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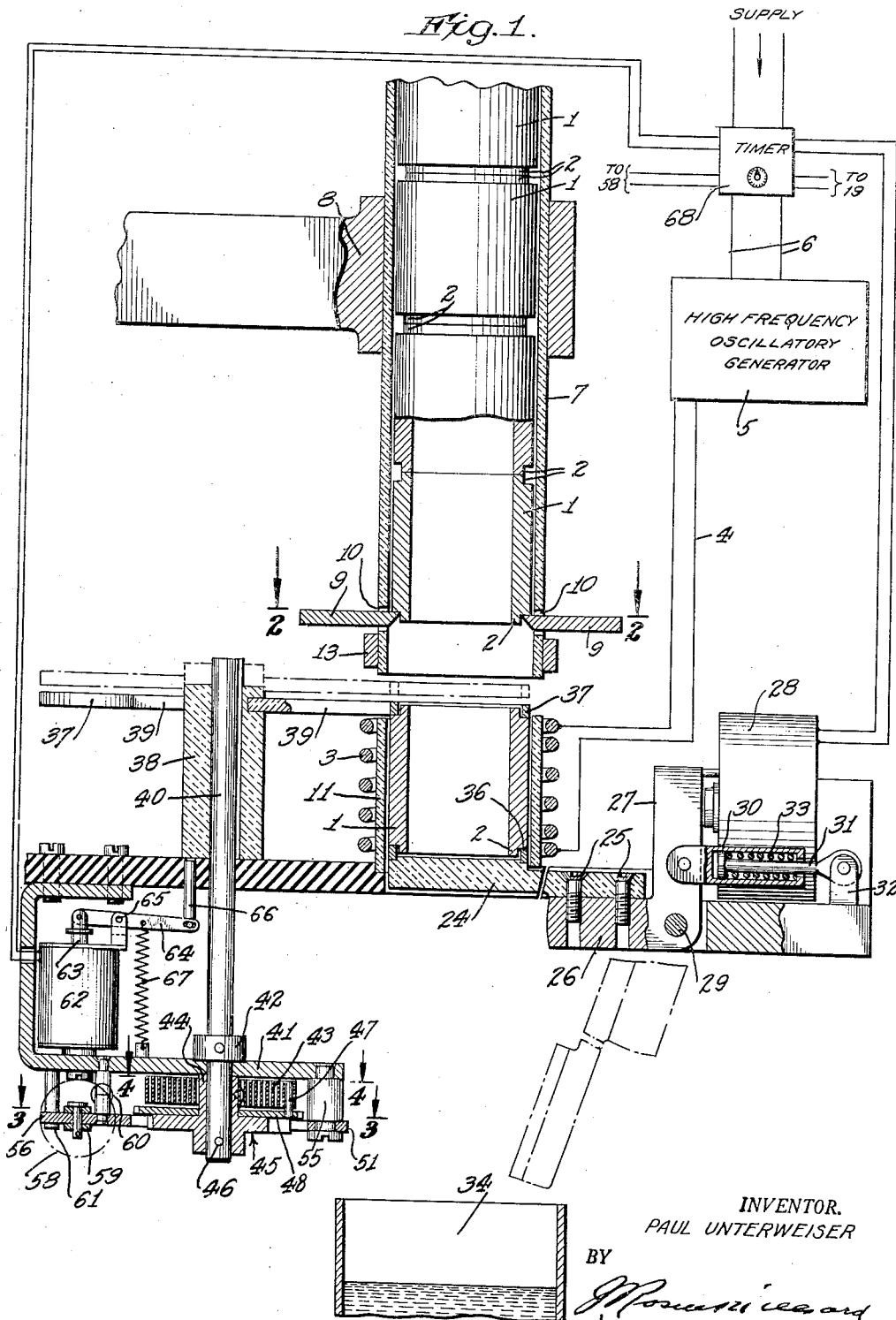
2,440,316

APPARATUS FOR INDUCTION HEAT TREATING OF WORK PIECES

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2 Sheets-Sheet 1

Fig. 1.



