United States Patent [19]

Phares et al.

[11] **3,909,575**

[45] **Sept. 30, 1975**

[54] **CHAIN LINK HEAT TREATING APPARATUS AND METHOD**

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[22] Filed: **Jan. 31, 1974**

[21] Appl. No.: **438,256**

[52] **U.S. Cl.** **219/50**; 219/10.57; 219/51

[51] **Int. Cl.**[2] **H05B 1/00**

[58] **Field of Search** 219/50, 51, 10.57

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[57] **ABSTRACT**

A system for heat treating chain links including an apparatus and method adapted to heat links one at a time at a desired temperature and for a given duration. The system includes the provision of a pair of electrodes which include clamping means whereby a link can be held by the electrodes during the passage of current through the link. When the desired temperature has been held for a given length of time, the link is released by retraction of the electrodes. A quench tank is preferably located beneath the electrodes whereby a link will drop into the quench tank upon release. Temperature detecting means are preferably employed along with a timing mechanism so that the electrodes will automatically release a link for quenching when the temperature and time factors have been accomplished.

17 Claims, 8 Drawing Figures

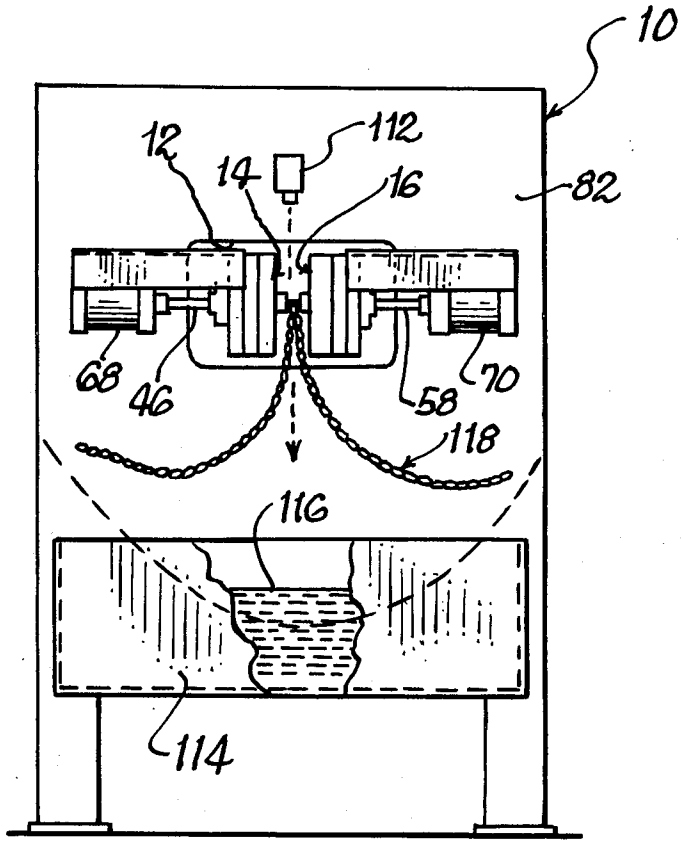


FIG. 1

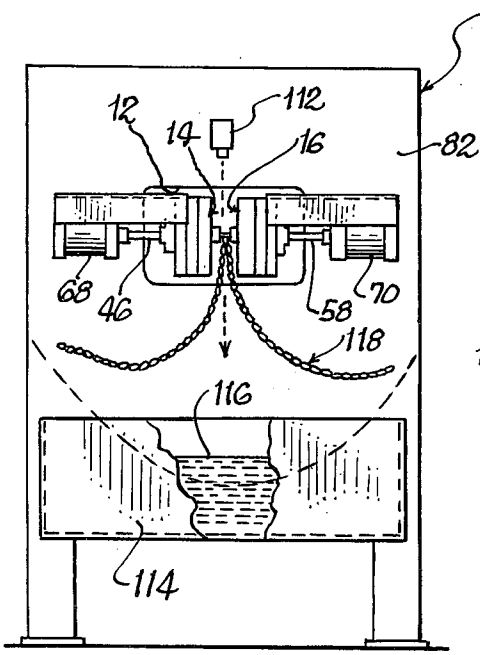


FIG. 2

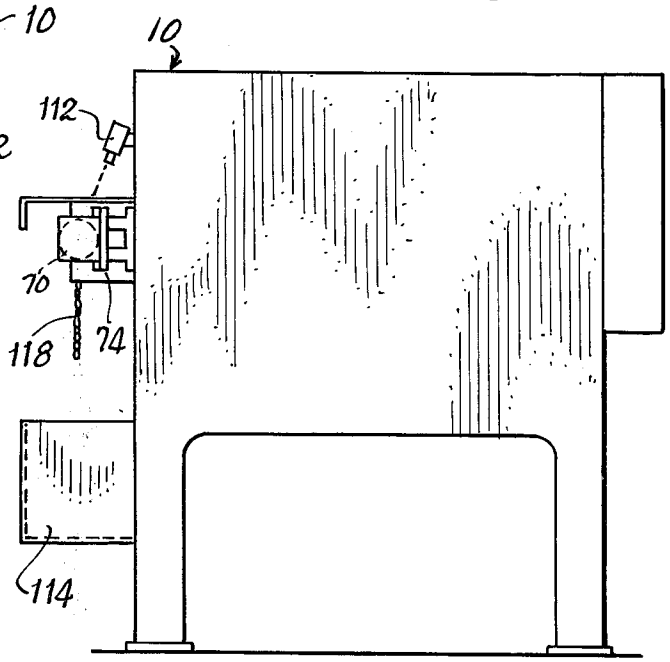


FIG. 3

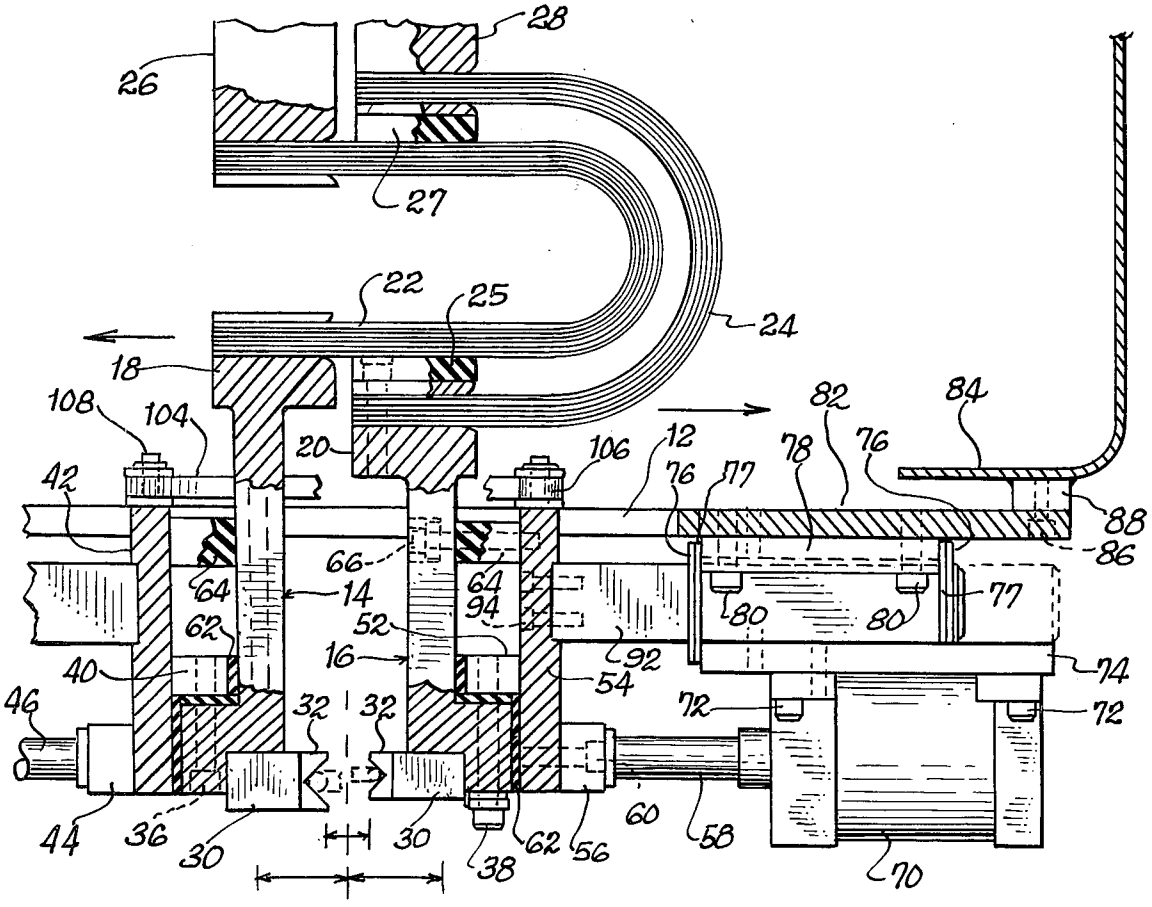


FIG. 4

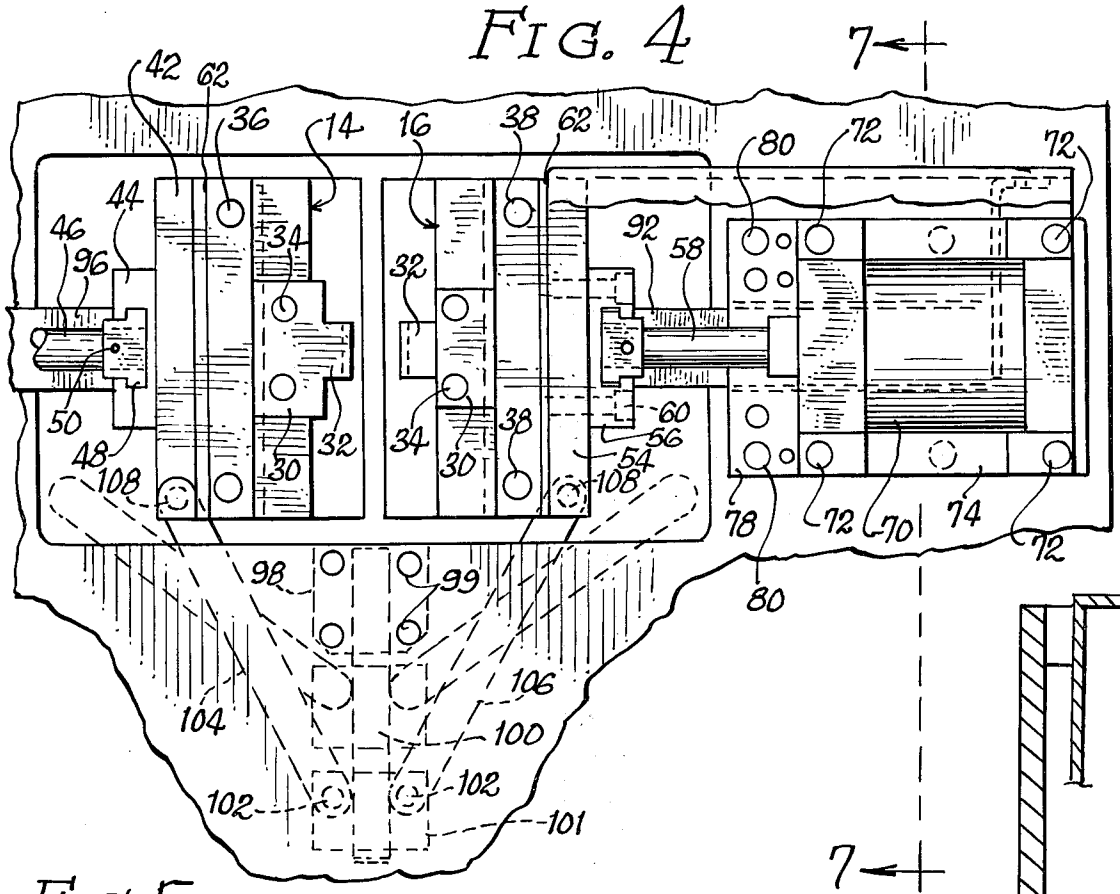


FIG. 5

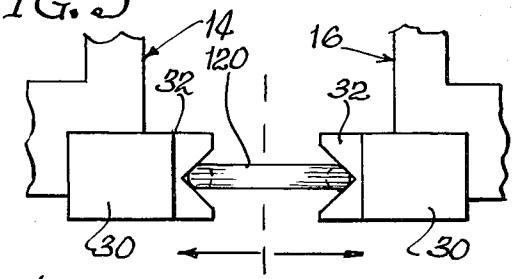
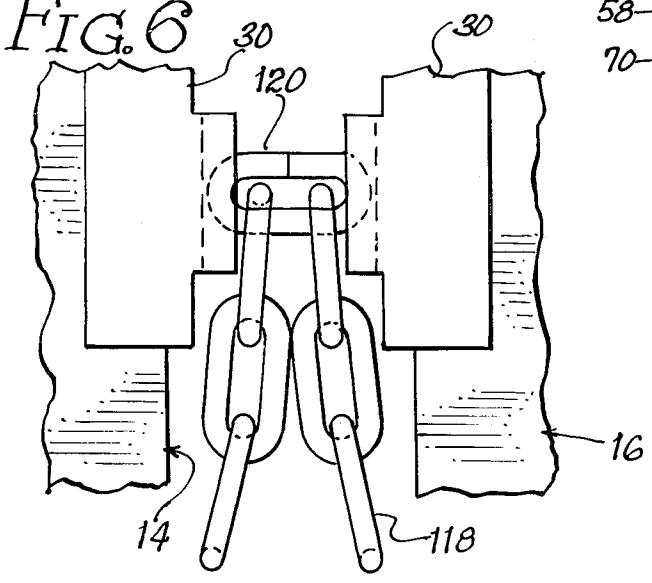


