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[54] **INDUCTION HEATING DEVICE WITH A CONTROLLED FEEDING MECHANISM**
2 Claims, 1 Drawing Fig.

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[51] **Int. Cl.** **H05b 5/00,** H05b 9/06
[50] **Field of Search** 250/265, 214, 207; 219/10.69, 10.55

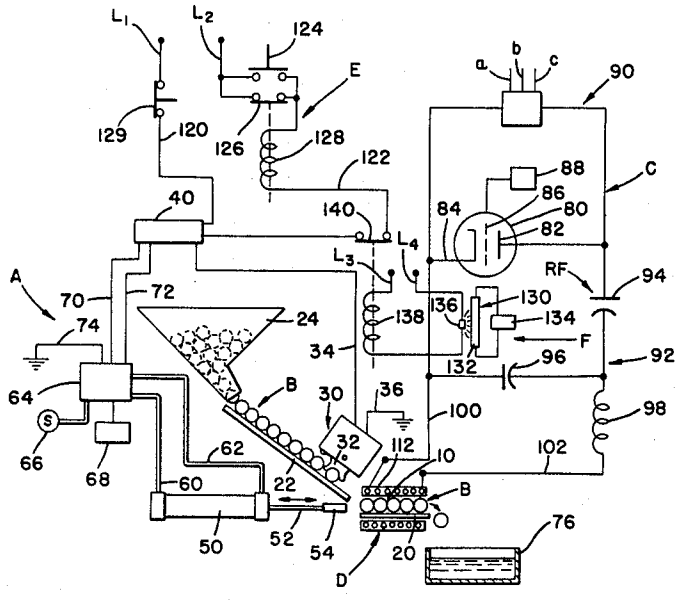
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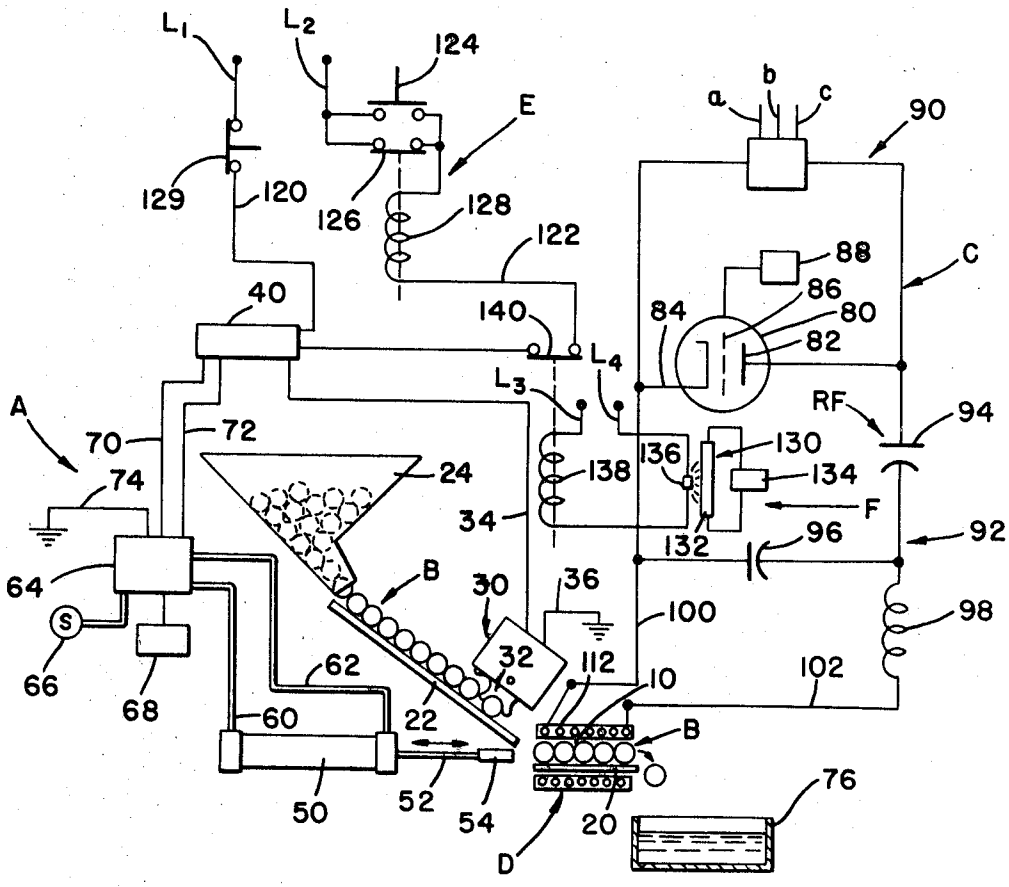
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ABSTRACT: In an induction heating device including an oscillator with a high frequency output circuit, a multiple turn induction heating coil with an internal workpiece-receiving passageway connected in the output circuit, means for sequentially feeding workpieces through the passageway and control means for actuating the feeding means, there is provided an energizable means for actuating the control means only when high frequency current is flowing in the output circuit of the oscillator whereby the feeding means is operable only when heating current is flowing in the coil.