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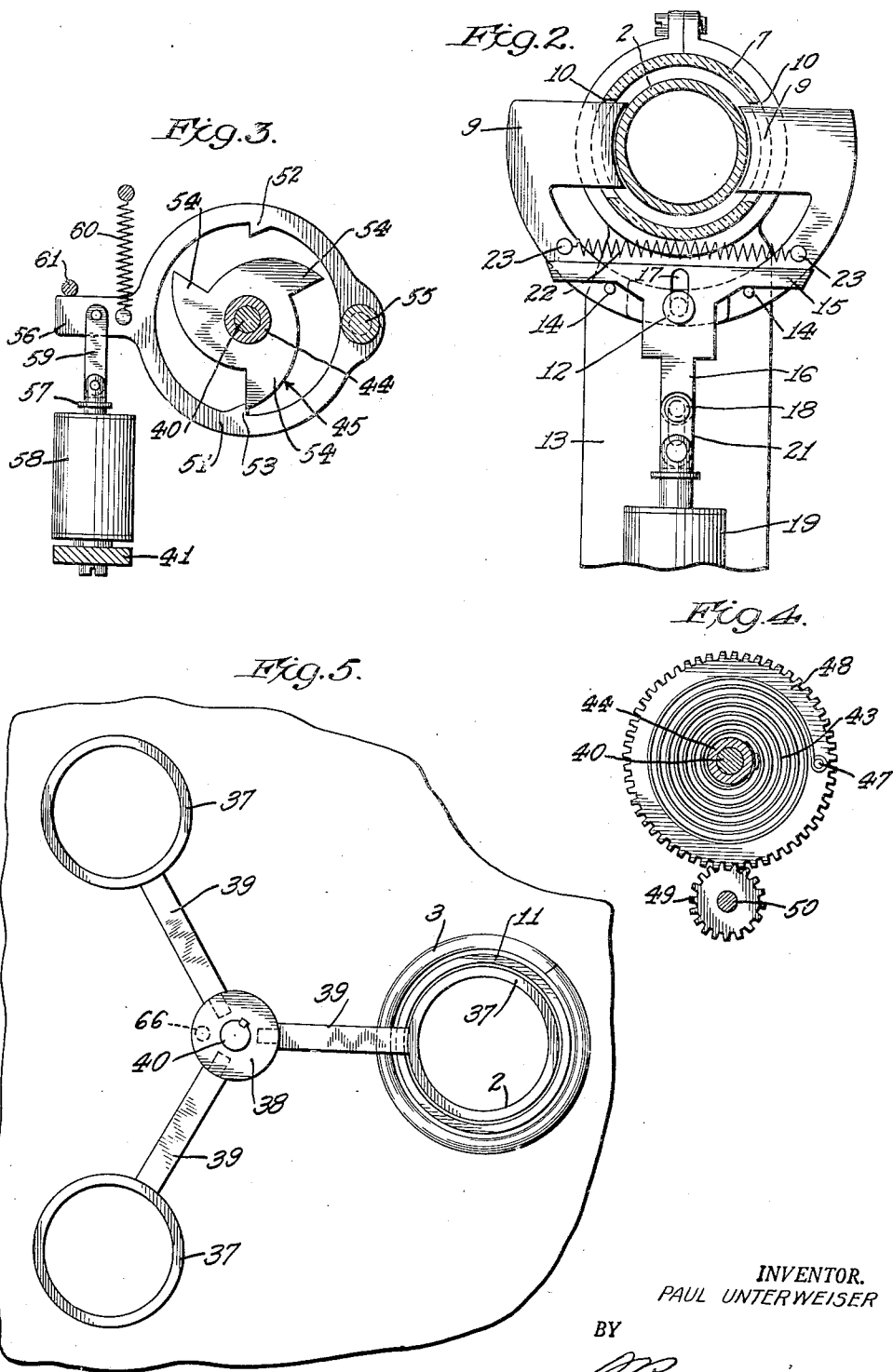
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APPARATUS FOR INDUCTION HEAT-TREATING OF WORK PIECES

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1

This invention relates to the art of inductively heating work pieces wherein portions of the work piece acted upon are to be shielded from the heating action and consists of an improved method and apparatus adapted for automatically and successively feeding or advancing the work pieces into operative relation to the induction heating coil and to position protective shielding elements with relation to the portion or portions of the work piece to be protected prior to and during the induction heating of the surfaces to be heated or hardened as by high frequency energizing of the inductor or heating coil.

