Feb. 4, 1958 E. K. BASTRESS 2,822,162

METAL ARTICLE TREATING APPARATUS

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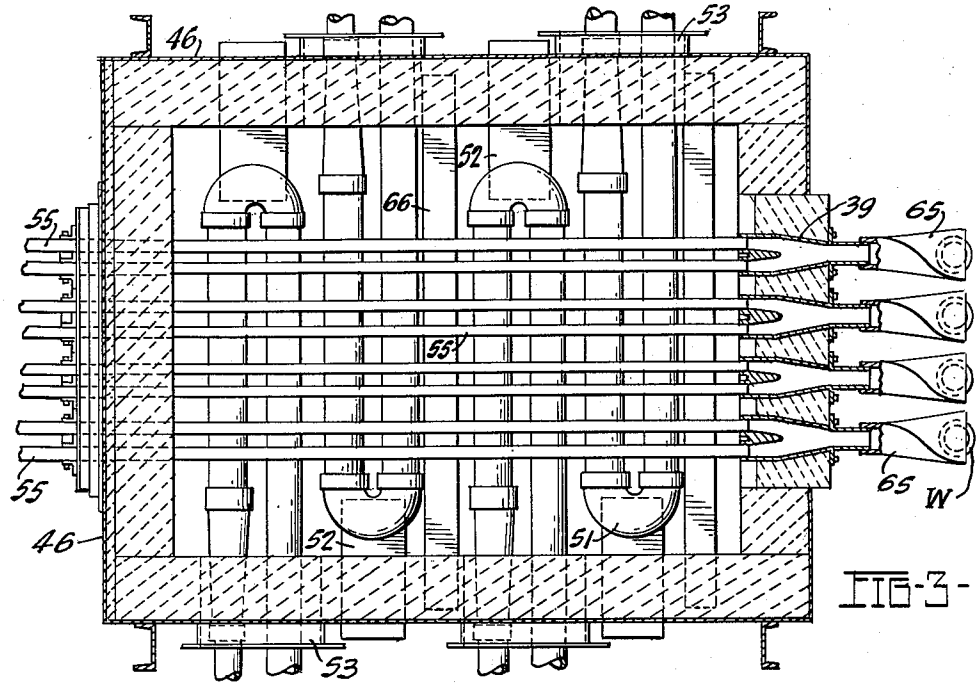


FIG-3-

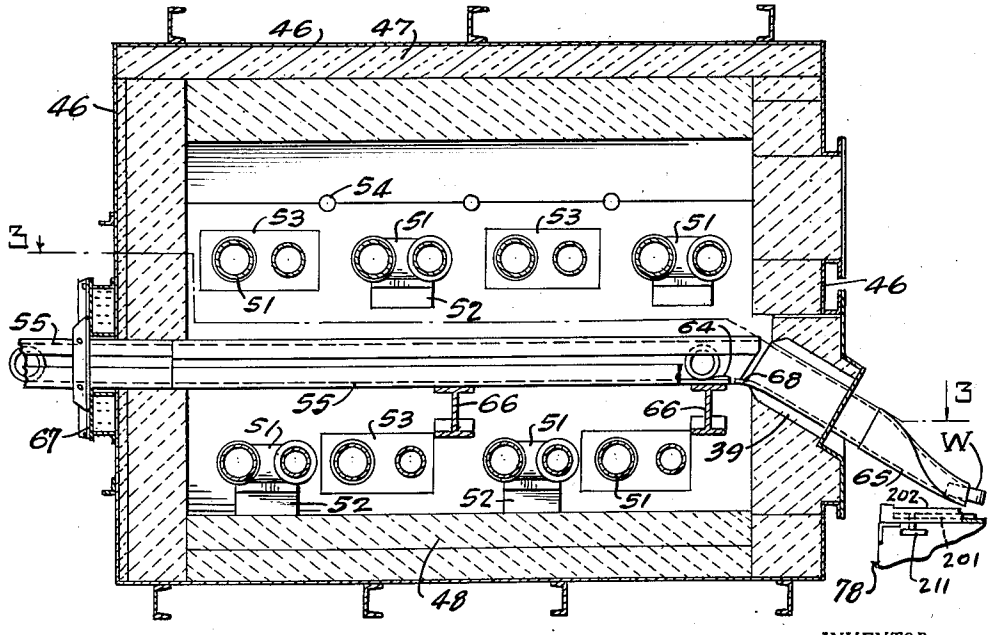


FIG-2-

INVENTOR:
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Atty.