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INDUCTION HEATING DEVICE WITH A CONTROLLED FEEDING MECHANISM

The present invention relates to the art of induction heating and more particularly to an induction heating device having a controlled feeding mechanism.

The invention is particularly applicable in controlling the sequential feeding of elongated, cylindrical workpieces through a multiturn induction heating coil, and it will be described with particular reference thereto; however, it should be appreciated that the invention has much broader applications and may be used for feeding various workpieces through such a multiturn induction heating coil.

It is somewhat standard practice to harden workpieces, such as bolts and nuts, by passing them through the central workpiece-receiving passageway of a multiturn induction heating coil connected in the output circuit of a power oscillator. While passing through the coil, these workpieces are heated to the appropriate hardening temperature so that they may be subsequently quench-hardened. In the past, the device, or mechanism, for feeding the workpiece through the coil was turned on when power was connected to the oscillator. The feeding mechanism continued to operate and feed workpieces through the coil until manually stopped. This arrangement caused certain difficulties. It was noted that certain bolts and nuts were not properly hardened by such an installation. Since the parts were generally in large volumes, it was difficult, if not impossible, to separate the unhardened workpieces from the hardened workpieces. Consequently, the location of any insufficiently hardened pieces required a complete rerun of the whole batch. This was time consuming and expensive.

The present invention is directed toward an induction heating mechanism with a controlled feeding device which overcomes the difficulties previously encountered with the arrangement discussed above. In accordance with the present invention, there is provided a sensing means responsive to the presence of a high frequency field in the output circuit of the oscillator. This sensing means is used to control the feeding device so that the feeding device is not operative when the output circuit of the oscillator is not conducting current. By using this invention, it is assured that all workpieces are properly heated before being quenched. Consequently, the probability of unhardened workpieces being found in a batch of workpieces is substantially diminished, if not completely eliminated.

The primary object of the present invention is the provision of an induction heating device for heating a series of workpieces by the output circuit of an oscillator, which device includes means for feeding the workpieces only when the output circuit of the oscillator is operating.

Another object of the present invention is the provision of an induction heating device for heating a series of workpieces by the output circuit of an oscillator, which device includes means for feeding the workpieces only when the output circuit is operating and which device may be incorporated into existing induction heating equipment.

Yet another object of the present invention is the provision of an induction heating device for heating a series of workpieces by the output circuit of an oscillator, which device includes a fluorescent tube for sending current flow in the output circuit of the oscillator and for controlling the feeding of parts accordingly.

These and other objects and advantages will become apparent from the following description used to illustrate the preferred embodiment of the invention as read in connection with the accompanying drawing in which:

The single FIG. is a schematic diagram showing the preferred embodiment of the invention.

