United States Patent [19]

Wardwell et al.

[11] **3,836,743**

[45] **Sept. 17, 1974**

[54] **LOCALIZED HEAT TREATING MACHINE**

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[73] Assignee: **Research Engineering & Manufacturing, Inc.,** New Bedford, Mass.

[22] Filed: **Jan. 21, 1974**

[21] Appl. No.: **435,333**

Related U.S. Application Data

[60] Continuation of Ser. No. 334,879, Feb. 22, 1973, abandoned, which is a division of Ser. No. 128,040, March 25, 1971, Pat. No. 3,769,103.

[52] **U.S. Cl.**..... **219/10.43,** 219/10.57, 219/10.69, 219/10.79, 266/5 EI

[51] **Int. Cl.** **H05b 5/02**

[58] **Field of Search**..... 219/10.41, 10.43, 10.57, 219/10.69, 10.67, 10.79, 7.5, 10.71; 266/4 EI, 5 EI; 148/145, 147, 150, 151, 39

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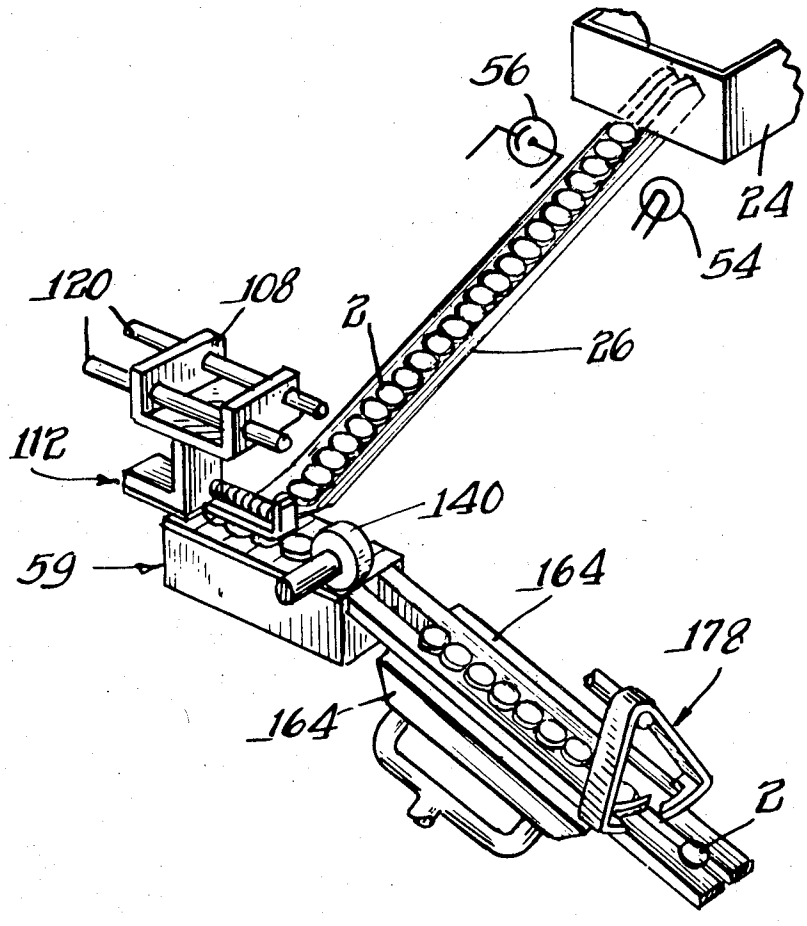
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Attorney, Agent, or Firm—Olson, Trexler, Wolters, Bushnell & Fosse, Ltd.

[57] **ABSTRACT**

An article is hardened or tempered in a localized zone. Where the article is a thread-forming device the zone is that part of its thread that does the thread-forming in the workpiece. The hardness of the remainder of the body of the article is left unchanged. The localized hardening is carried out by a method that includes high frequency induction heating only of the zone followed by quenching of the zone whereby the hardened zone is a skin of predetermined depth. A machine for making articles in accordance with the method comprises means for delivering the articles in succession to an induction heating element, a mechanism for advancing the articles through the heating element for progressive heating of the surface of the article in the localized zone to a predetermined depth, a quenching manifold for applying a spray of quenching liquid to the heated articles from the heating element and conveying them to the quenching manifold.

6 Claims, 17 Drawing Figures



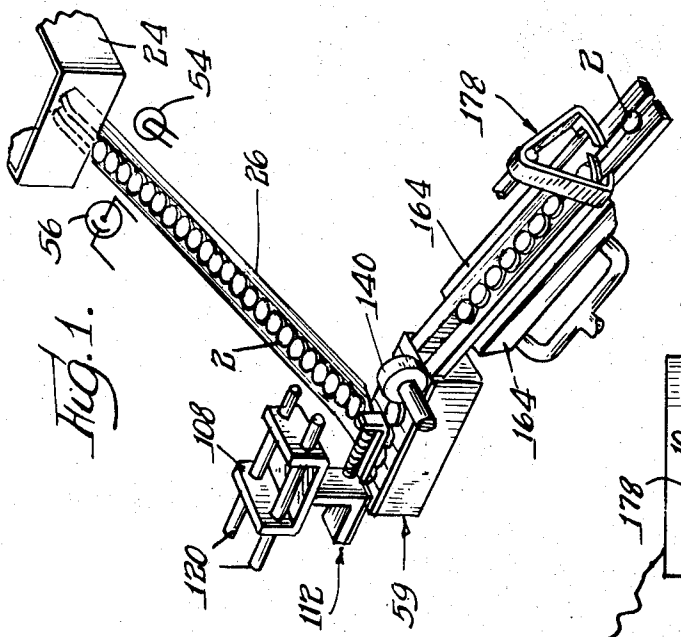

24
54
56
26
178
2
164
140
108
120
112
59

Fig. 1.