Feb. 4, 1958 E. K. BASTRESS 2,822,162

METAL ARTICLE TREATING APPARATUS

Filed May 5, 1952 15 Sheets-Sheet 2

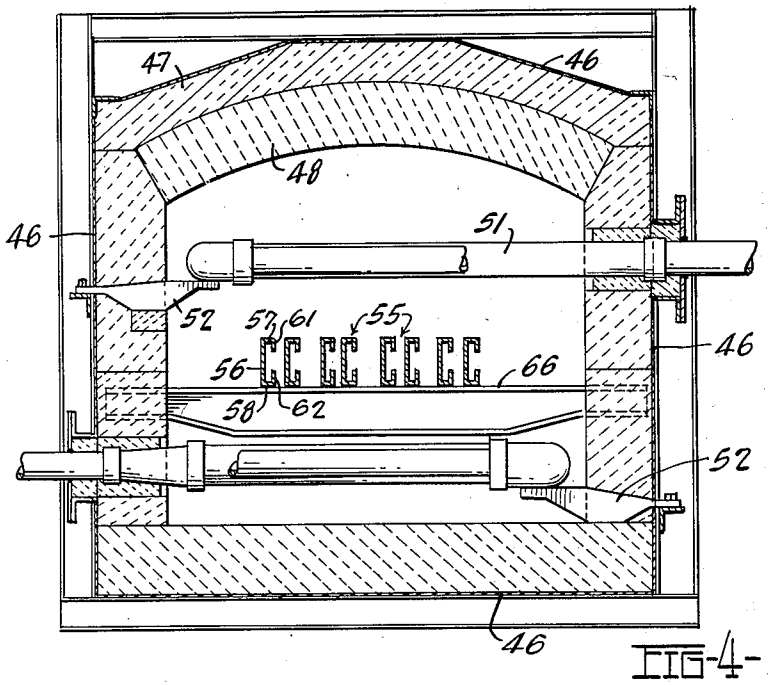


FIG-4-

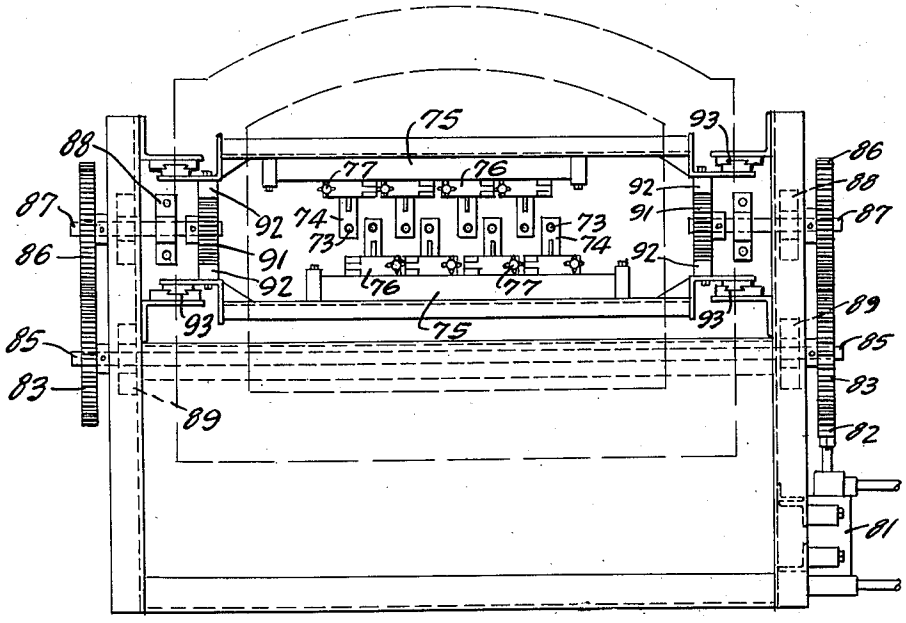


FIG-5-

INVENTOR:
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Feb. 4, 1958 E. K. BASTRESS 2,822,162