Referring now to the drawing, wherein the showings are for the purpose of illustrating a preferred embodiment of the invention only, and not for the purpose of limiting same, the sole figure shows a feeding mechanism A for feeding a plurality of workpieces B into a heating and quench-hardening device.

This device includes an oscillator C for powering a multiturn induction heating coil D having an internal workpiece-receiving passageway **10**. The feeding mechanism A is started by circuit E controlled, in turn, by a control device F, which forms the essential part of the present invention.

Referring now to the feeding mechanism A, this device is only schematically represented in the drawing and various changes can be made without departing from the intended spirit and scope of the present invention. Also, only essential elements are schematically represented as that is sufficient to define the present invention. Mechanism A includes rails **20** extending through passageway **10**, an inclined ramp **22** down which the workpieces are passed in sequence from a hopper **24**. It is appreciated that bulk feeding can be accomplished in various arrangements and that the workpieces B, in some instances, need not be oriented as illustrated. In accordance with the illustrated embodiment of the invention, an escapement **30** having an electrically indexed escapement wheel **32**, controlled by line 34 and ground **36** electrically connected to control device or timer **40**, is used to introduce the workpieces onto the rails **20**, only one of which is shown. Although this arrangement feeds only one workpiece at a time, other escapements could be used for feeding more than one workpiece, especially when random orientation is dictated by the particular shape of the workpieces being heated. A cylinder **50** having a push rod **52** terminating in an outwardly extending nose **54** periodically moves toward the coil D for forcing the workpieces through the coil wherein they are inductively heated. In accordance with the illustrated embodiment, the cylinder **50** is controlled by pneumatic lines **60**, **62** by a valve **64** having an air inlet supply **66** and an air outlet exhaust or sump **68**. Valve **64** is, in turn, electrically controlled by lines **70**, **72** and ground connection 74 from the sequence timer **40**.

In operation of the device so far explained, timer **40** indexes escapement **30** to drop the workpiece onto the rails **20** after which the push rod 52 pushes the workpiece into the coil and then the push rod is retracted. When an additional workpiece enters the coil, a heater workpiece is forced from the coil as it is dropped into the quench tank **76** where it is quench-hardened and then removed for subsequent use. After this operation has taken place, the timer or control device **40** actuates the escapement to place another workpiece onto rails **20**. Repeated operation of the escapement **30** and the push rod **52** in timed relationship by control device or timer **40** successively feeds the workpiece through the induction heating coil. The cross section of passageway **10** matches the workpieces in a manner which provides optimum induction heating during passage of the workpieces through the coil.

Referring now to the oscillator C, this oscillator is also schematically illustrated and various changes could be made without departing from the intended spirit and scope of the present invention. As illustrated, the oscillator includes a plate **82**, a cathode **84**, and a grid **86**. The grid incorporates any appropriate circuitry, illustrated by box **88**, for providing oscillations. This aspect does not form a part of the present invention. Input circuit **90** includes various other circuitry and components which are not essential to understand the present invention; therefore, for simplicity they have been eliminated. Suffice it to say, that a three phase power from lines *a*, *b*, and *c* provides the input power for the input circuit **90** which drives the oscillator. The output circuit **92** of the oscillator includes standard capacitors **94**, **96** and inductor **98** that cause proper oscillation of the output circuit when connected with the induction heating coil located across output leads **100**, **102**. The operation of the oscillator is well known in the induction heating art and no further discussion is deemed necessary.

In accordance with known practice, the induction heating coil D employs an encapsulating casing **110** and multiple turns **112**, which are water cooled with internal passages. The passageway **10** through the coil has a shape to match the desired heating effect and the coil surrounds the passageway to provide efficient coupling with the workpieces as they are moving through the passageway.