FIG. 6



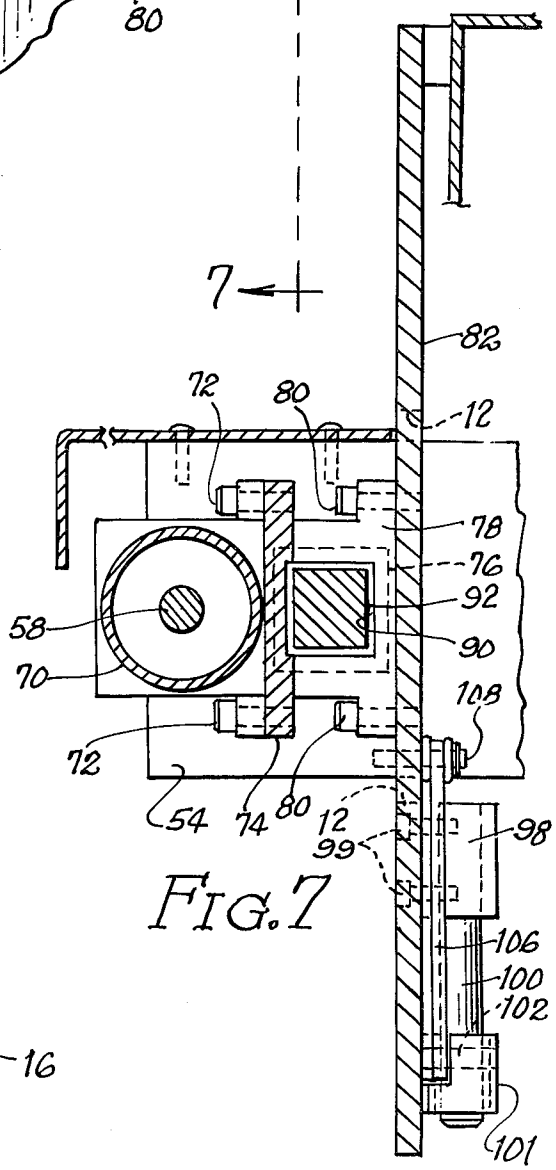
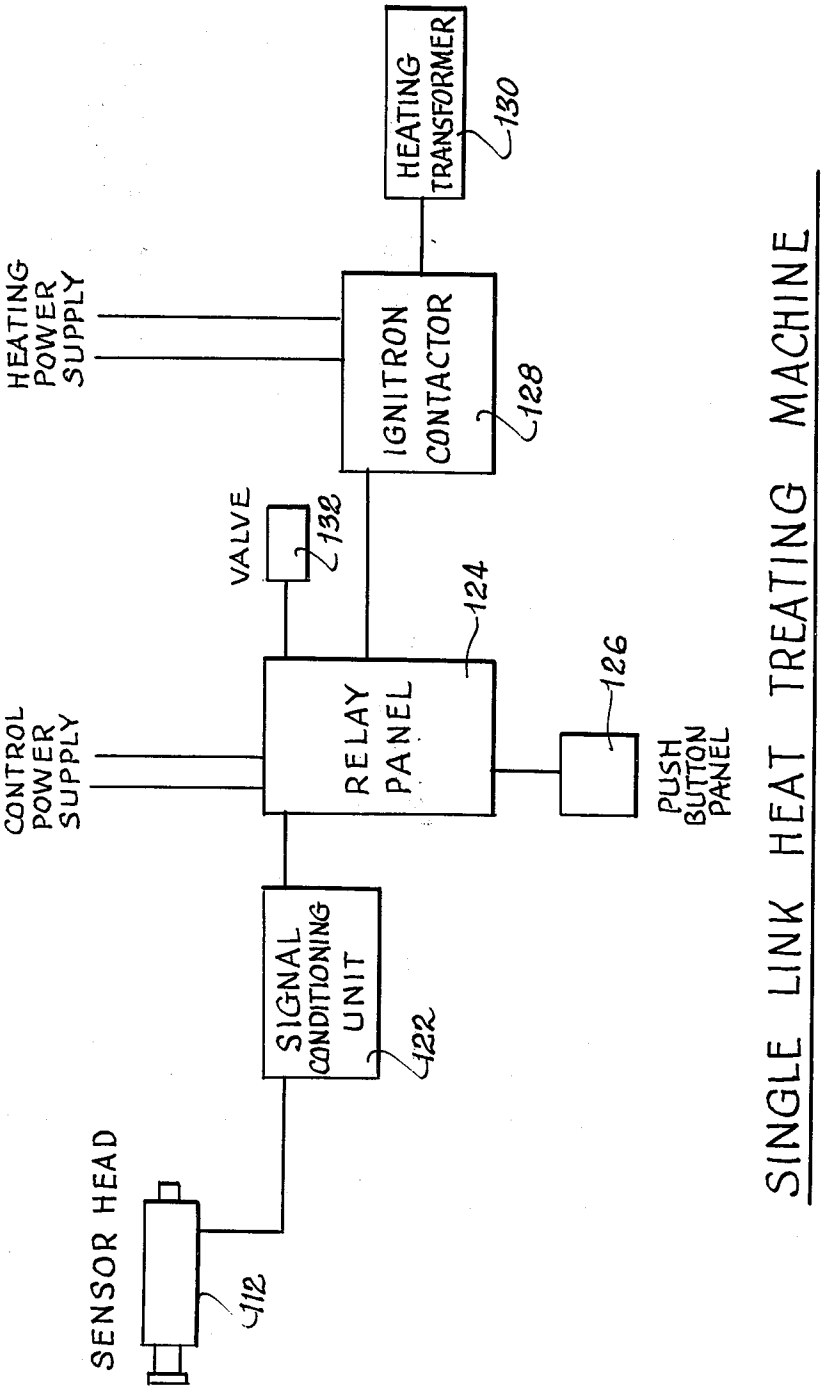


FIG. 7

FIG. 8



SINGLE LINK HEAT TREATING MACHINE

CHAIN LINK HEAT TREATING APPARATUS AND METHOD

SPECIFICATION

This invention is directed to a system for heat treating chain links and, in particular, to an apparatus and method for handling individual chain links which are located in a length of chain. The invention finds particular utility in connection with the repair of chains used for industrial purposes.