METAL ARTICLE TREATING APPARATUS

Filed May 5, 1952 15 Sheets-Sheet 3

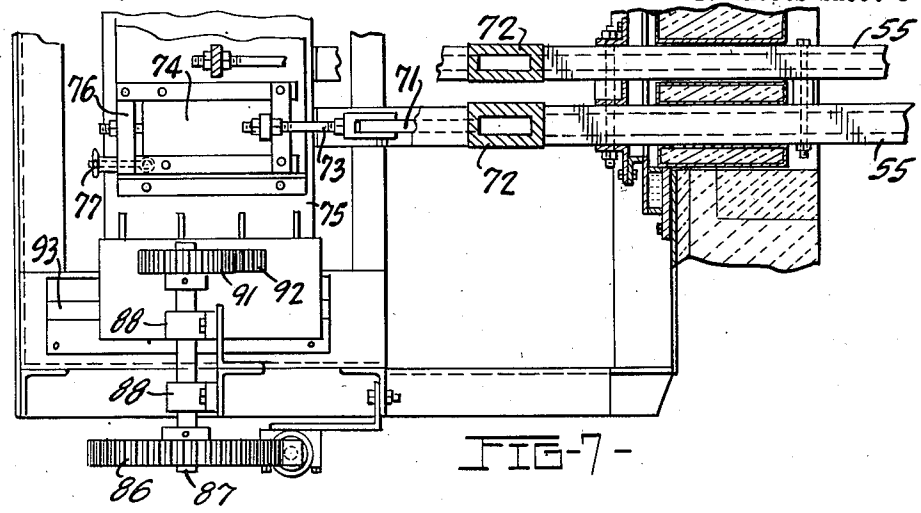


FIG-7-

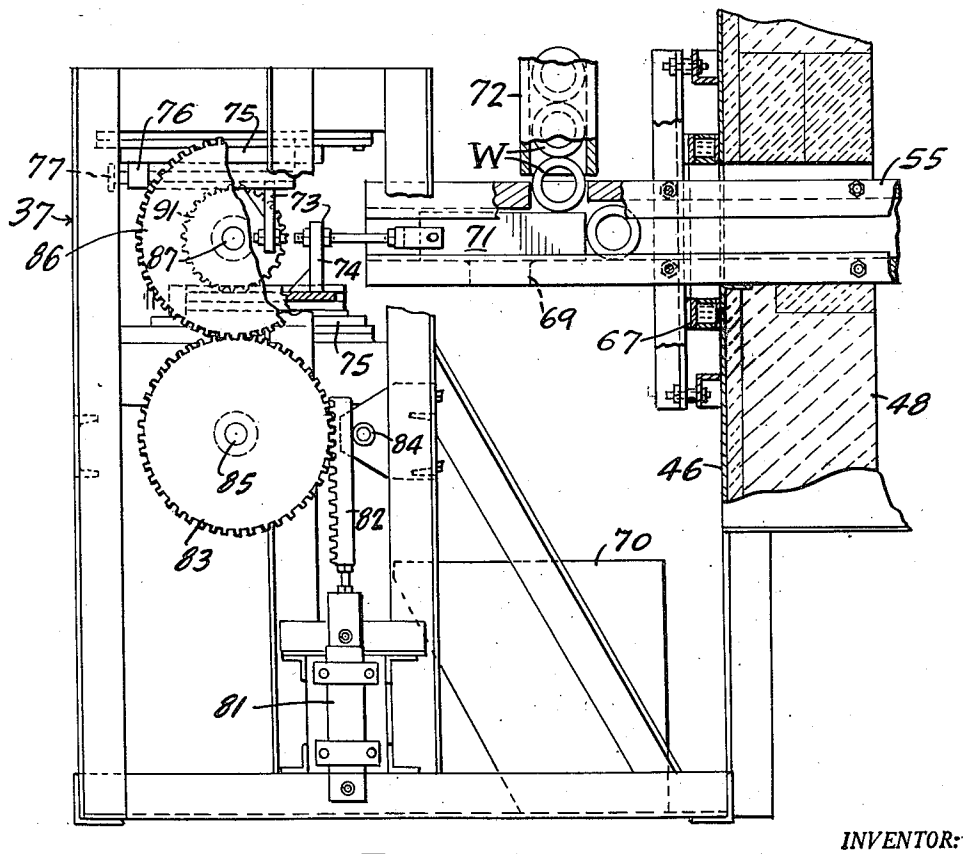


FIG-6-

INVENTOR:
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METAL ARTICLE TREATING APPARATUS

Filed May 5, 1952 15 Sheets-Sheet 4

