycle it is necessary to jump the charge pieces over one another in feeding them to and in removing them from the proper heating coils. Any delay in the handling of a charge piece causes wide fluctuation in the temperature of the other pieces. When the articles to be treated are small in size or light in weight such a system is not unworkable, but where large tubes or bulky pieces are involved the handling becomes a major problem.

In applicants' invention the ends of the charge pieces are fed consecutively into one side of a long narrow coil opening to a depth approximate with the length of the part to be heated. After an initial heating in that location they are stepped

along in the coil where the heat has a chance to distribute itself in the pieces. They are then carried to the far side of the coil where they are raised rapidly to the working temperature and are removed for working. The pieces may be fed to and along the coil on a continuous belt or they may be fed into the coil proper by a crane. Once in the furnace they do not need to be handled again until they have been heated and are removed for working. Each piece, on entering the furnace, is subjected to induction about a large portion of its periphery and since the currents induced in it are circumferential the end may be heated at a rapid and uniform rate. If the charge piece is magnetic the heating rate is faster than if it is non-magnetic. As charge pieces are taken out of the coil the pieces remaining therein are rolled or are shifted toward the end position. When in the central portions of the coil the charge pieces absorb energy at a much slower rate due to the poorer coupling with the inductor. This allows for equalization of temperature differences. When the charge pieces arrive at the end of their travel in the coil they are again placed in good coupling with the inductor and are given the final boost to the working temperature. High temperature is not required to be maintained for a long period and trouble from scale is thus greatly reduced.

The method has been found to have great advantages over previous methods of heating. The rapid initial heating, the somewhat slower heating immediately following, and the rapid heating at the end insure overall speed, uniformity and efficiency of production. Almost all guesswork regarding temperatures is eliminated. The pieces come to temperature in a regular order and the temperature may be controlled automatically on all as a group. There is no such overshooting in temperature as can result when separate coils and rapid heating are involved. The furnace as a unit has substantially a constant loading at all times and the wide fluctuations usual when a single load is placed in a single coil or when that load becomes non-magnetic, cannot exist.

The handling becomes extremely simple. There is no jumping of one piece over another or a chance of error in selecting the wrong charge piece from a coil. In this invention the operation is always the same. A heated tube or charge piece is withdrawn from one position in the coil; the other charges are moved along to fill the empty space, and a new charge is inserted.

Applicants do not claim to be the first to use

long flat inductor coils as described in this specification. They do believe however that they are the first to step the charge pieces along in such a coil as and for the purposes specified. It has previously been suggested to use a long flat inductor coil having a plurality of fixed charge receiving positions but by such an arrangement the charge pieces nearest the end portions or sides of the inductor become heated more rapidly than the pieces near the middle and the use of such an assembly has been worse than or little different from the method wherein individual coils have been used. An operator under such conditions usually must guess temperatures by eye with perhaps two or more charge pieces coming to temperature at the same time and with no method of control. Also, as in the method where unit coils are used it is necessary to jump charges in and out of line and over one another. No commercial units are believed to have survived these difficulties.

Referring to the figures, it may be desired to heat the end of an extruded blank for nosing it in to form an ordnance shell, as in Figure 3, for instance; or it may be desired to heat the end of a long section of pipe for upsetting the end to form a flange, as in Figure 4, or it may be desired to do any of a large number of jobs of which the illustrations are but general examples. Heretofore few such charge pieces have been heated by induction. It has been possible to heat most of the smaller size charges in resistance or salt bath furnaces or by gas. If the heating has been done by induction a set-up such as shown by Figure 2 usually has been employed.

In Figure 2 a plurality of inductor coils A, B, C are shown. They are separate and articulate and each is designed to heat a charge piece to a desired temperature in a desired time. The coils may be connected either in series or in parallel relation to a source of power supply, usually of intermediate or high frequency alternating current. On starting, a load is inserted in coil A, then say a half minute later a load is placed in coil B and so on. The heating characteristics being substantially uniform the established rotation and heating schedule is A, B, C, A, B, etc., on a half minute schedule. This means that if loads are being fed to the system from the right all loads fed to coil A must be lifted over or routed around loads B and C; all loads for coil B must be lifted over load C on entering and load A on leaving, etc. Such a system is in actual operation. If the number of inductor units is kept low the power fluctuation on the system is great as a load is inserted or removed or as it is heated through its magnetic stage. If a large number of units are used then it becomes practically impossible to control the temperatures and timing.

In applicants' method an arrangement as shown in Figure 1 is used. The inductor coil 1 is wound as an elongated oval. Its dimensions are adapted to the particular job in hand. The coil length is such that the charge pieces are heated only as far back as is desired. The height is as small as practicable to admit the charge and to allow for suitable electrical and heat insulation. The width is sufficiently great to admit enough charge pieces to insure that the heating of each will be uniform; that the required production is obtained, and that fluctuations in the line will be a minimum as new charge pieces are added.

The inductor coil 1 is adapted with the usual supporting members 2, terminals 3 and water connections 4. Insulation 5 is used between the charge pieces 6 and the inductor proper. One side of the inductor assembly may be raised giving the assembly a slight angle of tilt to cause the charge pieces to roll or slide progressively to the other side as successive pieces are removed, or the charge pieces may be progressed by moving them bodily on a belt or rack 7.

From an inspection of Figure 1 it will be evident that the entering and leaving charge pieces will be coupled with the inductor over more than half of their circumferential portions while the mid pieces are coupled only slightly at the top and bottom. It will be evident also that the handling is reduced to a minimum, the travel of the charge pieces being indicated by the arrows.

Applicants believe that they have developed a new and useful method of heating by induction which has many advantages over methods heretofore described. They request that United States Letters Patent be granted to them for all that is claimed.

We claim:

1. The method of heating a charge piece having substantial length which comprises placing it within and along one side of a cylindrical helical type inductor coil having a length along the axis of the coil approximately equal to the portion of the charge to be heated, a thickness approximately equal to the thickness of the charge and a width many times greater than said thickness, energizing said coil by passing an alternating current therethrough, moving said charge piece across the width of said inductor coil from a position where the coupling between the coil and charge is close about a substantial portion of the perimeter of the charge, through intermediate positions where the coupling is close only on opposite sides of the charge, to a position where the coupling is again good about a substantial portion of the perimeter of the charge, maintaining the length axes of charge and coil substantially parallel at all times and removing the charge piece from the coil.

2. The method of heating a succession of charge pieces having substantial length which comprises placing them successively within and along one side of a cylindrical helical type inductor coil having a length along the axis of the coil approximately equal to the portions of the charge pieces to be heated, a thickness approximately equal to the thickness of the charge pieces and a width many times greater than said thickness, energizing said coil by passing an alternating current therethrough, moving said charge pieces across the width of said inductor coil from a position where the coupling between the coil and a charge piece is close about a substantial portion of the perimeter of the charge piece through intermediate positions where the coupling is close only on opposite sides of the charge piece, to a position on the opposite side of the coil where the coupling is again good about a substantial portion of the perimeter of the charge piece, maintaining the length axes of charge pieces and coil substantially parallel at all times and successively removing the charge pieces from said opposite side of the coil.

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