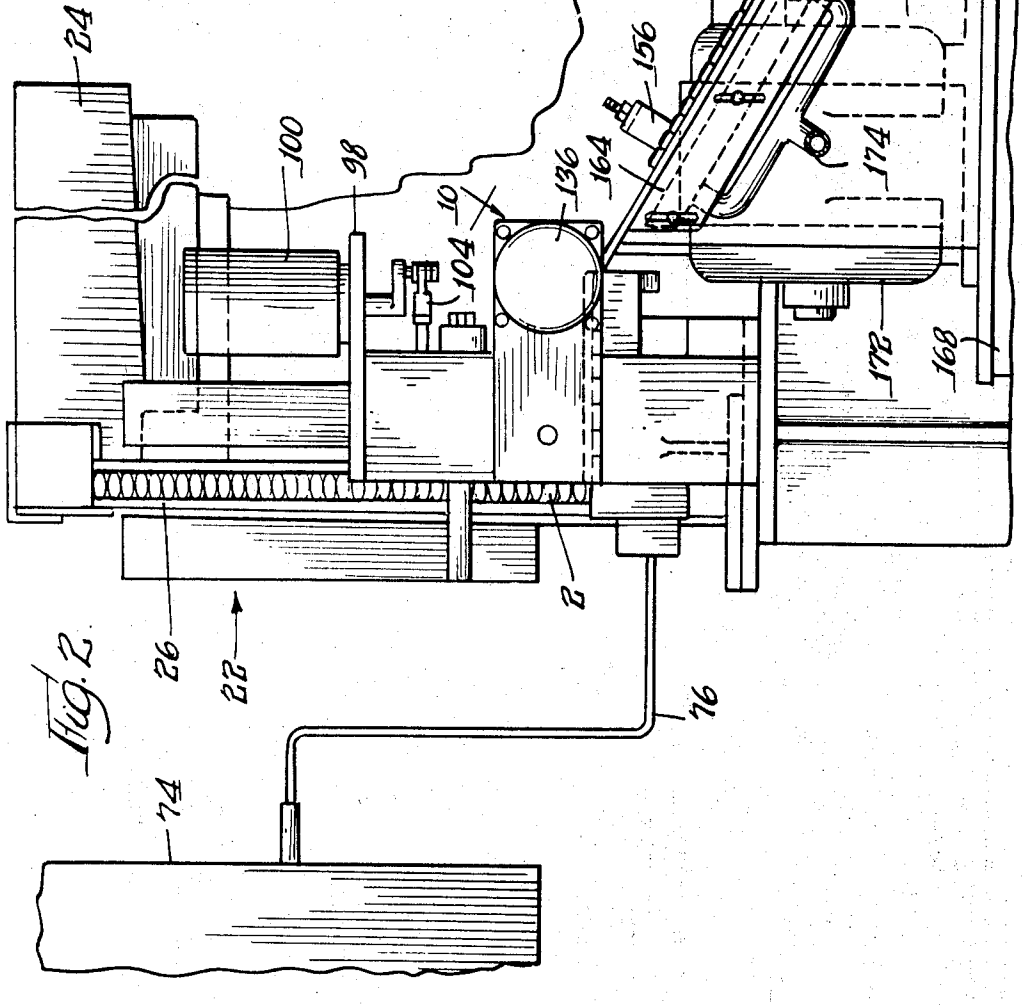

24
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Fig. 2.

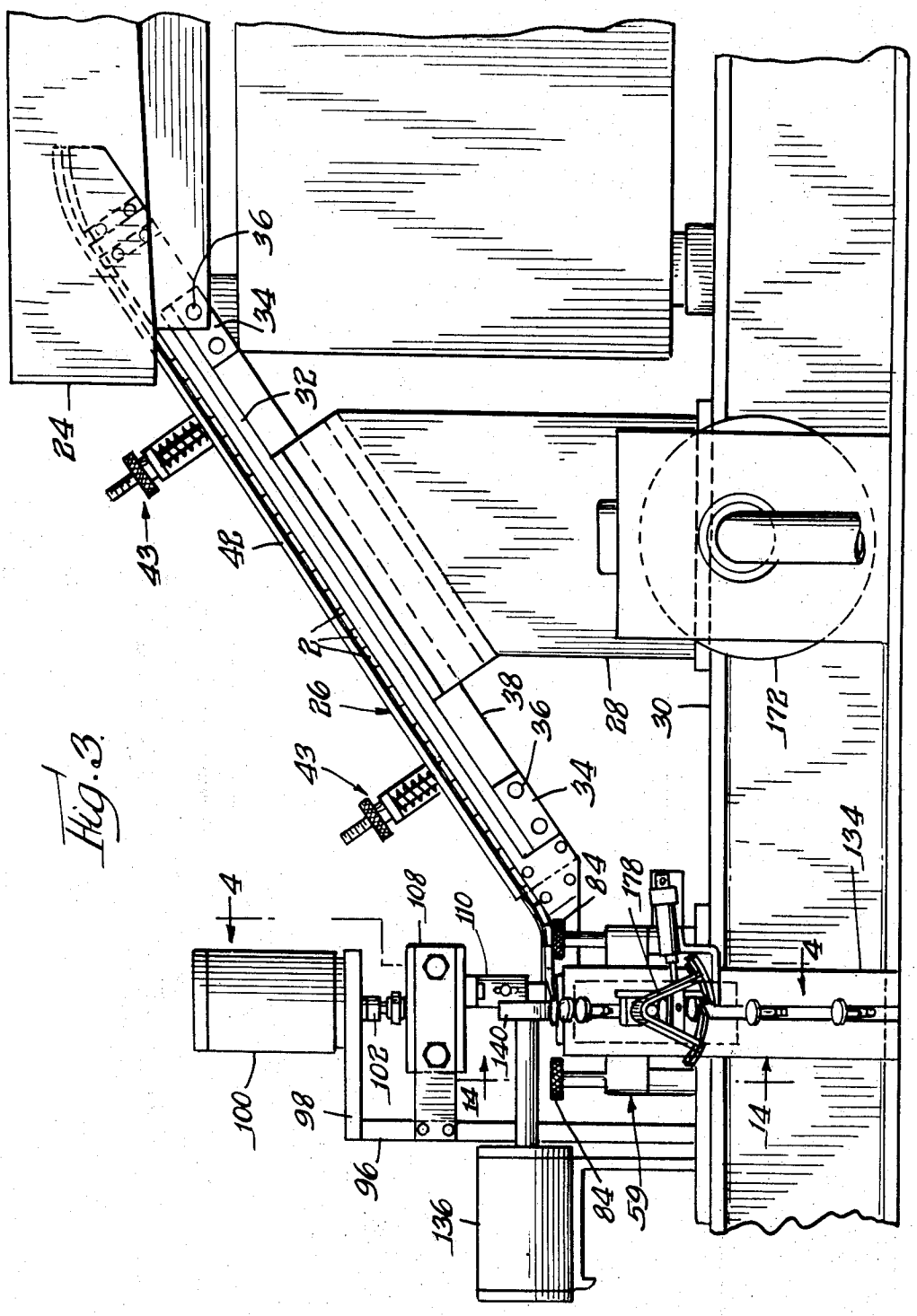

24
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34
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43
42
26
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100
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96
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59