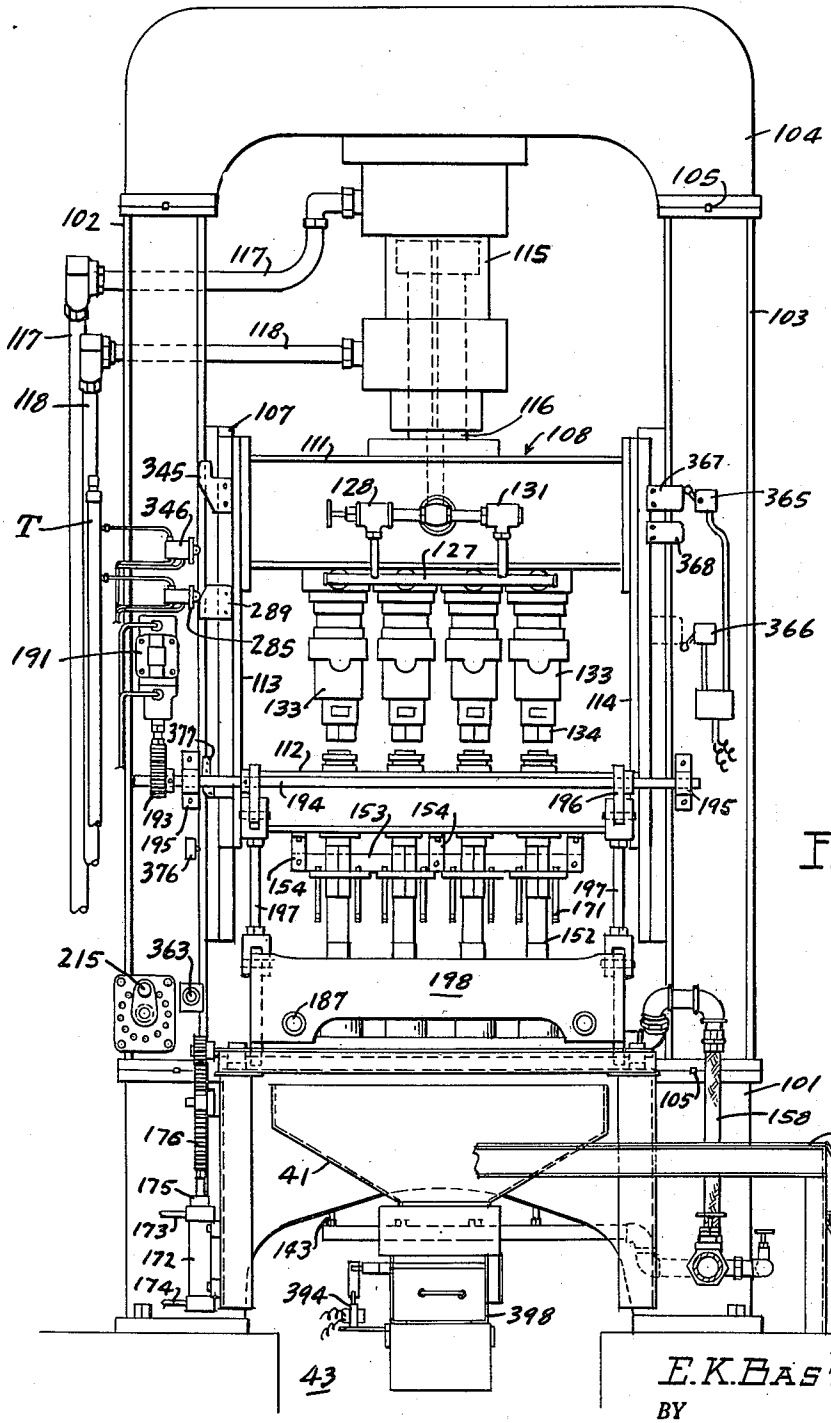


FIG-8-

INVENTOR.
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METAL ARTICLE TREATING APPARATUS

Filed May 5, 1952 15 Sheets-Sheet 5

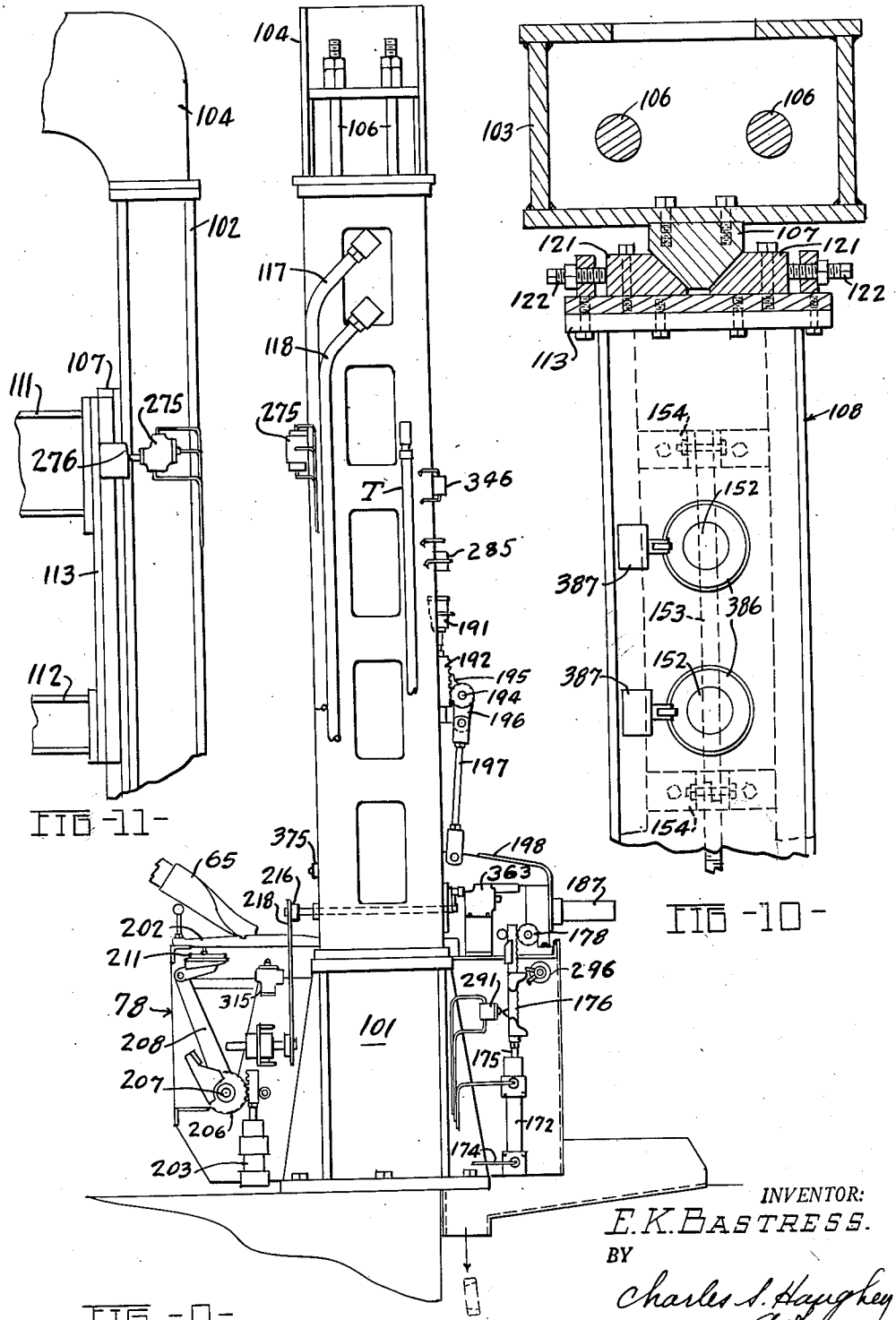


FIG -11-

FIG -10-

FIG -9-

INVENTOR:
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METAL ARTICLE TREATING APPARATUS