The improvements of the present invention are particularly designed for the heat treatment of work pieces wherein different or separated portions of the work piece acted upon are to be shielded as in the instance of the case hardening of cylindrical roller bearing races wherein annular end flanges are to remain unhardened so as to permit of their subsequent deformation to function as a retaining flange in the assembling of the bearings for use. An object of the invention is to provide means for effectively and automatically feeding the work pieces into heating position intermittently from a supply and for automatically ejecting the work pieces upon the completion of each heating operation the work pieces being received within a suitably positioned quenching tank. A further object is to incorporate with the feeding means provision for protecting the portions of a work piece not to be heat treated or hardened with operating means therefor to effect the proper positioning of the shielding elements with relation to the work and the subsequent removal of the shielding elements; these operations being effected in timed relation to the feeding movement and heating operation.

The foregoing and other features and advantages of the present improvements will be more fully understood by reference to the accompanying drawings wherein like reference characters are applied to the corresponding parts in the several views:

In the drawings,

Fig. 1 is a central vertical sectional view, with portions diagrammatically shown, illustrating a preferred embodiment of the invention;

Fig. 2 is a horizontal cross-sectional view taken on line 2—2 of Fig. 1;

Fig. 3 is a horizontal sectional view taken on line 3—3 of Fig. 1 to illustrate details of the escapement mechanism controlling the movement of the shielding elements;

Fig. 4 is a similar view taken on line 4—4 of Fig. 1;

Fig. 5 is a top plan view of the rotatable shielding ring structure.

In the preferred embodiment of the features of the invention as here shown, the apparatus:

2

is specially designed for the surface or case hardening of the outer peripheral surface of cylindrical bearing races by high frequency induction heating and wherein portions thereof are to be shielded from the heating action. The ball races or work pieces to be heat treated are shown at 1 comprising cylindrical body portions having at each end reduced diameter flange extensions 2 of annular form which it is desired to protect from the hardening action so as to permit of their being subsequently deformed or turned inwardly to function as retaining members in the assembled bearing. The work pieces are successively or intermittently advanced into an operating position within an inductor heating coil 3 connected as indicated in the output circuit 4 of a high frequency oscillatory generator 5 connected over leads 6 and a timer 63 to a suitable supply source.

To deliver the work pieces into heating or operating position, corresponding to the lowermost work piece as shown in Fig. 1, they are fed by gravity through a delivery tube 7 of quartz glass supported by a bracket 8 with the advance of the work pieces under the control of movable escapement or holding jaws 9. These jaws are horizontally and oppositely disposed with their inwardly directed curved ends projecting through opposite slots 10 formed in tube 7. The holding jaws 9 as indicated are positioned to engage the under shoulder portion of the lower work piece of a column passing through the tube as from a supply hopper. The jaws support the column of work pieces in spaced relation to the work piece occupying the heating position which is surrounded by the inductor and a fixedly supported guide tube extension 11 likewise of quartz. These holding jaws 9, as shown in Fig. 2, are fulcrumed on a pivotal bearing pin 12 supported on the bracket 13 and each of the jaws has mounted thereon a pin 14 engaged by an extension 15 of an actuating slide 16 supported on the bracket with a guide slot 17 fitted to pin 12 and the slide is connected by pivot 18 to have movement imparted thereto by a solenoid 19 having its movable core 20 connected by pivotal link 21 to the actuating member 16. To effect the inward or return movement of the jaws, a coil spring 22 is connected to anchor pins 23 on the respective jaw members. In operation, for successively releasing of the bottom-most work piece of the supported column, the solenoid 19 is intermittently actuated in response to a timing switch control and is of a suitably quick action type permitting release of the bottom-most work piece with quick return movement to effect reengagement of the jaw members or support of the succeeding work piece which latter operation is performed by the action of the spring 22.