Fig. 3

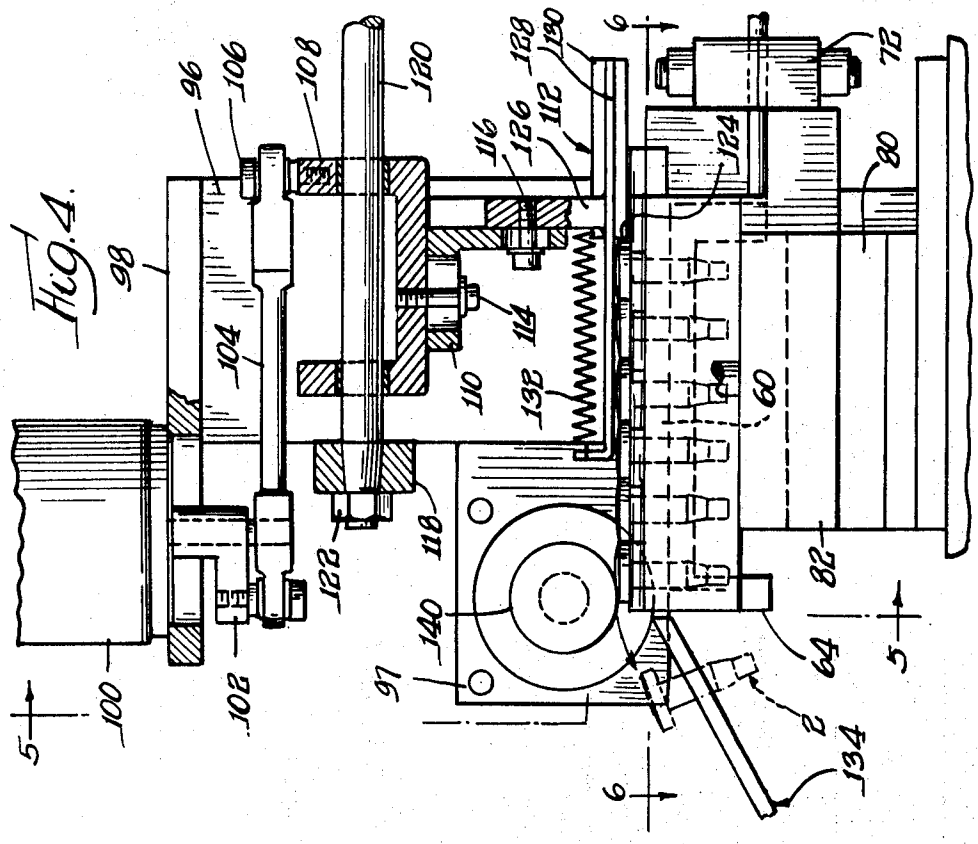


Fig. 4.

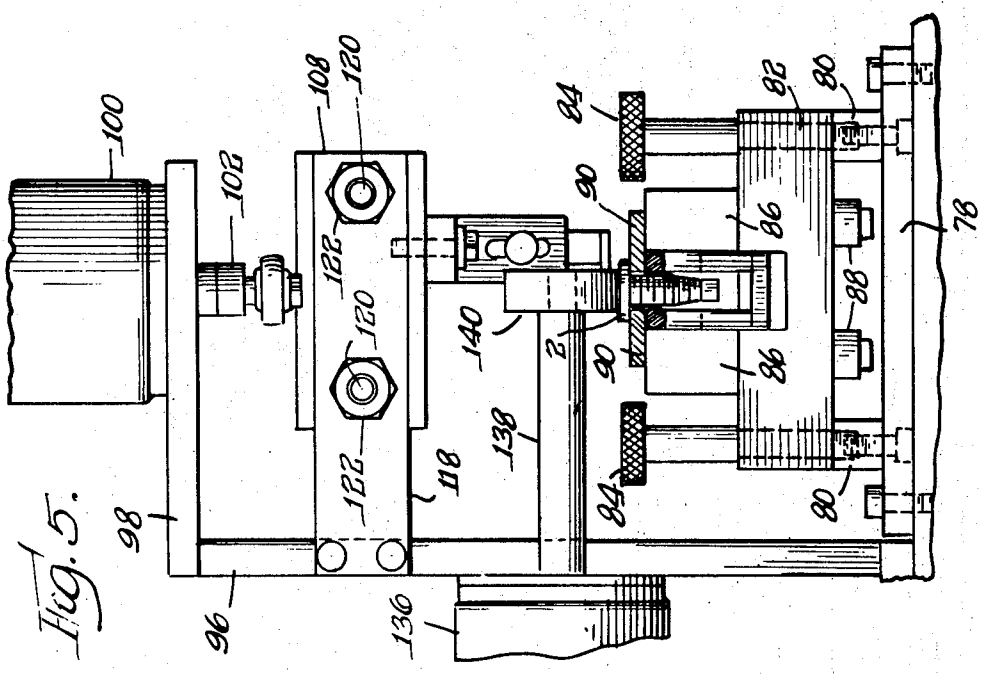


Fig. 5.

Fig. 6.

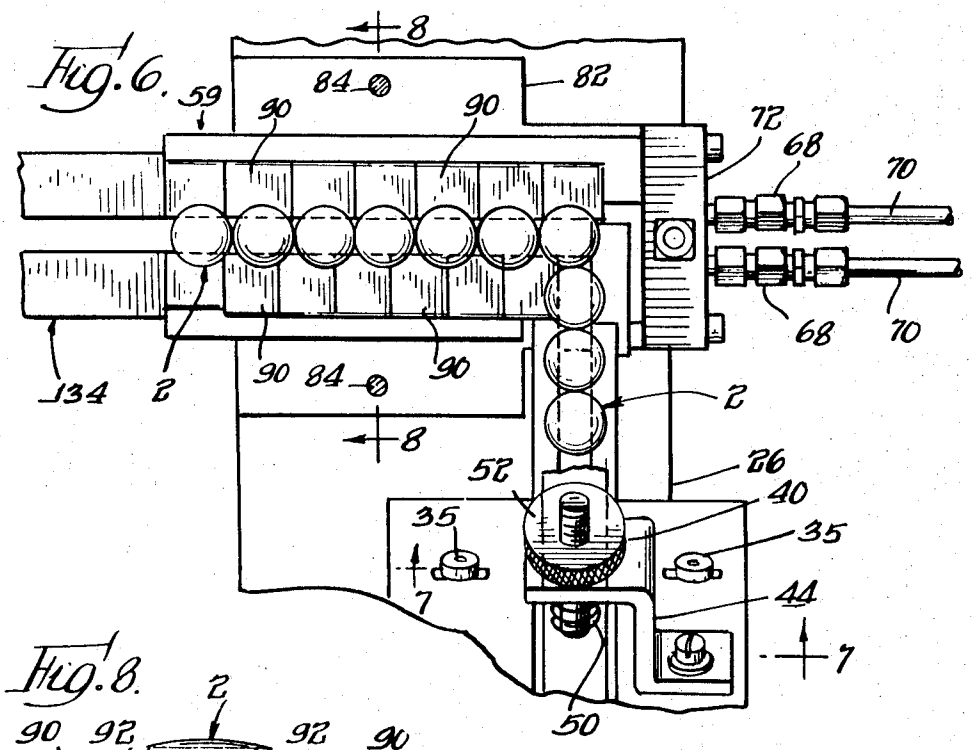


Fig. 8.

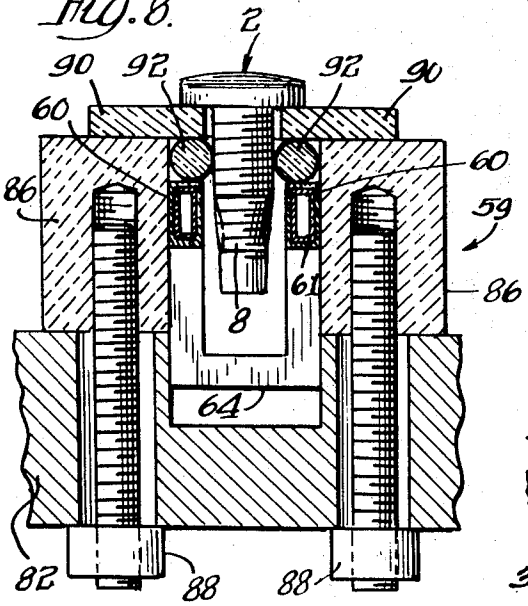
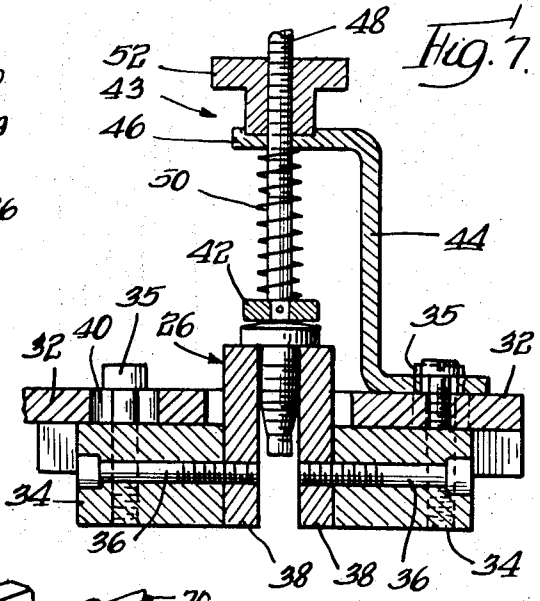


Fig. 7.