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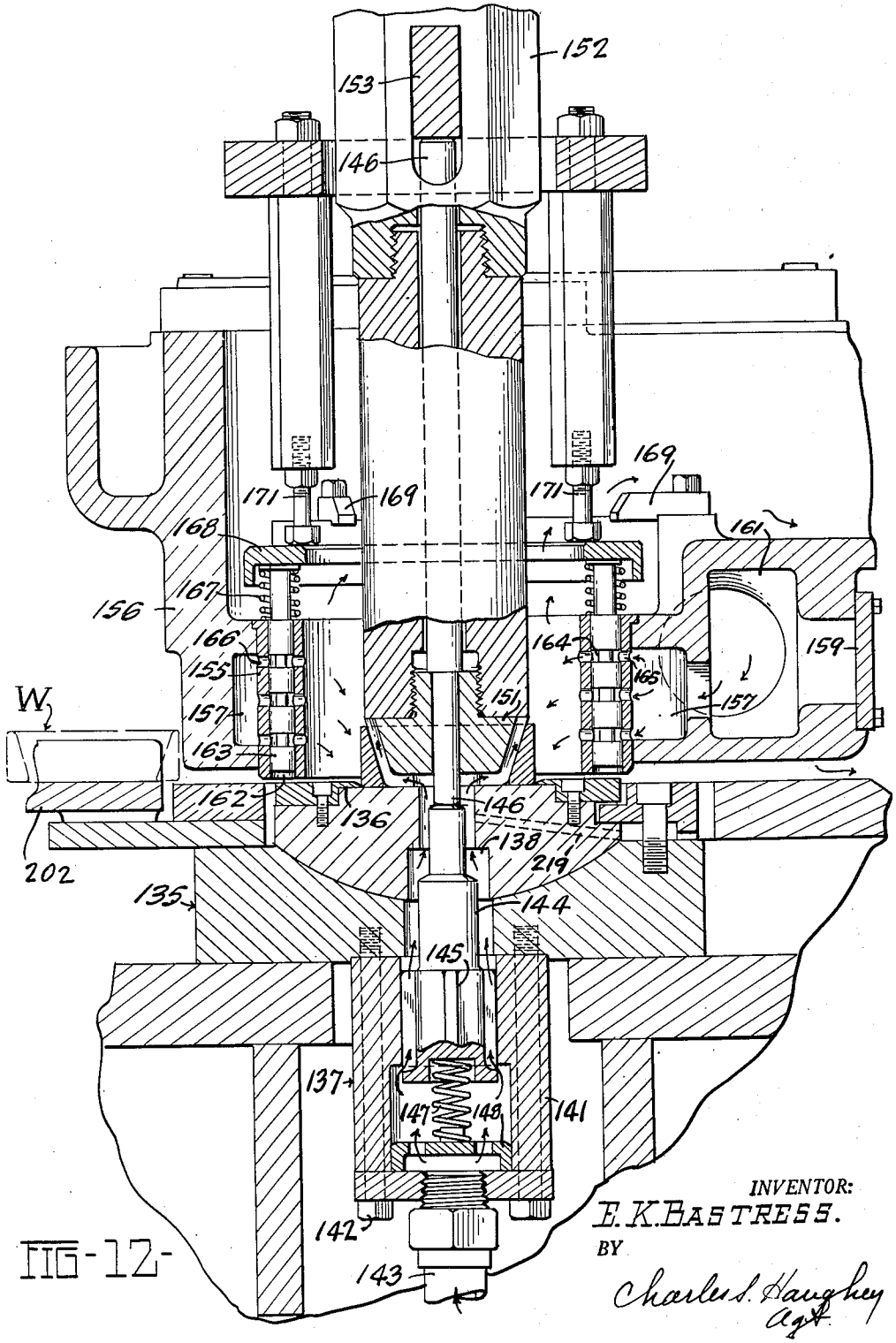


FIG-12-

INVENTOR:
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METAL ARTICLE TREATING APPARATUS

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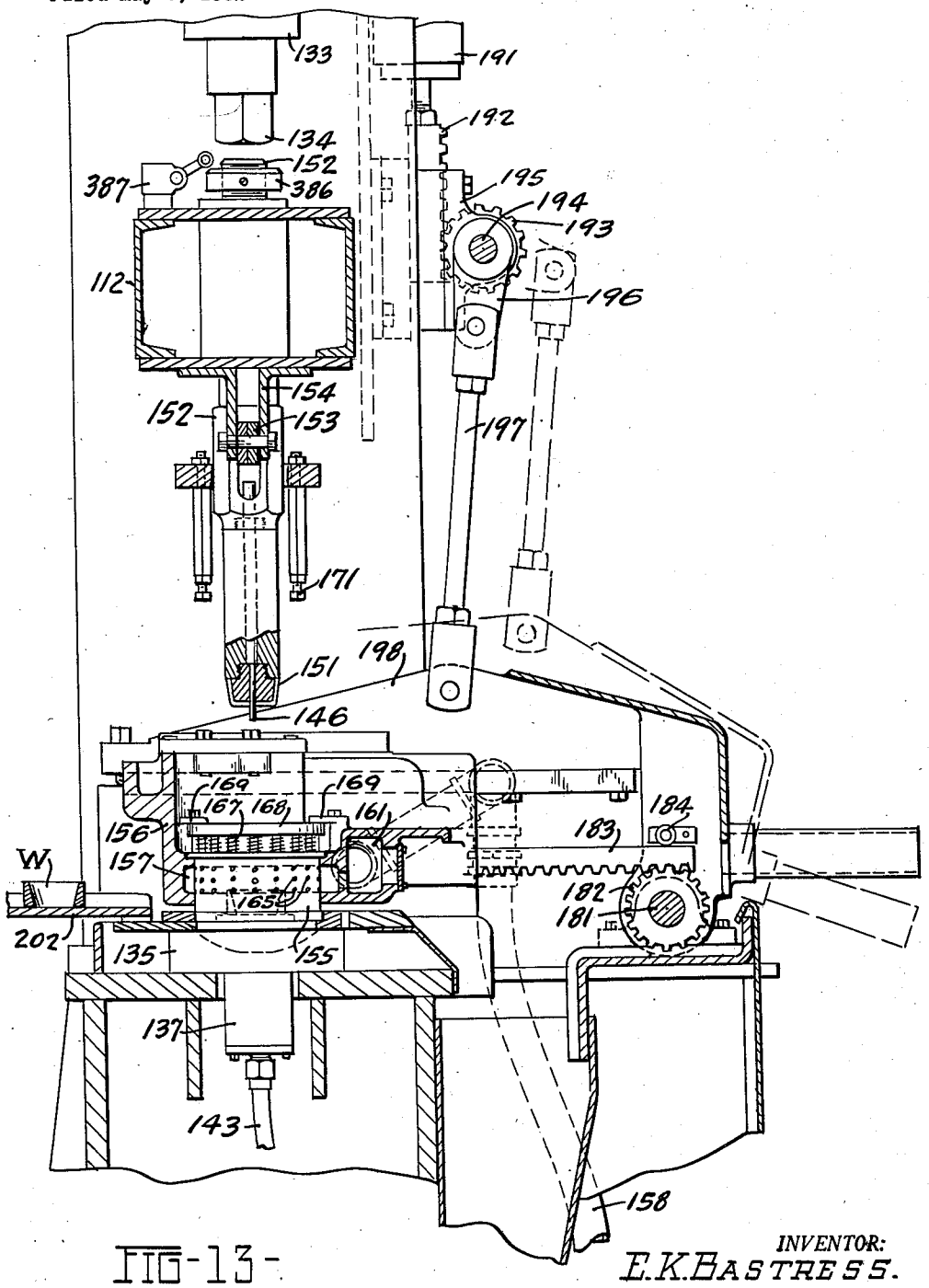