The feeding mechanism A is started by a circuit including lines **120**, **122** connected with an AC source L_1, L_2. A start button, or switch, **124** energizes the timer **40** and, also, a normally open holding switch **126** through a holding coil **128**. As the switch **124** is depressed, the holding switch **126** is closed to start the feeding mechanism. To stop the feeding mechanism, normally closed switch **129** is opened to open switch **126**. Of course, this starting circuit is only schematic in nature and various other arrangements could be used for energizing the feeding mechanism.

Referring again to the oscillator C, the control device F for the feeding mechanism is illustrated as a sensing element **130** including a standard fluorescent tube **132** mounted within the field created by RF current in circuit **92** by a mounting element **134**. In accordance with the invention, a sensing element **130** involves a device for sensing the presence of current flow within the output circuit **92** of the oscillator C. It has been found that a fluorescent tube can be used for this purpose if the tube is positioned in close proximity to the output circuit. Generally the output current is a RF current which causes the coating of the fluorescent tube to glow. This creates a light source when RF current is flowing in circuit **92**. Mounted adjacent to the fluorescent tube is a photo-responsive tube **146** which is actuated, or made conductive, when the coating of the fluorescent tube **132** starts to glow in response to the presence of high frequency current within the output circuit of the oscillator. In accordance with the invention, the sensing element **130** blocks the operation of the control device **40** at any time when high frequency is not flowing in the output circuit **92**. To accomplish this objective, an illustrated circuit is shown wherein coil **138** connected across lines L_3, L_4 controls normally open switch **140**. It is appreciated that other current-sensing elements of the type which create a signal, preferably a light signal, when current flows in circuit **92**. The circuit actuated by the sensing device must be modified to be responsive to the particular current-sensing element being employed.

In operation, when the oscillator is generating a high frequency within circuit **92**, the coating of the fluorescent tube **132** glows to create a light source. This light source renders the photo-responsive tube **136** conductive which actuates coil **138**. This closes switch **140** so that the feeding mechanism may be operated, as previously explained, by control device or timer **40**. As so far explained, the feeding mechanism could not be operated until the oscillator C is in a condition for heating the workpieces. If for any reason the oscillator discontinues heating by discontinuing the high frequency within the output circuit **92**, the coating of the fluorescent light stops glowing. This renders the tube **136** nonconductive which opens switch **140**. The feeding device is therefore immediately shut off. Consequently, no workpieces can be discharged into the quench tank and into subsequent supplied of workpieces without being properly heated and quench-hardened.

As a slight modification, the starting circuit F could be changed to have continuous operation so that the switch **140** would successively actuate or deactuate the control means **40** without requiring the attention of the operator for restarting the feeding mechanism. The present invention, as illustrated, prevents actuation of the feeding mechanism until the oscillator is functioning properly and requires attention of the operator when the oscillator, for any reason, stops oscillating. This brings the operator to the installation so that he may remove the workpieces within the coil and place them back into the hopper so that improperly heated workpieces will not be fed into the quench tank by a circumstance wherein the oscillator stops oscillating and then starts oscillating for some reason. In this circumstance, certain workpieces within the passageway **10** could be cooled before quenching which could produce an improperly hardened workpiece. For this reason, the illustrated embodiment of the present invention wherein the feeding device is completely deactuated and requires operator attention before starting up again is preferred.

Having thus defined my invention, I claim:

1. In an induction heating device comprising an oscillator with a high frequency output circuit, a multiple turn induction heating coil with an internal workpiece-receiving passageway connected in said output circuit, means for feeding workpieces through said passageway, and control means for activating said feeding means, the improvement comprising: energizable means for activating said control means of said feed means only when said control means is in a selected condition, and a light source responsive to high frequency current flow in said output circuit of said oscillator for causing said energizable means to be in said condition only when said current flow is present in said output circuit.

2. The improvement as defined in claim **1** wherein said energizable means includes a circuit with a light-responsive element, a power source, a switch-actuating electrical component and a switch means for operating said control means when said switch means is actuated and said light-responsive element being positioned adjacent said light source for actuation thereby so that said switch means is activated.