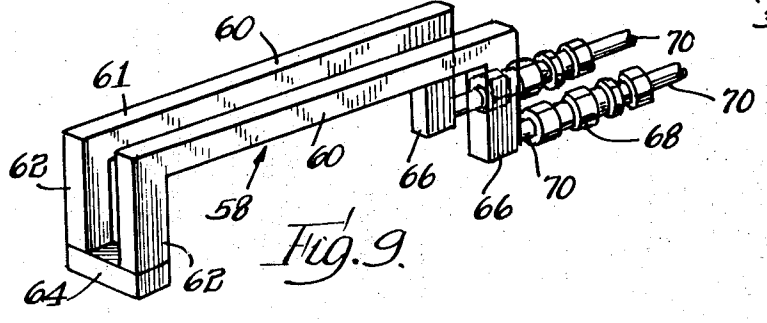


Fig. 9.

Fig. 10.

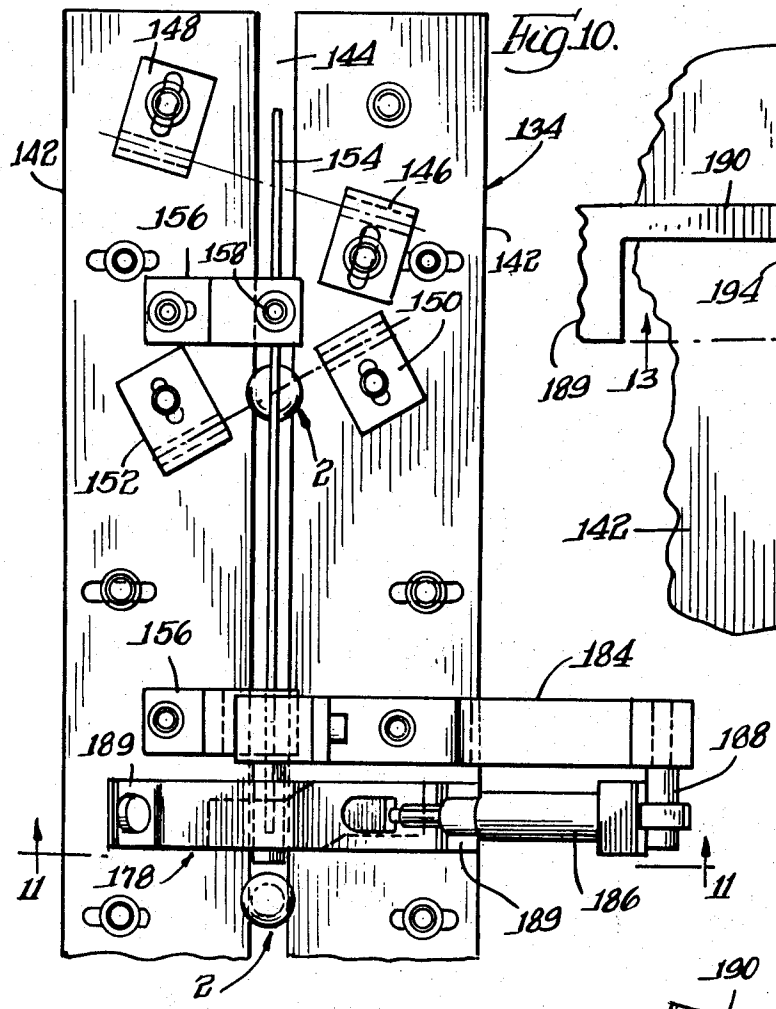


Fig. 12

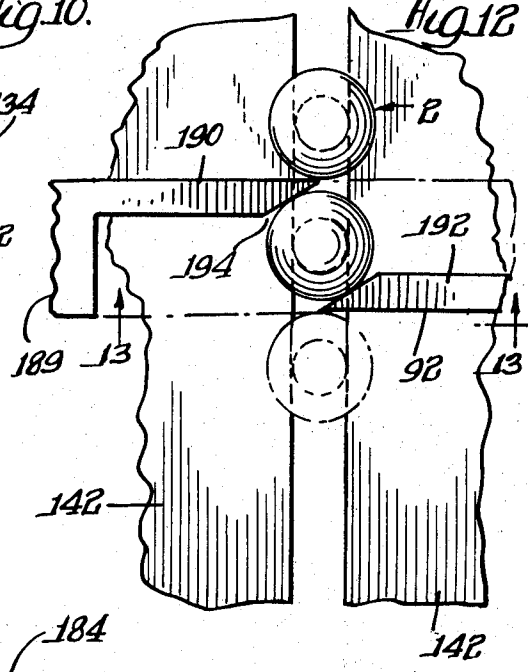


Fig. 13.

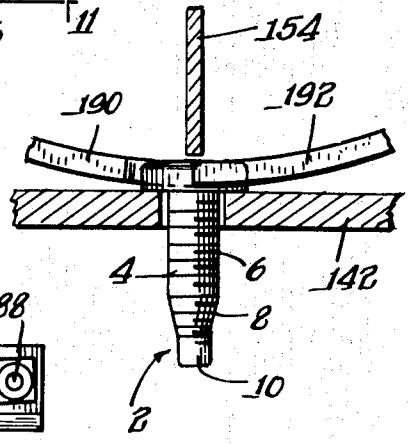
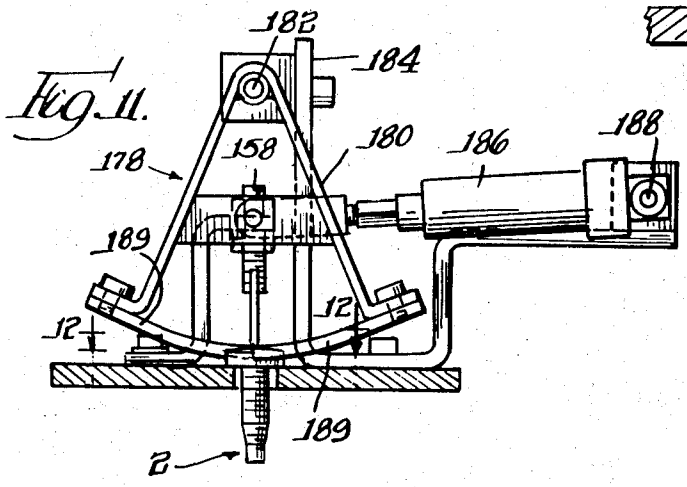


Fig. 11.