FIG-13-

INVENTOR:
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METAL ARTICLE TREATING APPARATUS

Filed May 5, 1952 15 Sheets-Sheet 8

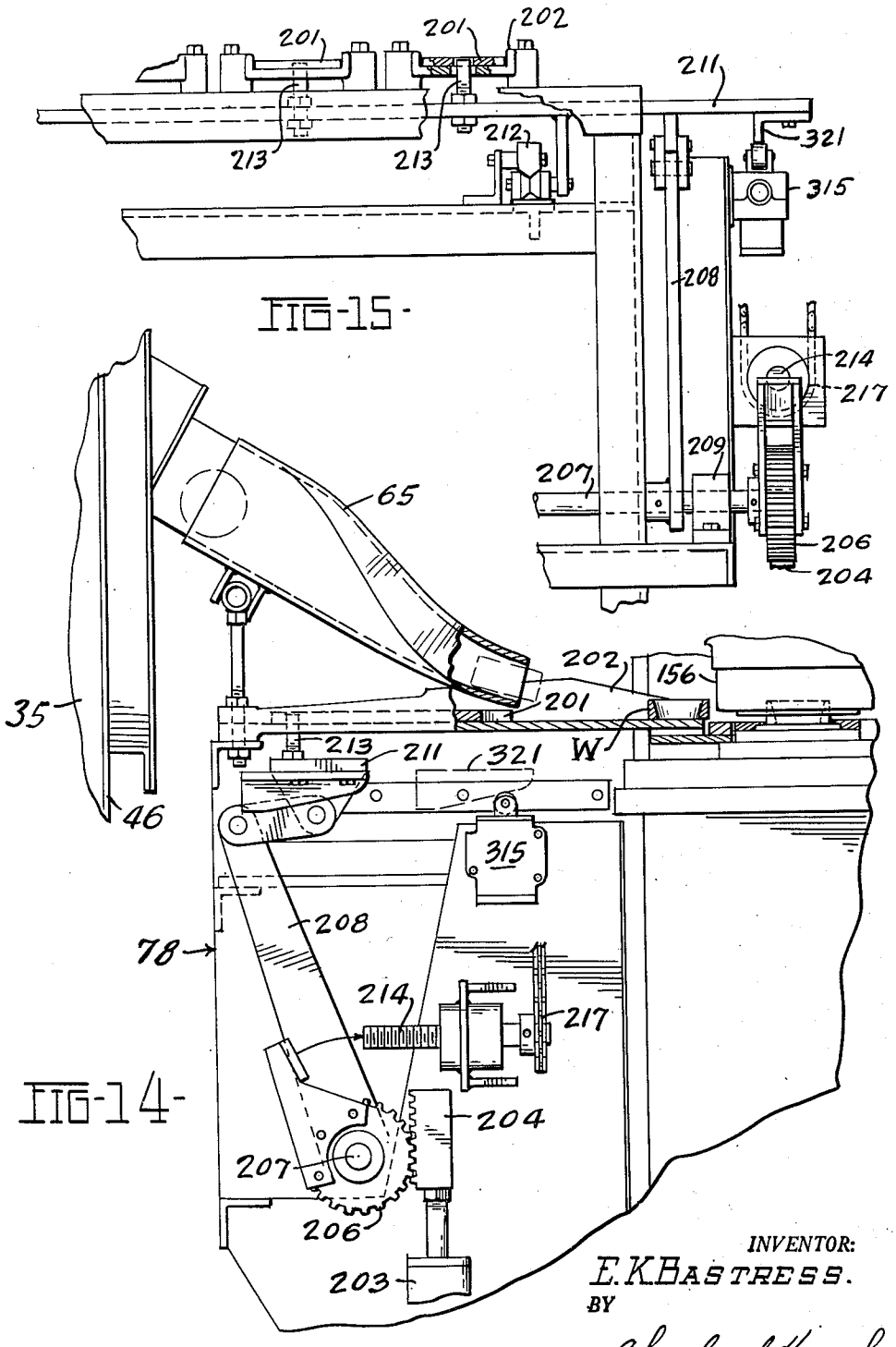


FIG-15-

FIG-14-

INVENTOR:
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Feb. 4, 1958 E. K. BASTRESS 2,822,162