Chain is utilized in industry for numerous purposes. For example, so-called sling chains are widely employed in industry for transmitting goods throughout plants. Such chains are subjected to heavy loads, and it is, therefore, necessary to maintain the chains in proper condition in order to avoid down-time of the equipment. More importantly, and particularly in the case of over-head cranes, the failure of a chain during operation can lead to injury to workmen and to damage of the goods being carried as well as to structures over which the goods are being transported.

In order to reduce the liklihood of chain failure, legislation has been enacted requiring periodic inspection of chain. The inspection must be thorough enough to insure that a chain is in proper operating condition, and this requires relatively careful inspection procedures. In particular, proper inspection requires removal of the chain from the crane or other equipment in order that the chain sections can be thoroughly studied and to permit the replacement of any links which do not meet required standards.

The necessity for removing chain from equipment creates significant problems for users since a new chain must be made available so that the equipment will not have a lengthy down-time. In view of the fact that regulations require frequent chain inspection, it is necessary to provide substitute chains for all equipment involved, and this can lead to significant expense and inventory problems for larger industries.

When inspection procedure reveals that a particular link in a chain is defective, cutting means are utilized for removing the link. A new link is then inserted, and secured in the chain length by splice welding techniques. In order to insure that the new link will perform properly, heat treating of the new link must follow so that the mechanical properties of the link will be acceptable.

Application Ser. No. 290,872, filed on Sept. 21, 1972 and entitled "Chain Inspection and Repair System", now U.S. Pat. No. 3,788,062, describes an arrangement for handling the above described procedures in an extremely efficient fashion.

This invention has a particular object the provision of heat treating apparatus and method which is highly suitable for use in systems of the type described in the foregoing application and in operations independent of such systems.

It is a further object of this invention to provide an apparatus and method which permits the rapid and accurate heat treating of repair links in a length of chain whereby the new links will be characterized by properties at least equal to the properties of the other chain links.

It is an additional object of this invention to provide an apparatus and method of the type referred to which is also applicable for use in the manufacture of new sling chain constructions.

These and other objects of this invention will appear hereinafter and for purposes of illustration, but not of limitation, a specific embodiment of the invention is shown in the accompanying drawings wherein:

FIG. **1** is a front elevational view of a heat treating apparatus characterized by the features of this invention;

FIG. **2** is a side elevation of the heat treating apparatus;

FIG. **3** is a fragmentary detail view, partly in section, illustrating the clamping electrodes and drive mechanisms utilized in the construction;

FIG. **4** is a fragmentary detail view illustrating the mechanisms of FIG. **3** in elevation;

FIG. **5** is a fragmentary view illustrating the manner in which a single link is held by the clamping electrodes;

FIG. **6** is an elevational view of the arrangement shown in FIG. **5**;

FIG. **7** is a fragmentary cross-sectional view taken about the line **7—7** of FIG. **4**; and,

FIG. **8** is a diagrammatic illustration of the control mechanisms utilized in accordance with the preferred form of the invention.

This invention generally relates to an apparatus and method for heat treating chain links. The apparatus includes spaced apart electrodes which include means for clamping a single link between the electrodes whereby electrical power can be utilized for passing a current through the link to achieve a desired temperature in the link for a desired period of time.

The preferred forms of the invention are automated including the means employed for releasing a chain link after the desired heating has been accomplished. The releasing portion of the cycle is preferably controlled by means for detecting the temperature reached in the link being treated and by timing means which control the duration of the heating. A quench tank is located beneath the clamping electrodes so that upon release by the electrodes, the link will automatically drop into the quench tank. The cycle of operation can conveniently include heat treating at an elevated temperature, for example a normalizing or hardening operation. After quenching, the single link can be reclamped to achieve a desired temper and then dropped again into the quench tank. The latter operation is, of course, desirable in order to facilitate handling of the chain.

The accompanying drawings illustrate an apparatus including a main housing **10.** This housing is provided mainly for a power supply, and a transformer would typically be included in the housing along with other circuit elements. A control panel is conveniently located on the housing for purposes of initiating the various operations to be described.

The front panel of the housing defines an opening **12** through which electrodes **14** and **16** extend. The ends **18** and **20** of these electrodes are provided with means for attaching the ends of flexible conductive straps **22** and **24.** An insulating member **25** is attached to the end **20** of electrode **16** so that the strap **22** will at all times be insulated from the strap **24.**

The other ends of the straps **22** and **24** are connected to supply terminals **26** and **28,** respectively, with insulation **27** separating strap **22** from terminal **28.** Since, as will be described in greater detail, the electrodes **14** and **16** are movable, the flexible straps enable continued connection of the electrodes to the power supply.