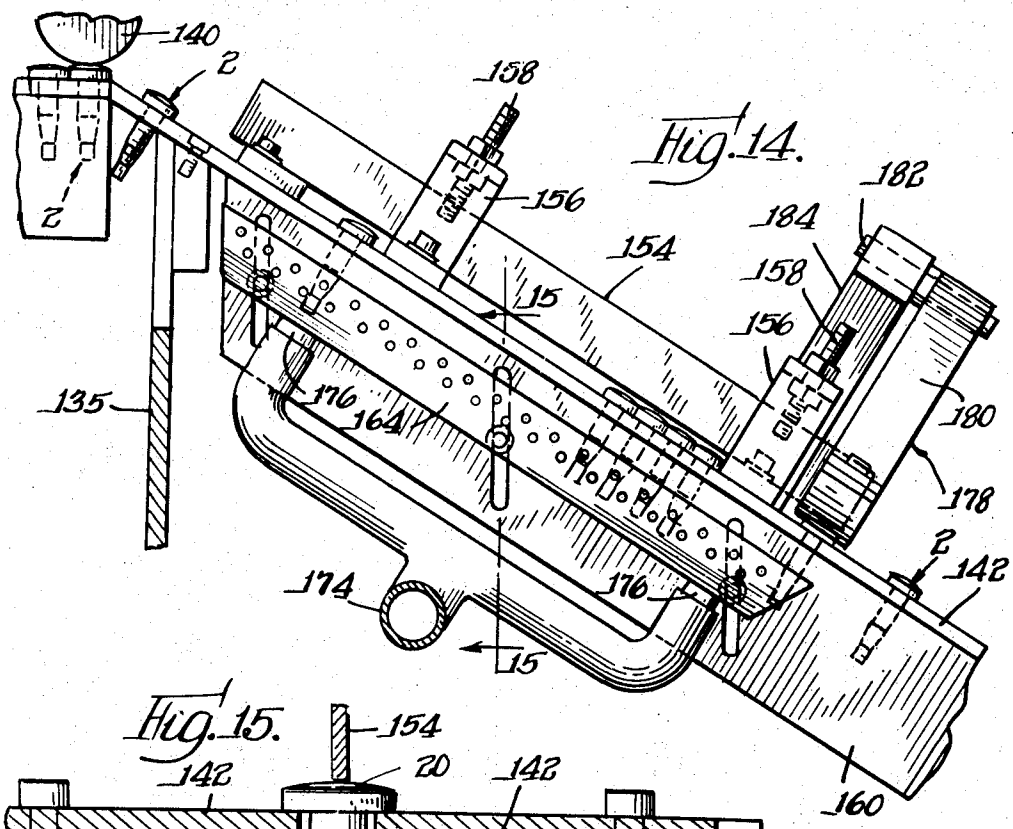


Fig. 14.

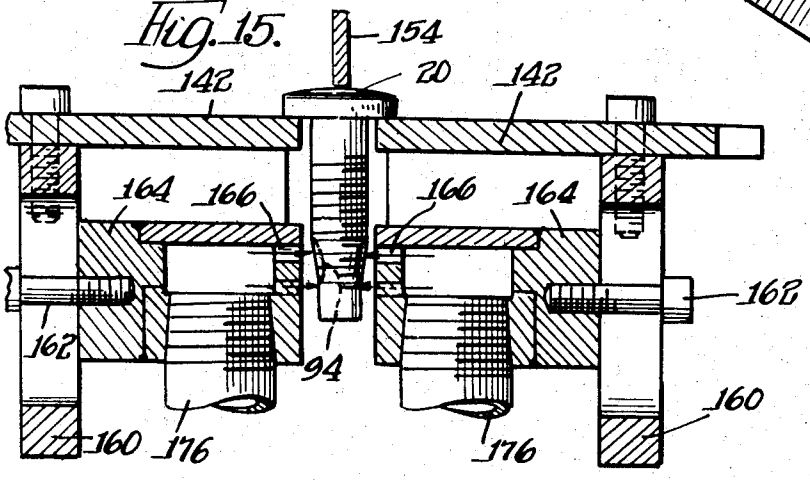


Fig. 15.

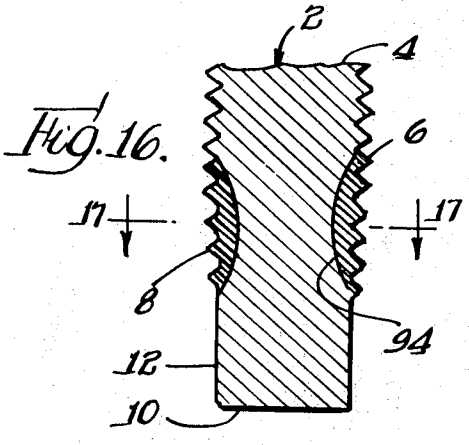


Fig. 16.

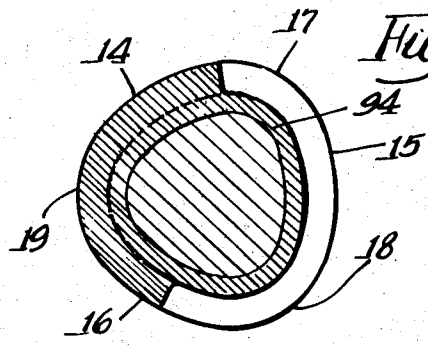


Fig. 17.

LOCALIZED HEAT TREATING MACHINE

This is a Continuation of application Ser. No. 334,879, Filed Feb. 22, 1973, now abandoned, which in turn is a division of Ser. No. 128,040, filed Mar. 25, 1971 now U.S. Pat. No. 3,769,103.

BACKGROUND OF THE INVENTION

This invention relates to a selectively heat-treated article, such as a screw, threaded article, or the like and to a method and machine for making the same.

In the manufacture of thread-forming screws of hardenable metal, it is a common practice to case harden the screws so that the thread thereon will be effective to swage or cut a thread in the workpiece. Case hardening involves heat treating in a special atmosphere, usually one that is enriched in carbon. In accordance with case hardening techniques, the screw or other workpiece is heated through its entire body, and during the heating the carbon penetrates a predetermined distance into the body. Upon quenching in water or oil the carbonized skin forms a hardened shell or case. A mild temper for stress relief may follow the quenching operation.

It is also known to harden and temper thread-forming devices (e.g., self-tapping screws, taps) by simply hardening in an atmosphere that contains sufficient carbon to prevent reduction of the carbon content of the surface of the thread. However, the process skill involves a heating of the entire device to the requisite treatment temperature.

Conventional hardening processes of the foregoing type, and others of the prior art, do not always produce a thread-swaging screw of desired properties. The hardening may be satisfactory so far as producing a thread that is able to withstand thread-forming pressure in the workpiece; however, it often results in a screw that has undesirable structure and/or composition for certain purposes. In this regard it should be noted that in many thread-swaging fasteners, only a portion of the thread actually is used to form the thread while the remainder of the thread is for holding the screw and workpiece assembled. Thus, where the screw, when assembled with the workpiece, is subjected to dynamic stresses or even high static stresses, the surface of the screw may be subject to cracking due to the inherent brittleness. This may result in spreading of the crack through the body of the fastener and ultimate failure thereof.