METAL ARTICLE TREATING APPARATUS

Filed May 5, 1952 15 Sheets-Sheet 9

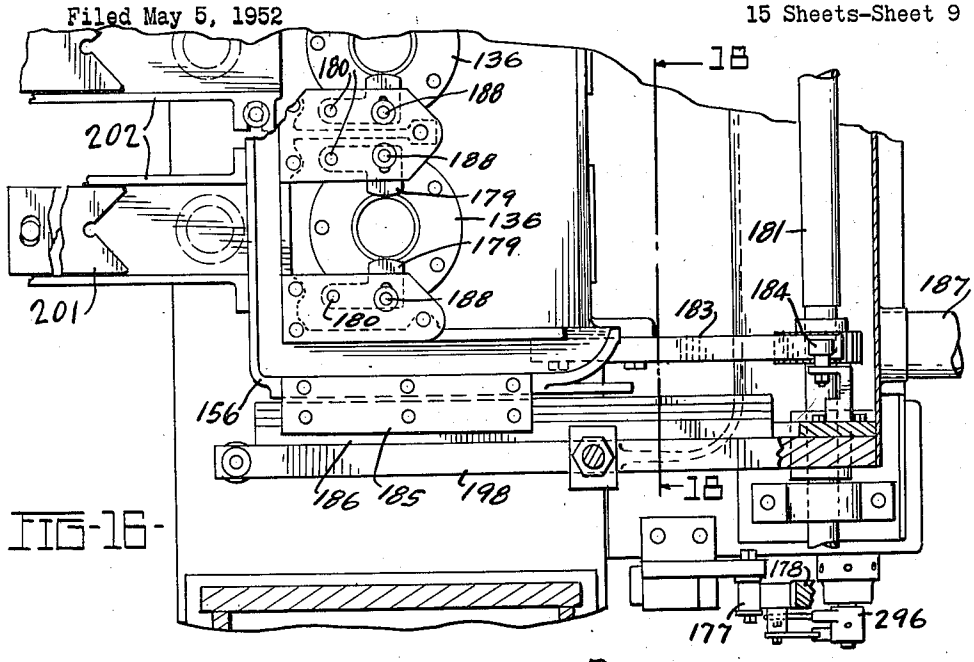


FIG-16-

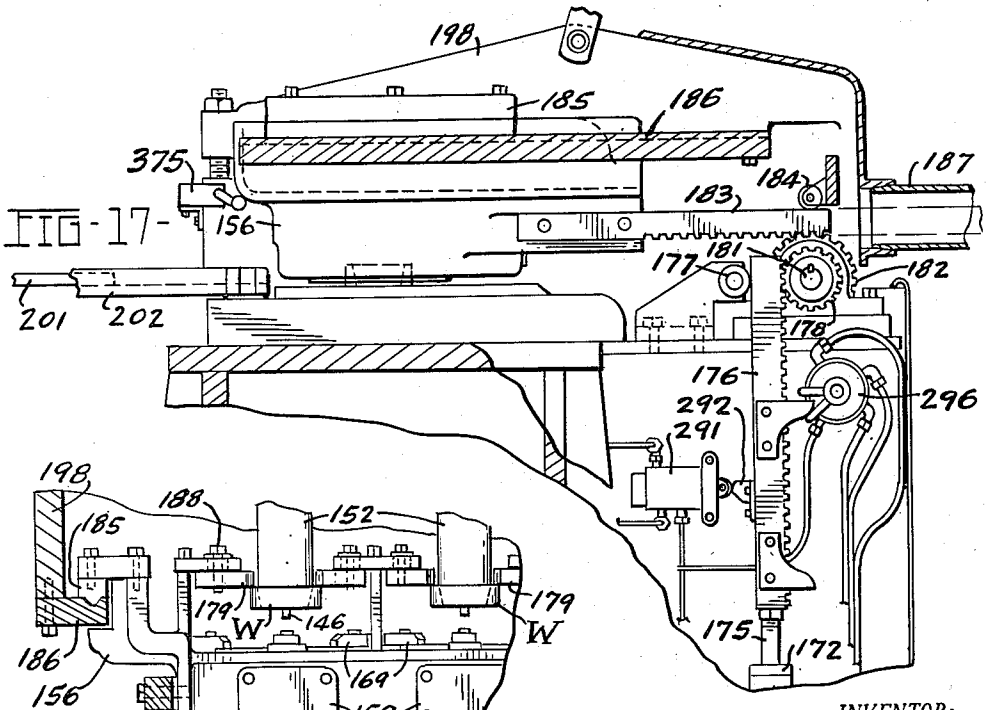


FIG-17-

FIG-18-

INVENTOR:
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METAL ARTICLE TREATING APPARATUS

Filed May 5, 1952 15 Sheets-Sheet 10

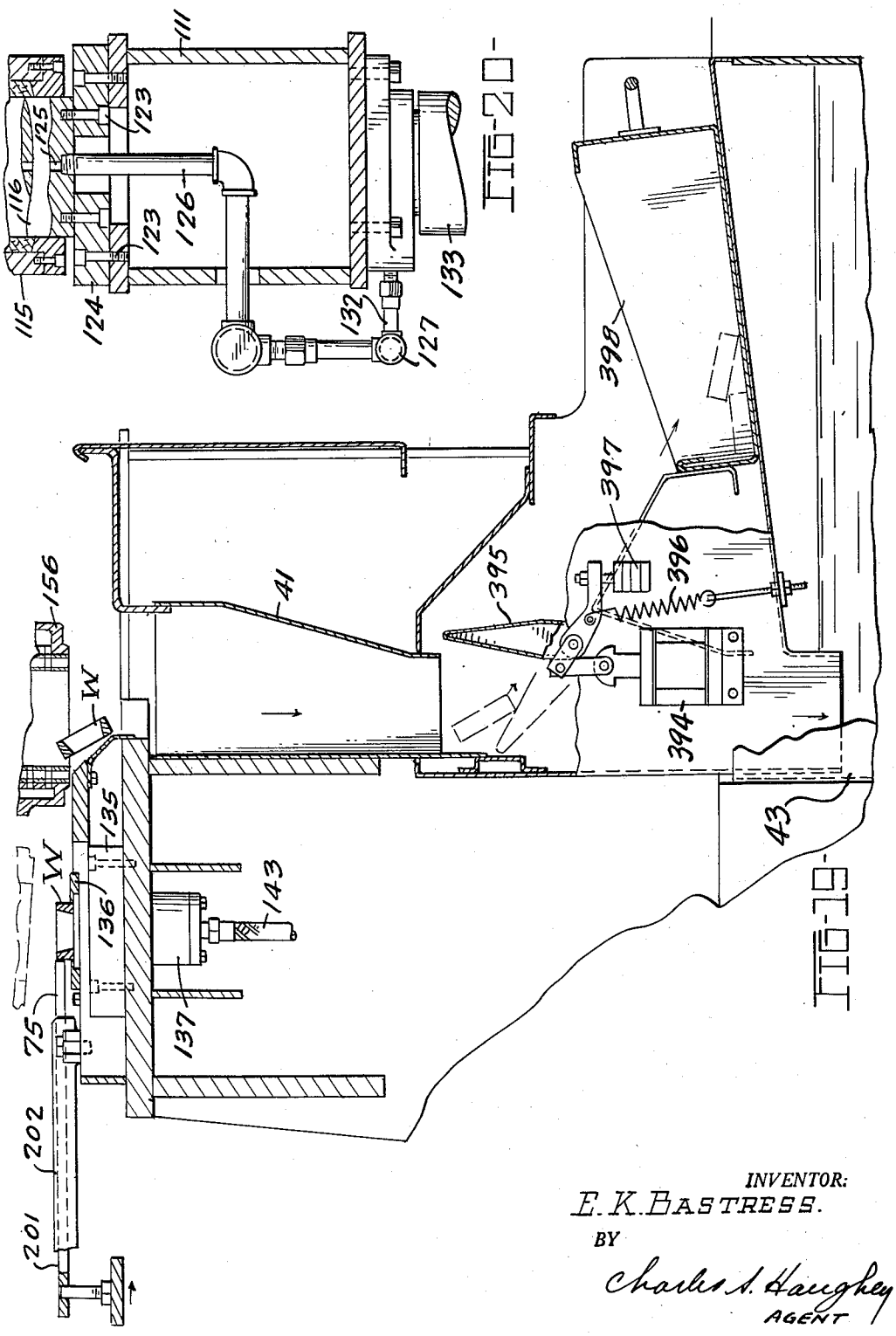


FIG-20-

FIG-19-

INVENTOR:
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Feb. 4, 1958 E. K. BASTRESS 2,822,162

METAL ARTICLE TREATING APPARATUS

Filed May 5, 1952 15 Sheets-Sheet 11

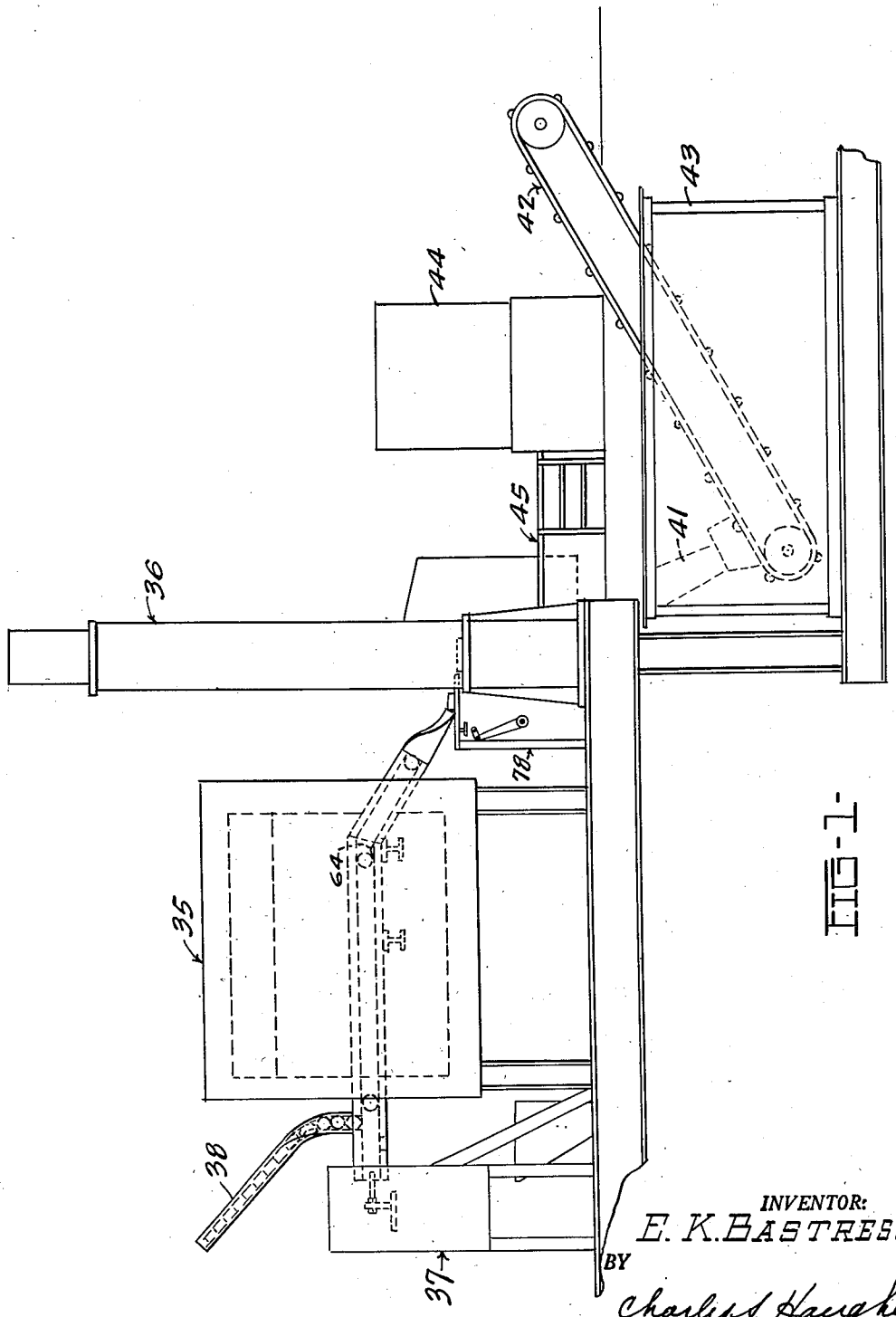


FIG-1-

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METAL ARTICLE TREATING APPARATUS