The electrodes **14** and **16** each carry a clamp member **30.** The clamp members include V-shaped ends **32** which, as best shown in FIGS. **3** and **5,** are adapted to engage a chain link. The clamp members are secured to the electrodes, preferably by means of threaded fasteners **34** so that the clamp members can be removed. This enables selection of a clamp member is accordance with the size of a link.

The electrodes **14** and **16** are secured to movable supporting structures by means of bolts **36** and **38,** respectively. The bolts **36** are received in a block **40** which is supported on plate **42.** Also secured to plate **42** is a block **44** which serves to secure the end of piston **46** to the plate. As best shown in FIG. **4,** the end of the piston is received in a member **48** and is secured to this member by means of pin **50.** The member **48** is received by the block **44** and held securely therein.

The bolt **38** extends through the electrode **16** and is received by a block **52** which is carried by plate **54.** This plate also supports a block **56** which receives the end of piston **58.** The block **56** is secured to the plate by means of bolts **60,** and similar bolts (not shown) are utilized for securing the block **44** on the other side of the construction.

The plates **42** and **54** are insulated from the respective electrodes by means of insulating sheets **62** and by means of insulating pieces **64.** The bolts **36** and **38** as well as the bolts **66** utilized for holding insulation **64** in place are formed with non-conductive materials so that current passed to the electrodes will be exclusively directed to the clamping members and to a link held between the clamping members.

Cylinders **68** and **70** are associated respectively with the pistons **46** and **58.** These cylinders are mounted by means of bolts **72** to a support plate **74.** The plate **74** has thin plates **76** attached thereto as by bolting, and these plates are in turn secured to a support member **78.** The plates **76** hold wiper blades **77** of plastic (such as Teflon) which engage slides **92** movable therein. The support member **78** is secured to the front panel of the housing by means of bolts **80.** This front panel **82,** as illustrated best in FIGS. **3** and **7,** comprises a relatively heavy plate secured to housing wall **84** by means of fasteners **86.** The fasteners **86** are received by spacing members **88** which are welded to the wall portion.

The assembly on the block **78** provides a guide opening constituted principally of openings **90.** A slide **92** which is secured to plate **54** by means of fasteners **94** is received in the openings **90.** A similar slide **96** is attached to the plate **42** and a corresponding arrangement of guide openings is located on this side of the construction. Upon operation of the pistons **46** and **58,** the slides move in a confined path thereby rigidly controlling the electrode movement.

A mounting member **98** is attached on the opposite side of panel **82** by means of bolts **99,** and a guide rod **100** is press fit into a bore defined by the member **98.** A sliding block **101** defines a central bore which receives the rod **100.** A pair of pins **102** are secured to the sliding block **101,** and these pins serve as pivotal connections for linking arms **104** and **106.** The opposite ends of the linking arms are pivotally attached to pins **108** which extend through the opening **12** in the panel **82** for attachment to plates **42** and **54.** a corresponding arrangement (not shown) is preferably provided on the other side of the slides (top of FIG. **4**) with linking arms corresponding with the arms **104** and **106** being pivotally attached on the upper sides of plates **42** and **54** and with a guide rod corresponding with rod **100** extending upwardly along the back of panel **82.**

The mechanical structure illustrated results in a controlled movement of the clamping electrodes **30.** Specifically, the operation of cylinders **68** and **70** will result in movement of pistons **46** and **58** whereby the support plates **42** and **54** will transmit movement to the electrodes. Since the linking arms **104** and **106** are also connected to the plates **42** and **54,** movement of the linking arms and sliding block **101** must take place simultaneously with the electrode movement. Because of the location of the block **101** along a center line extending between the electrodes, the arrangement insures that the same movement will occur in each electrode and, therefore, when a link is clamped between the electrodes, the link must be centered in the construction.

In the preferred form of the invention, a temperature detecting means **112** is located on the panel **82.** This detecting means may comprise, for example, a Honeywell infra-red detector which is directed along a center line whereby a link located at the precise center of the construction can be observed by the detector.

Any suitable control system may be utilized in conjunction with the temperature detecting mechanism. This system can be readily set so that a particular heat treating temperature will be realized and the temperature held for a desired period of time. When this has been accomplished, the cylinders **68** and **70** can be automatically operated so that a link will be released from between the clamping electrodes at a precisely controlled point in the cycle of operations.

A quench tank **114** holding quenching liquid **116,** for example water, is mounted on the front of the housing. When the clamping electrodes release a link, the link will be automatically dropped into the quench tank without any necessity for handling by an operator of the apparatus.