OBJECTS AND SUMMARY OF THE INVENTION

It is an object of this invention to provide a threaded article, such as a self-tapping screw, in which the thread is locally hardened at the work-entering portion of the thread (i.e., the part of the thread that forms a thread in the workpiece) but wherein the remainder of the screw is left at a hardness to which it has been previously heat-treated and which is ordinarily the hardness that is best adapted to the use for which the screw is intended. The zone of hardness is controlled or limited to a predetermined depth necessary to provide the work-entering portion of the thread with such hardness as may be necessary to withstand the thread-forming pressure from the workpiece. The thread-forming portion or zone need not have a knife edge as in a thread cutting device.

A further object of this invention is to provide a thread-swaging screw in which the depth of hardness of the localized zone is reasonably consistent throughout the circumference of the screw at such zone. The thread-swaging screw may be of various known types; however, a type having an arcuate polygonal cross-section with arcuate sides and arcuate intermediate thread-swaging lobes is a particularly suitable form of this invention.

It is also an important object of this invention to provide a method of making a thread-forming article that comprises locally heating a thread-forming zone of the article to a predetermined depth that includes the thread thereat and then quenching the heated zone to harden such zone. The core of the article that is surrounded by the hardened zone as well as the remainder of article remote from the zone is left substantially unchanged as to hardness. The method is particularly suitable for thread-swaging screws of the type stated, but the principles are applicable to other kinds of thread-forming devices (e.g., taps, locking screws or bolts) or to other types of screws wherein the hardening or tempering of only a portion of the article is desired.

It is a further object of this invention to provide a method of the type stated in which the localized heating in the aforesaid zone is carried out by an inductive heater that induces at said zone a high frequency alternating current field. The induced field results in a "skin effect" heating to a predetermined depth that may be controlled so as to be no greater than is actually needed. The process is carried out in ordinary ambient air.

A further object of this invention is to provide a machine for carrying out the aforesaid method to produce the zone hardened articles on a continuous flow, mass-production basis, or to temper articles on a mass-flow basis.

A more specific object of this invention is to provide a machine that comprises an induction heating element for heating articles only in a desired localized zone, mechanism for feeding the articles automatically to said induction heating element, mechanism for automatically removing the heated articles from the heating element, and a quenching manifold for spraying a quenching liquid, such as water or oil, onto the heated zone while the latter is still sufficiently hot to produce the desired hardness. The machine is principally intended for zone hardening of screws, but other elongated articles might also be zone hardened by the machine.

In accordance with the foregoing objects, articles such as thread-forming screws, are supplied from a hopper to a raceway in which the screws are fed, one at a time, by a pusher mechanism onto a support so that the shanks of the screws are disposed between and perpendicular to the general plane defined by parallel bars that form part of a single turn induction heater. The height of the bars and their positions relative to the shanks of the screws are such that the bars induce a current field locally into the selected zone of each shank peripherally therearound. In the normal operation of the machine, a group of screws is positioned in abutting parallel relation between the bars so that the screws are progressively heated as they are pushed through the path between the bars in a step-by-step manner by the pusher. As a screw is fed from the raceway and into the space between the bars to commence heating of that screw, another screw that has now been moved completely through the path between the bars

(and is now fully heated) is discharged from between the bars by a feed roller. The feed roller causes the heated screw to become deposited on a second raceway down which the heated screw immediately passes to the quenching manifold that quenches the zone uniformly with a high pressure spray. For tempering the quenching is not used. An escapement mechanism is interposed in the second raceway adjacent to the discharge end of the quenching manifold to allow a quenched screw to be released for further movement down the raceway to a receptacle as soon as a heated screw is discharged from the induction heater and approaches the quenching manifold.

BRIEF DESCRIPTION OF THE FIGURES

In the drawings:

FIG. **1** is a fragmentary perspective view showing portions of a machine constructed in accordance with and embodying the present invention;

FIG. **2** is a fragmentary and elevational view of the machine;

FIG. **3** is a front elevational view thereof;

FIG. **4** is an enlarged fragmentary sectional view taken along line **4—4** of FIG. **3**;

FIGS. **5** and **6** are fragmentary sectional views taken along lines **5—5** and **6—6** respectively of FIG. **4**;

FIGS. **7** and **8** are fragmentary sectional views taken along lines **7—7** and **8—8** respectively of FIG. **6**;

FIG. **9** is a perspective view of the induction heating element that forms part of the present invention;

FIG. **10** is a fragmentary plan view as seen from line **10—10** of FIG. **2**;

FIG. **11** is a fragmentary sectional view taken along line **11—11** of FIG. **10**;

FIG. **12** is an enlarged fragmentary sectional view taken approximately along line **12—12** of FIG. **11**;

FIG. **13** is a fragmentary sectional view taken along line **13—13** of FIG. **12**;

FIG. **14** is an enlarged fragmentary sectional view taken approximately along line **14—14** of FIG. **3**;

FIG. **15** is an enlarged fragmentary sectional view taken along line **15—15** of FIG. **14**;

FIG. **16** is a fragmentary longitudinal sectional view of a thread-forming screw constructed in accordance with and produced by the method of the present invention; and

FIG. **17** is a sectional view taken along line **17—17** of FIG. **16**.

DETAILED DESCRIPTION

Referring now in more detail to the drawing and in particular to FIGS. **15–17**, there is shown a self-tapping screw of one type with which the present invention is concerned. The screw **2** includes a shank **4** having a helical thread **6** thereon. The thread **6** includes a thread-swaging portion **8** at which the crest of the thread is of progressively decreasing diameter toward the work-entering end **10** of the screw. In the form of screw shown in FIG. **16**, there is a relatively long unthreaded tapered portion **12** between the work-entering end **10** and the thread-swaging portion or zone **8**; however, the screw **2** may be of a type having its thread extending to the work-entering end **10** or almost thereto. As seen in FIG. **17**, the cross-section of the thread defines a regular polygon with an odd number of sides. This cross-sectional configuration may be present throughout the full length of the thread **6** or it may simply be in the threadswaging zone **8** and such lead section **12** as may be present. In the specific form shown, the cross-section of the thread defines three arcuate sides **14, 15, 16** with arcuate intermediate thread-swaging lobes **17, 18, 19**. The screw **2** also has a head **20** that is larger in diameter than the adjacent part of the shank **4**.

Referring now to FIGS. **1–3, 6** and **7**, the machine, generally designated at **22**, comprises a hopper **24** for holding a supply of screws **2**. The hopper includes a feeding mechanism of known type for feeding the screws one by one into a downwardly inclined raceway **26**. The raceway **26** is mounted at the desired angle of inclination on an upstanding support **28** which is, in turn, mounted on a suitable frame portion **30** of the machine. The raceway support **28** includes side members **32, 32** that are bolted to end blocks **34, 34**. Passing through the end blocks **34, 34** are bolts **36, 36** for threaded engagement with rails **38, 38**. When the screws **2** slide down the raceway **26**, the screw head **20** rests on the tops of the rails **38, 38** and the screw shank **4** projects into the gap between the rails **38, 38**. To provide for adjustable spacings of the rails **38, 38** the bolts **35** are disposed in elongated slots **40**, one such slot being shown in FIG. **7**.

Also in FIG. **7**, a hold down bar **42** is disposed above the rails **38, 38** and is adjustably positioned so that the heads of the screws when on the rails **38, 38** keep the screws perpendicular to the raceway. The mounting for the hold down bar **42** includes two assemblies **43, 43** each having a bracket **44** that is bolted to one of the side members **32**. At its upper end the bracket has a flange **46** for receiving the threaded stud **48**, the lower end of which is secured to the hold down bar **42**. A coil spring **50** encircles the stud **48** and is interposed between the flange **46** and the hold down bar **42**, and above the flange **46** a hand screw **52** is threaded onto the stud **48**. Thus, by turning the screws **52, 52**, the position of the hold down bar **42** may be adjusted relative to the rails **38, 38**.