Upon release of the lowermost work piece by

3

the escapement action of the holding jaws 9, the work piece is dropped into the heating or operating position within the inductor coil 3 where it is supported upon a pivoted or gate support 24 of dielectric material in which position it is held for a timed period for the desired degree of induction heating. The support 24 is mounted by means of screws 25 upon the lower leg 26 of an angular armature 27 of a magnet 28. The armature member 27 is pivotally supported at 29 upon the base of the magnet and is connected by means of a sleeve and rod link 30 and 31 to a fixed bracket 32 on the magnet with a spring 33 interposed between the head of the rod and the sleeve end portion in a manner whereby upon deenergizing of the magnet, the armature will be normally retained in partially elevated position to be within the magnetic field and will be depressed under the weight of the work piece and against the influence of the spring 33 to permit dropping of the work piece into a quenching tank as shown at 34. As will be understood upon energizing of the magnet 28, its armature 27 will be attracted and held for the supporting of the work piece in position for heating as shown in full lines in Fig. 1.

To protect the flange portions 2 of the work pieces during the induction heating operation provision is made for positioning annular shields of copper or other good conducting material to overlie or shade the flange outer surfaces prior to and during the heating operation. In the instance of the lower flange this is provided for by mounting an annular shield element 36 upon the upper surface of the gate support 24 in position to receive the flange of the work piece as it is introduced to heating position within the coil and tube extension 11.

To protect the uppermost flange of the work piece by the similar positioning of an annular shield element 37 it is required that the shielding element shall be moved into position in axial alignment with the work piece above the latter and subsequently lowered into effective position surrounding the flange to there remain during the heat treating period. For this purpose there is provided an arrangement composed of a shielding ring carrier comprising a vertically sliding hub portion 38 provided with the radial supporting spokes 39 (of which three are shown) each carrying at its outer end an annular shielding element or copper ring 37. The hub portion 38 is slidably keyed upon a vertical shaft 40 journaled in a supporting bracket 41 and having a bearing collar 42 affixed thereto. The shaft 40 is rotated by a motion transmitted through the instrumentality of a coil spring 43 having its inner end attached to a sleeve 44 of an escapement member 45 secured by pin 46 to the lower end of the shaft. The outer end of the spring is secured by a pin 47 carried on a drive pinion 48 journaled on the sleeve 44 and continuously driven by a drive pinion 49 fixed on vertical drive shaft 50 (see Fig. 4) and driven from a suitable source with slip friction drive not shown. In association therewith a suitable escapement retaining means is provided operating intermittently to release the escapement member 45 permitting the energized spring to transmit rotary motion to shaft 40 as will be understood. The escapement means provided to cooperate with the member 45 comprises an annular member 51 having radially inwardly extending detents 52, 53 positioned to cooperate with the three detents 54 of the member 45 upon oscillatory movement

4

to effect successive or intermittent release of the detents. The annular member 51 is fulcrumed upon pivot 55 carried by bracket 41 and has an extension 56 to which armature 57 of a solenoid 58 is connected by pivotal link 59. The solenoid 58 is of a push-pull type and operates the escapement release member 51 against the influence of the spring 60 connected to the member 51 normally to move it in contact with a stop pin 61 as shown.

Further incorporated with the escapement rotary motion transmitting means for the shield carrier 39, there is provided means for elevating the carrier to clear the top of the work piece flanges in the positioning of the rings. This provision consists of a solenoid 62 having its armature 63 pivotally connected to a rocking lever 64 fulcrumed at 65 and having its inner end pivotally connected to a lift pin 66 slidably fitted in the base support and engaging the under side of the bushing or sleeve 38 to effect the lifting thereof on energizing of the solenoid 62. A tension spring 67 is connected to the lever 64 and to the bracket 41 normally acting to move the pin 66 into lower or retracted position.