FIG. **8** provides a diagrammatic illustration of a suitable control system utilizing a sensor head **112** which may, for example, comprise any device adapted to transform infra-red energy detected in the link being treated to an electrical signal. Such devices include a lens system focused on the heated link for detecting the infra-red energy and proper alignment of the link relative to the sensor head is, therefore, an important aspect of the invention.

The sensor head is connected to signal conditioning unit **122** which receives the electrical signal from the sensor head. This unit may amplify and modulate the signal, eliminating extraneous electrical noise. Two control features are preferably provided in this unit with one control being set at the upper temperature limit for the "harden" cycle and the other set at the lower temperature limit for the "draw" cycle. Accordingly, when the signal from the sensor head indicates that a temperature limit has been reached, the unit **122** will develop an appropriate signal.

The unit **122** is connected to relay panel **124** which is provided with a power supply and suitable pushbutton controls **126.** The relay panel controls the sequence of operations and includes timers for regulating the time of heating. Magnetic relays are preferably utilized. When an operation is initiated by the pushbutton panel and when the unit **122** indicates that the desired temperature has been reached, the relays control the time

during which the heat is applied in the respectiive cycles. It will be appreciated that the panel **126** will control the operation of one relay for the harden cycle and a separate relay for the draw cycle.

After the selected time has expired, the relays are adapted to operate the ignitron contactor **128** which then shuts off the heating transformer **130.** The valve **132** is also operated to release the link clamping means whereby the heated link will be dropped into the quench tank.

The pushbutton panel **126** preferably also has indicator lights to indicate to the operator the particular stage of the cycle. It will be appreciated that variations in the particular components used in the control system are available, and that various conventional means may be employed for the recited purposes.

In a typical utilization of the described construction, a chain **118** is brought into position as shown in FIGS. **1, 5** and **6.** A link **120** in the chain, usually a repair link which has just been welded, is held between the clamping electrodes, for example with a pair of tongs. It is only necessary to locate the link in approximate position, and a pushbutton or other control member is then utilized for operating the cyclinders **68** and **70.** The mechanism already described and the V-shaped design of the clamping members will automatically locate the link **120** in the precise center of the construction. This will insure alignment of the link with the detecting mechanism **112.** Contours other than the V-shape shown may be provided depending particularly on the shape of the link involved.

After clamping, a typical operation will involve energization of the power supply whereby the link will be heated through resistance heating with the detecting means and suitable timing mechanisms determining the magnitude and duration of the heating operation. In the preferred operation of the invention, the current is continuously interupted at timed intervals. The use of a pulsating current has been found to provide a more uniform distribution of heat to thereby provide more uniform properties in the resulting heat treated link. The pistons are then automatically retracted whereby the heat treated link will automatically drop into the quench tank.

In many instances, it is desirable to reset a link to achieve a draw or temper, and the above cycle of operations can simply be repeated but with the heating operation taking place at a lower temperature. Again, a control system can be employed whereby an initial pushbutton operation or the like will automatically achieve clamping, heating, unclamping and quenching. As noted, the operating cycles are useful with respect to the manufacture of new chain as well as for repair links.

It will be understood that various changes and modifications may be made in the above described construction which provide the characteristics of the invention without departing from the spirit thereof, particularly as defined in the following claims.

That which is claimed is:

1. An apparatus for heat treating a single link which is connected in a chain made up of a plurality of chain links, comprising a pair of spaced apart electrodes, said electrodes defining clamp means for clamping a single chain link in position to span the gap between the electtodes with the body of the link being substantially centered relative to the electrodes and being confined thereby, means for supplying electrical power to the electrodes whereby current is passed through said body of the link for heating of the link, separate supports for the electrodes, means for driving at least one of the electrode supports relative to the other between a first position for clamping a chain link and a second position for releasing the chain link, including means for automatically detecting the temperature reached in a link during heat treating, said detecting means being positioned to observe a link held at approximately the center line between said electrodes when said supports are in said first position, said means for driving the supports including position control means whereby said center line is at the same location each time the supports are moved to the first position, means for controlling the magnitude and duration of the supplying of the electrical power to thereby determine the temperature and time of heat treatment, means operatively connected to said detecting means for releasing the link from between the electrodes when the heat treating time has expired, and quenching means for the link, said quenching means being located for receiving the link after release by the electrodes.

2. An apparatus in accordance with claim **1** wherein said quenching means comprises a quench tank positioned beneath said electrodes, said driving means moving the electrodes horizontally between said first and second positions, said link dropping vertically into the quench tank upon release by the electrodes.

3. An apparatus in accordance with claim **2** wherein the chain portions on opposite sides of the clamped link are suspended over the quench tank.

4. An apparatus in accordance with claim **1** wherein said clamp means comprises V-shaped clamp members attached to each electrode for engaging the opposite sides of a link, and including flexible conductive straps extending between each electrode and the electrical power supply whereby said electrodes can be moved and positioned for the clamping of chain links of different sizes while maintaining the connection between the electrodes and the power supply.

5. An apparatus in accordance with claim **4** wherein said clamp members are releasibly connected by fastening means to the electrodes to permit changing of the clamp members for accommodating links of different devices.