In the normal operation of the machine, the feeding mechanism within the hopper **24** should maintain a supply of screws **2** in the raceway **26**. To make sure that the raceway is kept supplied, there is shown diagramatically in FIG. **1**, a light source **54** and a photocell **56** that may be used to control the motor that operates the feeder within the hopper **24**. When the light beam ceases to be interrupted by screws **2**, the feeder begins to operate to discharge screws from the hopper **24** into the raceway **26**.

At the bottom of the raceway **26** the machine has an induction heating element **58** and related structure **59** for mounting the element in place and for providing a slidesupport for the screws that pass through the element **58**. The heating element is in the nature of a one turn induction coil. As best seen in FIG. **9**, the element **58** is a tubular copper member of rectangular cross-sections (see FIG. **8**) having spaced parallel bars **60, 60**, the forward ends of which have downturned legs **62, 62** that are cross connected by an end section **64**. At its opposite ends there are additional depending legs **66, 66** which are electrically and mechanically connected through fittings **68, 68** to electrical tubular copper leads **70, 70**. Intermediate the fittings **68, 68** and the legs **66, 66** the leads **70, 70** may be clamped in a suitable manifold **72** (FIGS. **4** and **6**). As best seen in FIG. **8**, the element **58** may be coated with glass or ceramic **61** for insulation purposes. Current may be sup-

plied to the leads **70, 70** from an induction heating generator **74** (FIG. **2**) through a pair of tubular supply lines **76** that are respectively connected to the leads **70, 70.** In addition to electric current, cooling water may be circulated from a suitable source of supply through the lines **76** and the leads **70** to the coil **58** to maintain the coil at the desired operating temperature. The electric current supply to the coil is preferably of a radio frequency and may be of the order of 400KHz.

Referring more particularly to FIGS. **4, 5, 6** and **8** it will be seen that the structure **59** includes a base plate **78** that is bolted or otherwise rigidly secured to a frame portion **80** of the machine. Bolted to the upper surface of the base plate **78** are spacer blocks **80** that support an upper block **82.** The upper block **82** is secured to the spacer blocks **80** by hand screws **84, 84.** On top of the block **82** are dielectric members **86, 86** which are disposed on opposite sides of the coil bars **60, 60.** The members **86, 86** may be secured to the block **82** by fiber nuts and studs **88.** On top of the members **86, 86** and secured thereto in any suitable manner are ceramic plates **90** that provide a relatively low friction surface for engagement by the heads of the screws **2** as the screws pass between the coil bars **60, 60.** Interposed between the upper surfaces of the bars **60, 60** and the ceramic plates **90** are insulating glass spacer rods **92, 92.**

As each screw **2** leaves the lower end of the raceway **26** and comes to rest on the ceramic plates **90, 90,** as shown in FIG. **6,** the screws will progressively pass between the bars **60, 60** to become inductively heated. The relative positions of the bars **60, 60** with respect to the thread-swaging zone **8** of the screw **2** and the sides of the bars **60, 60** should be such that the bars approximately span the axial length of the thread-swaging zone **8** and with the thread-swaging zone **8** being closely adjacent to the bars **60, 60** to effect maximum inductive heating and close control over the depth of heating. Accordingly, when the screws are advanced in the space between the bars **60, 60,** the high frequency electric current will be induced at the zone **8** through a predetermined depth such as indicated by the line **94** in FIGS. **16** and **17.** Since the high frequency alternating current produces a "skin effect," the heating is confined to the localized area of the thread-swaging zone **8** leaving substantially unheated the core of the screw that surrounds the heated zone and the parts of the screw axially remote therefrom. The heating is progressive and may be readily controlled so that just the proper amount of depth of heating in the localized zones is attained. The depth and length of the heated zone need only be that sufficient to withstand the thread-forming pressures to which the screws are intended to be subjected during use.

The mechanism for feeding the screws between the coil bars **60, 60** will now be described, and for this purpose reference should be had to FIGS. **4** and **5.** Suitably secured to the frame of the machine is an upstanding motor bracket **96** having a top plate **98** upon which is mounted a variable speed feeder motor **100.** The top plate **98** is apertured for receiving the motor shaft which has thereon a crank **102** that is journalled at one end of a connecting rod **104.** The other end of the connecting rod **104** is journalled on a pin **106** that is secured to a yoke **108.** The yoke **108** carries with it a depending angle bracket **110** which, in turn, carries a pusher **112.** The angle bracket **110** is adjustably secured to the yoke **108** by bolt **114** while the pusher **112** is adjustably secured to the angle bracket **110** by bolt **116.** This allows for adjustments for various sizes of screws being processed. The pusher **112** reciprocates and has a stroke as determined by the throw of the crank **102.** For purposes of guiding the yoke **108** and thus the pusher **112** in the path of reciprocation, a flange **118** is bolted to the motor bracket **96** for rigidly supporting spaced parallel guide pins **120, 120.** Nuts **122, 122** retain the guide pins in place. For each rotation of the crank **102,** the edge **124** of the pusher engages the bottommost screw in the raceway **26** and pushes it into the space between the coil bars **60, 60** to commence the zone heating of the screw.

An anti-jam feature of the pusher **112** is also provided. For this purpose the vertical arm portion **126** of the pusher **112** is rigidly secured to a member **128** that is slidable within the horizontal portion **130** of the pusher **112.** A spring **132** is operatively interposed between the leading end of the slidable member **128** and the vertical arm portion **126.** This biases the arm portion **126** into abutting relationship with the portion **130.** However, if the leading edge **124** meets excessive resistance due to jamming of the machine, the member **128** will slide relative to the portion **130** causing the spring **132** to expand. The member **126** and the member **128** will then be able to move to the left (FIG. **4**) relative to the member **130** to take up the stroke of the mechanism.

As will best be seen from FIGS. **4** and **6,** a plurality of screws **2** with the heads thereof in abutting relationship are supported on the ceramic plates **90** for step-by-step movement between the bars **60** so that each screw becomes locally heated a sufficient amount as it reaches the left hand end (FIGS. **4** and **6**) of the heater. Accordingly, the left hand end of the heater is suitably provided with a device for removing the heated screw and delivering the screw to a downwardly inclined raceway **134** for movement to a water quenching device, which forms part of the machine. As shown, the upper end of the raceway **134** is adjacent to the discharge end of the induction heater. This feed off mechanism comprises a motor **136** that is mounted on a bracket **97** and includes a shaft **138** that has a feed off roller **140** overlying the ceramic plate **40** at the end of the coil. The periphery of the feed roller **140** engages the fully heated screw at the head thereof each time the pusher **112** feeds a screw from the raceway **26** into the space between the bars **60, 60.**

Referring more particularly to FIG. **10,** the raceway **134** comprises opposed plates **142, 142** on which the head of the screw slides, and the plates define a gap **144** through which the screw shank projects. The raceway plates **142, 142** may be mounted on the frame of the machine by a support structure **135.** Mounted on the plates **142, 142** is a first electric eye control mechanism comprising a light transmitting source **146** and a photocell **148** that actuates a time delay safety mechanism. If a screw does not, within a specified period of time, interrupt the light beam, the machine is shut off. This may occur, for instance, should the machine jam. Further down the raceway **134** is a second photocell control arrangement comprising a light transmitting source **150** and a photocell **152** for the purpose of operating an escapement mechanism, to be hereinafter described.