For the control of the induction heating period and for the respective solenoids and magnets 28, 23, 58 and 62 in cooperating and properly timed relation, an automatic multiple timer or timing switch conventionally indicated at 68 is employed and connected to the power supply leads. This timer is adapted adjustably to determine the duration of the induction heating operation and is further adapted to control the energizing of the respective magnets in the required relation and timing to effect the intermittent feeding of the work pieces into operating position, positioning of the shielding rings 37 thereon prior to and during the heating, subsequent release of the finished work piece and removal of the shield 37 from interfering position as the succeeding work piece enters the heating coil. In the operating sequence, assuming that a series or stack of work pieces are fed to and supported by the holding jaws 9, which are normally closed, the timing cycle of the automatic timer 68 energizes the solenoid 19 causing the jaws to open and permitting a work piece 1 to fall upon the gate support 24 into its operating position. At this time the magnet 28 is energized so as to hold the gate support in its elevated position for supporting of the work piece in the operating or heating position within the coil. During the dropping of the work piece referred to, the shield ring carrier 39 is retained by detent 53 in an intermediate position and prior to the heating the solenoid 58 is energized to release the member 45 whereby the escapement feed mechanism rotates the shield carrier 39 to advance the protective shield 37 into position above the race, while at the same time the solenoid 62 is energized to impart to it an elevating motion to clear the top of the work piece. The magnet 62 is then deenergized allowing the protective ring 37 to drop into its protecting position on the race as will be understood. The heating coil is then energized for the set period and at the end of the heating operation the magnet 28 is deenergized to permit dropping of the work piece into the quenching tank 34 and the operating cycle then is successively repeated whereby the work pieces are automatically fed and heat treated in successive manner.

What is claimed is:

1. An apparatus for heat treating work pieces,

5

comprising an inductor, means for intermittently energizing said inductor, means for holding a plurality of work pieces in inoperative position, means for releasing said holding means and for depositing successively said work pieces into operative position in said inductor, a support for the work piece in the operative position, means for intermittently removing said support, and timing means connected to control the related operations of the holding means, the inductor energizing means and the movement of said support, whereby work pieces will move successively into said inductor, will be heated therein, and will fall therefrom when the heat treatment is completed.

2. An induction heating apparatus comprising an inductor, an energizing source connected thereto, a feed tube positioned for advancing of work pieces by gravity into an operating position relative to the inductor, escapement holding jaws positioned to engage a work piece at the bottom of a series of work pieces for supporting the series above the operating position, means operative intermittently to open the holding jaws successively to release a work piece to permit it to drop into the operating position and a movable support for the work piece in the operating position, means for moving the said support, and timing means connected to control the related operations of the escapement jaws, the inductor energizing means and the movement of the supporting member for the release of a finished work piece.

3. An induction heating apparatus comprising an inductor, an energizing source connected thereto, means operative successively to feed work pieces into an operating position in heating relation to the inductor, shielding means movably supported and actuating means operative to effect the movement of the shielding means into and out of effective shielding relation to the work piece in the operating position.

4. An induction heating apparatus comprising an inductor, an energizing source connected thereto, first electro-magnetic means operative successively to feed work pieces into an operating position in electrically coupled relation to the inductor, shielding elements movably supported with relation to an operating position, second electromagnet controlled actuating means operative to effect movement of the shielding elements into and out of effective shielding position relative to a work piece in the operating position and a timer connected to control the energizing of the inductor and said electro-magnetic means in timed relation.

5. An induction heating apparatus comprising an inductor, an energizing source connected thereto, electromagnetic actuated means operative successively to feed work pieces into an operating position in electrically coupled relation to the inductor, shielding elements rotatably supported with relation to the operating position, electromagnetic controlled actuating means operative to effect rotation of the shielding elements into and out of effective shielding position relative to a work piece in the operating position, a movable support for the work piece in operating position, a shielding element carried by the support, electromagnetic means to operate the movable support and a timer connected to control the energizing of the inductor and said electromagnetic means in timed relation.

6. An induction heating apparatus comprising an inductor, an energizing source connected

6

thereto, a feed tube positioned to guide the advance of a series of work pieces to an operating position within the inductor, a pivotal gate support adapted to support the work piece in operating position, escapement holding jaws operatively positioned to engage the lowermost of and support a column of work pieces advancing to the operating position, a first electromagnetic means connected to operate the jaws successively to release the lowermost work piece of the column, a second electromagnetic means connected to operate the gate support and a timer connected to control the operation of the first and second electromagnetic means and the energizing of the inductor in timed relation.