6. An apparatus in accordance with claim **1** wherein said means for driving comprises a piston connected to each support, and means for simultaneously extending and retracting the pistons during movement between the first and second positions.

7. An apparatus in accordance with claim **1** wherein the means for releasing the link comprises means connected to said temperature detecting means for automatically unclamping a link when the desired temperature is reached and after the link is held at temperature for a desired period of time.

8. An apparatus for heat treating chain links and the like comprising a pair of spaced apart electrodes, said electrodes including means for clamping a single chain link in position to span the gap between the electrodes, means for supplying electrical power to the electrodes, means for driving the electrodes between a first position for clamping a chain link and a second position for releasing the chain link, said driving means including a piston connected to each electrode, and means for simultaneously extending and retracting the pistons dur-

ing the movement between the first and second positions, at least four linking arms, each having one end connected to a respective electrode, a reciprocating element, the other ends of said linking arms being connected to said reciprocating element, the combination of the reciprocating element and the linking arms tying the movement of the electrodes together, means for controlling the magnitude and duration of the supplying of the electrical power to thereby determine the temperature and time of heat treatment, means for operating said driving means for releasing the link from between the electrodes when the heat treating time has expired, and quenching means for the link, said quenching means being located for receiving the link after release by the electrodes.

9. An apparatus in accordance with claim **8** including a guide member extending vertically beneath and above said electrodes, said reciprocating member defining a bore receiving said guide member whereby the reciprocating element is moved up and down as the electrodes are moved to and from said second position.

10. An apparatus in accordance with claim **9** including movable supports for said electrodes, stationary guide means positioned adjacent said movable support, and means carried by said movable supports received by said stationary guide means for controlling the position of said electrodes during movement thereof.

11. An apparatus in accordance with claim **10** including a housing for said electrical supply, said stationary guide means being mounted on the front of said housing, and an opening defined by the housing receiving said electrode supports, and including flexible conductive strips attached at one end to said supports and at the other end to said power supply.

12. A method for heat treating a chain link comprising the steps of providing a pair of spaced apart electrodes, inserting a single chain link between the electrodes, driving the electrodes toward the chain link to clamp the chain link therebetween, running a current through the chain link to heat the chain link to a predetermined temperature and for a predetermined time, providing means for automatically detecting the temperature reached in a chain link clamped between the electrodes, detecting the temperature by operating said last mentioned means, providing means for controlling the time at temperature, determining the elapse of a desired time by means of said control means, automatically retracting the electrodes when the desired time at temperature has been reached, and quenching the chain link by locating a quench tank beneath the electrodes whereby the chain link drops into the quench tank when the electrodes are retracted, reinserting said link between said electrodes and clamping the link between the electrodes, reapplying a current to reheat the chain link to a lower predetermined temperature for a predetermined time, said first mentioned temperature comprising a hardening temperature for the link material and said lower temperature comprising a drawing temperature for the material, and then again releasing said link from said electrodes.

13. A method in accordance with claim **12** wherein a length of chain is located beneath the electrodes with one link thereof being clamped between the electrodes, at least portions of the chain length being dropped into the quench tank along with the chain length being heat treated.

14. A method in accordance with claim **12** wherein said link is heated by a pulsating current passed through the link.

15. A method in accordance with claim **12** wherein a plurality of individual links are heat treated and are thereafter joined together to form a new sling chain.

16. A method for heat treating a chain link comprising the steps of providing a pair of spaced apart electrodes, inserting a single chain link between the electrodes, driving the electrodes toward the chain link to clamp the chain link therebetween, running a current through the chain link to heat the chain link to a predetermined temperature and for a predetermined time, providing means for automatically detecting the temperature reached in a chain link clamped between the electrodes, providing means for controlling the time at temperature, automatically retracting the electrodes when the desired time at temperature has been reached, and quenching the chain link by locating a quench tank beneath the electrodes whereby the chain link drops into the quench tank when the electrodes are retracted.

17. A method for heat treating a single link which is connected in a chain made up of a plurality of chain links, comprising the steps of providing a pair of spaced apart electrodes, said electrodes defining clamp means for holding a single chain link in the gap between the electrodes, the clamp means for the link including electrodes driveable between a first position for clamping the link and a second position for releasing the link, inserting a chain link between the electrodes, simultaneously driving the electrodes toward the chain link to clamp the chain link therebetween, the body of the link being thereby substantially centered relative to the electrodes and being confined thereby, controlling the movement of the electrodes whereby the center of each link treated is always on a line between and equidistant from each electrode when in said first position, running a current through the link to heat the link to a predetermined temperature and for a predetermined time, providing means for automatically detecting the temperature reached in the link during heat treating, positioning said detecting means to observe the link at said substantially centered position, controlled the time at temperature, retracting said electrodes when the desired time at temperature has been reached, locating a quench tank beneath the electrodes, and quenching the link by allowing it to drop into the quench tank when the electrodes are retracted and moved to said second position.

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