A hold down member **154** is provided to maintain the screws **2** in the raceway in the proper positions, that is generally perpendicular to the plates **142, 142.** The hold down member **154** includes brackets **156, 156** that are mounted on one of the plates **142** and contain adjusting screws **158** by which the height of the member **154** relative to the raceway **134** may be adjusted for different sizes of screws.

Mounted on and depending from the raceway **134** are members **160, 160** having secured thereto as by bolts **162** a pair of opposed quenching manifolds **164, 164.** Formed in the quenching manifolds **164, 164** are orifices **166,** which are disposed along a substantial length of the raceway **134** and provide a means by which quenching liquid, such as water or oil, may be applied to the heated screws in the localized zone at which the screws are heated in the induction heating element **58.** Accordingly, the quenching manifolds **164, 164** should be mounted at distances below the raceway plates **142, 142** such that the orifices **166** are approximately in alignment with the locally heated thread-swaging zone **8,** as seen in FIG. **15.** Thus, the vertical positions and the spacing of the quenching manifolds are adjustable.

Water for the quenching manifold may be stored in a suitable reservoir or tank **168** (FIG. **2**). A pump **170,** driven by electric motor **172,** draws water from the tank **168** and delivers the water under pressure to manifold piping **174** which connects with pipe sections **176, 176** (FIG. **15**) for delivery of the fluid to the respective manifolds **164, 164.** The quenching water that impinges upon the screws drops downwardly between the manifolds and may be suitably collected for recirculation to the supply tank **168.**

Since the heated screws **2** are rapidly fed from the heater **58** by the roller **140** and the screws quickly slide down the raceway **134** to the quenching manifolds **164, 164,** the initial quenching is quite rapid, which gives desired hardness properties to the localized zone. Further cooling of the screws **2** takes place at the lower portions of the quenching manifolds **164** where, as shown in FIG. **10,** several screws **2** may be positioned, the lowermost of which is in abutment with an escapement mechanism **178.**

The escapement mechanism **178** is of a type that is capable of operating faster than the normal machine feed and independently thereof. The escapement mechanism **178** includes a sector-shaped member **180** that is journalled for rocking movement on a pin **182,** the pin **182** being carried by an escapement mounting bracket **184** that is bolted to one of the raceway plates **134.** A pneumatic piston and cylinder assembly **186** is pivotally connected to the member **180** and also pivotally connected to the bracket **184,** the connection to the latter being at pivot pin **188.** The piston of the assembly **186** operates to rock the escapement member **180** back and forth through one cycle of operation when the stack or group of screws fills the raceway **134** up to the beam from the light source **150.** This interruption must be for a predetermined period of time so as to prevent actuation of the escapement when a screw is fed from the heating coil and momentarily breaks the beam from the light source **150.** Thus, the photocell **152** controls the actuation of the piston and cylinder assembly **186.** The arrangement of suitable valves for the assembly **186** and the manner of operating them by the photocell **152** can be carried out in accordance with known techniques.

Arcuate plates **189, 189** are bolted to the free ends of the sector member **180** and present portions **190, 192** that define an opening **194** (FIG. **12**). When the plate **189** swings clockwise about the pivot pin **182,** reference being to FIG. **11** a screw **2** will drop into the opening **194** and will be held therein between the portions **190, 192.** However, when the plate **189** then swings counterclockwise past dead center, the offset portion **192** will be out of the way of the screw in the opening **194** so that the screw will slide freely down the raceway **134** to a receptacle below. The next screw in line abuts the up raceway side of the member **190.** When the plate **189** moves back counterclockwise past dead center, the aforesaid next screw will become lodged in the opening **194.**

The screws **2** thus treated are now locally hardened uniformly in an annular zone which is of a predetermined depth from the periphery of the swaging portion **8** of the screw thread. Such depth of hardness is indicated by the line **94** in FIGS. **16** and **17.** This depth may be only a minor fractional part of the nominal diameter of the screw threads and need encompass only a few turns of the thread, namely those that do the thread-swaging in the work. The core of the screw surrounded by the locally hardened zone and the part of the screw axially of the hardened zone is of optimum hardness for intended use. Those regions are essentially unchanged as to composition or grain structure as a result of the process of this invention.

The invention is claimed as follows:

1. A machine for heat-treating elongated articles in a localized peripheral zone that is a fractional part of the length of the article and which envelopes a core of the article, comprising an induction heater, said heater having spaced bars, means for suspending said articles between said bars so that said localized zone is adjacent to said bars and said articles are sufficiently closely spaced to be inductively coupled for complete peripheral heating in said zone, means for feeding said articles through said induction heater, means for quenching in succession each article in said peripheral zone, means for conveying the heated articles in succession to the quenching means, and wherein the lengths of the bars are such that a plurality of articles can be supported between said bars by said suspending means with the articles running substantially perpendicular to the general plane defined by said bars and with the articles extending beyond said general plane, said means for feeding said articles through said induction heater cooperating with said means for conveying the heated articles to the quenching means to feed an article to an initial induction heating position between said bars and at the same time discharge another article from a final heating position from between said bars for conveyance to said quenching means.

2. A machine according to claim **1** including a raceway for containing a plurality of said articles, said raceway terminating adjacent to said bars for delivery of articles to said feeding means, said feeding means comprising means engageable with the articles delivered thereto by said raceway, and said conveying means comprises a rotatable feed wheel.

3. A machine for heat-treating screws each having a head and a peripherally threaded shank with a localized zone of the thread being of a type for producing a

thread in a workpiece: comprising an induction heater having means forming a region with a high frequency alternating current field, means for feeding said screws substantially non-rotatably through said field and such that said shanks are similarly oriented in said field and are sufficiently closely spaced side-by-side to be inductively coupled for heating at said zones circumferentially therearound at least to a tempering temperature while leaving substantially unheated the cores of the shanks that are surrounded by said zones, said induction heater being of such extent relative to the axial extent of said shanks that said zones are adjacent to said heater and said shanks extend beyond said heater thereby to leave substantially unheated the shanks remote from said zones, means by which said screws are withdrawn from said heater, and means for supporting said screws at their heads as they are fed through said field.

4. A machine according to claim **3** including means for quenching said screws at said zones.

5. A machine according to claim **3** including a raceway for receiving said screws as they are withdrawn from said heater, said raceway including means for slidably supporting the heads of said screws, said last-named means forming a gap for receiving the shanks of said screws.

6. A machine according to claim **3** in which said heating element comprises spaced bars between which said screws move and with the shanks of said screws being perpendicular to a general plane defined by said bars.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,836,743 Dated SEPTEMBER 17, 1974

Inventor(s) CHARLES H. WARDWELL and NORMAN L. HOLCOMB

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Abstract, line 17,	"articles" should be --article--; after "article" insert --and means for removing the heated articles--
Col. 1, line 22,	"carbonized" should be --carburized--
Col. 1, line 29,	"skill" should be --still--
Col. 6, line 11,	After "pusher" insert --112--

Signed and sealed this 17th day of December 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334.

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