7. An induction heating apparatus comprising an inductor, an energizing source connected thereto, a feed tube positioned to guide the advance by gravity of a series of work pieces to an operating position relative to the inductor, a movable support adapted to support the work piece in operating position, escapement holding jaws operatively positioned to engage the lowermost of and support a column of work pieces advancing to the operating position, a first electromagnetic means connected to operate the jaws successively to release the lowermost work piece of the column, a second electromagnetic means connected to operate the movable support and a timer connected to control the operation of the first and second electromagnetic means and the energizing of the inductor in timed relation.

8. An induction heating apparatus comprising an inductor, an energizing source connected thereto, a feed tube positioned to guide the advance of a series of work pieces to an operating position relative to the inductor, means operative successively to release work pieces of the series to advance by gravity to the operating position and shielding means movably supported with relation to the work pieces in the operating position, said shielding means comprising a rotatable support, a multiplicity of spaced shielding elements carried by the support and an actuating means for the shielding means operative intermittently to effect rotation of the support whereby the shielding elements occupy positions successively in shielding relation to the work and in an intermediate position giving clearance for the advance of a succeeding work piece to operating position.

9. An induction heating apparatus comprising an inductor, an energizing source connected thereto, a feed tube positioned to guide the advance of a series of work pieces to an operating position relative to the inductor, means operative successively to release work pieces of the series to advance by gravity to the operating position and shielding means movably supported with relation to the work pieces in the operating position, said shielding means comprising a rotatable support, a multiplicity of spaced shielding elements carried by the support and an actuating means for the shielding means operative intermittently to effect rotation of the support whereby the shielding elements occupy positions successively in shielding relation to the work and in an intermediate position giving clearance for the advance of a succeeding work piece to operating position, a timer connected to control the energizing of the inductor and to control the operation of the shielding means in timed relation thereto.

10. An induction heating apparatus comprising an inductor, an energizing source connected

thereto, a feed tube positioned for advancing of work pieces by gravity into an operating position relative to the inductor, movable holding jaws positioned to engage a work piece at the bottom of a series of work pieces for supporting the series above the operating position, electromagnetic means operative intermittently to open the holding jaws successively to release a work piece to drop into the operating position and a timer connected to control the operation of the said electromagnetic means with relation to the energizing of the inductor, said holding jaws being pivotally connected and formed for inter-engagement to be movable in opposition upon motion being transmitted to one of said jaws and a retractile spring interconnecting the jaws and operative normally to effect the closing thereof.

11. An induction heating apparatus as claimed in claim 2 wherein the jaw members are positioned to engage opposite sides of the work piece and are formed with pivotally connected arm portions having provision for inter-engagement whereby opening movement imparted to one jaw will transmit like movement to the other jaw, one of said jaws being formed with a detent positioned to engage the jaw detent for transmitting motion thereto, a pivotal link connection from the actuator to the said electromagnetic means and a retractile spring connecting the jaw members normally to effect closing thereof.

12. An induction heating apparatus comprising an inductor, an energizing source connected thereto, means operative successively to feed work pieces into an operating position in heating relation to the inductor, shielding means movably supported with relation to the work pieces in the operating position, said shielding means comprising a rotatable support, a multiplicity of spaced shielding elements carried by the support and actuating means for the support comprising a suitably journaled vertical shaft keyed to the support whereby the latter is vertically slidable thereon, a ratchet escapement element secured to the shaft, a helical spring connected to the ratchet and shaft at its inner end, a drive pinion

suitably journaled and connected to the outer end of the spring, means for rotating the pinion and a pivotal escapement member formed with detents alternately engaging the teeth of the ratchet, an electromagnet connected to impart oscillatory movement to the escapement member and a timer connected to energize said electromagnet in timed relation to the positioning of the work pieces in operating position.

13. An induction heating apparatus as defined in claim 12 preceding further including a lifting means engaging the under side of the shield support and an electromagnet connected to actuate the lifting means and connected to the timer to effect a timed operating relation to the rotation of the support.

14. An induction heating apparatus comprising an inductor, an energizing source connected thereto, means for successively advancing work pieces to an operating position with relation to the inductor, a pivotal gate support adapted to support a work piece in operating position, electromagnetic means connected to operate the gate support and consisting of a magnet having a pivoted armature to which the gate support is secured, a yieldable connection pivotally attached to the armature and operative normally to move the armature into its attracted position and a timer connected to control the operation of the magnet and the energizing of the inductor in timed relation.

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