Filed May 5, 1952 15 Sheets-Sheet 12

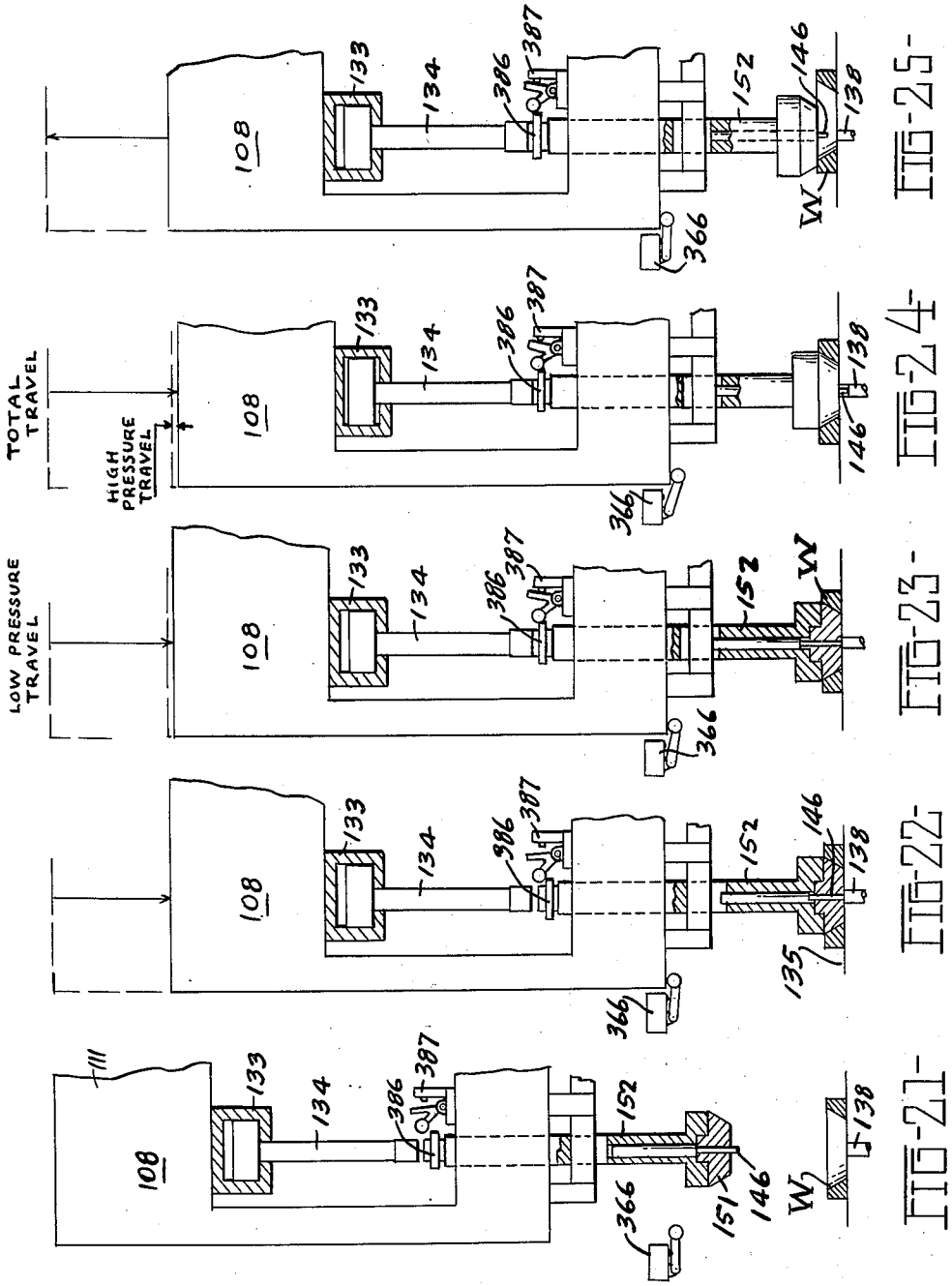


FIG-25-

FIG-24-

FIG-23-

FIG-22-

FIG-21-

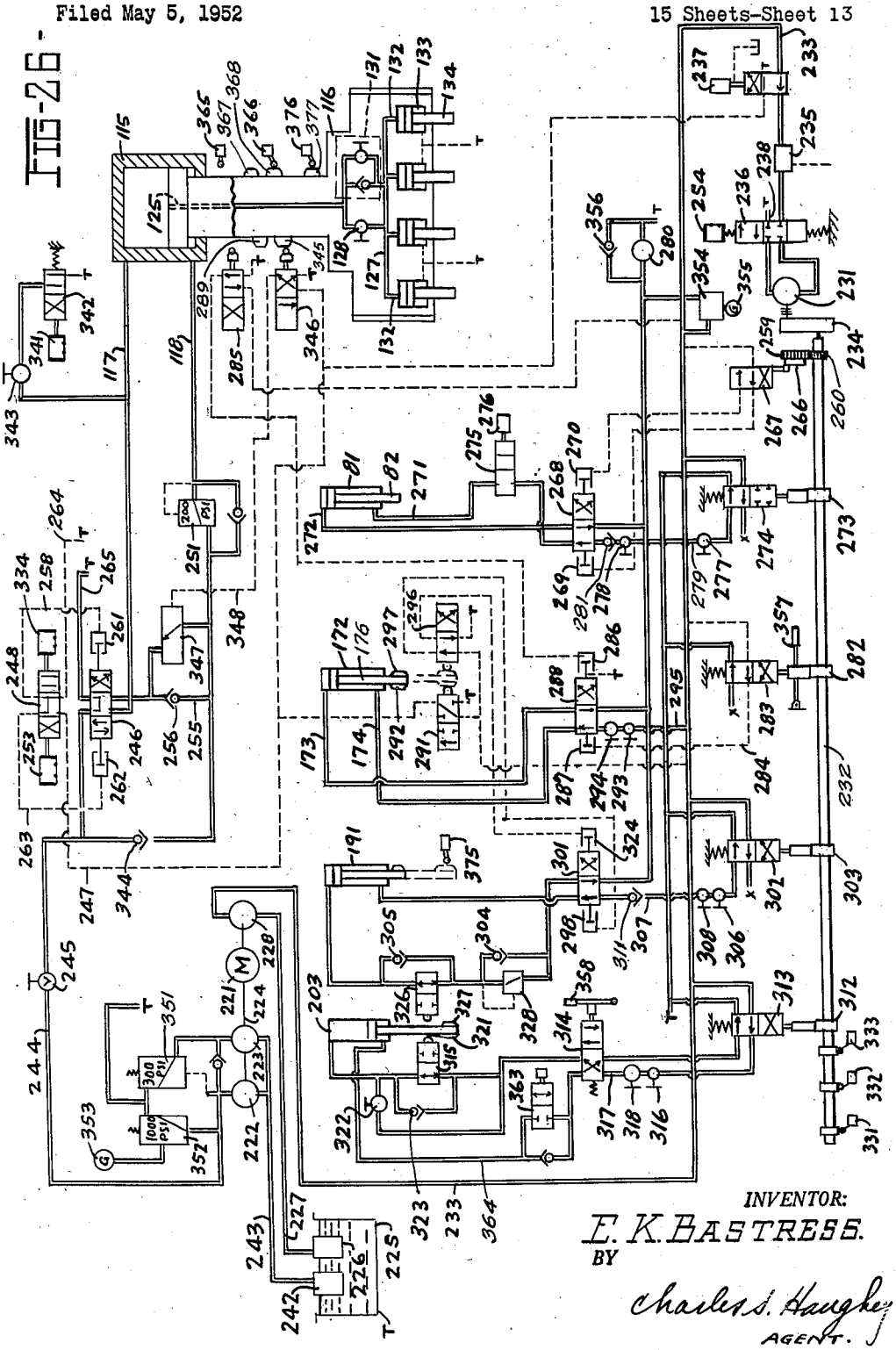
INVENTOR:
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METAL ARTICLE TREATING APPARATUS

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FIG-26-



INVENTOR:
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METAL ARTICLE TREATING APPARATUS

Filed May 5, 1952 15 Sheets-Sheet 14

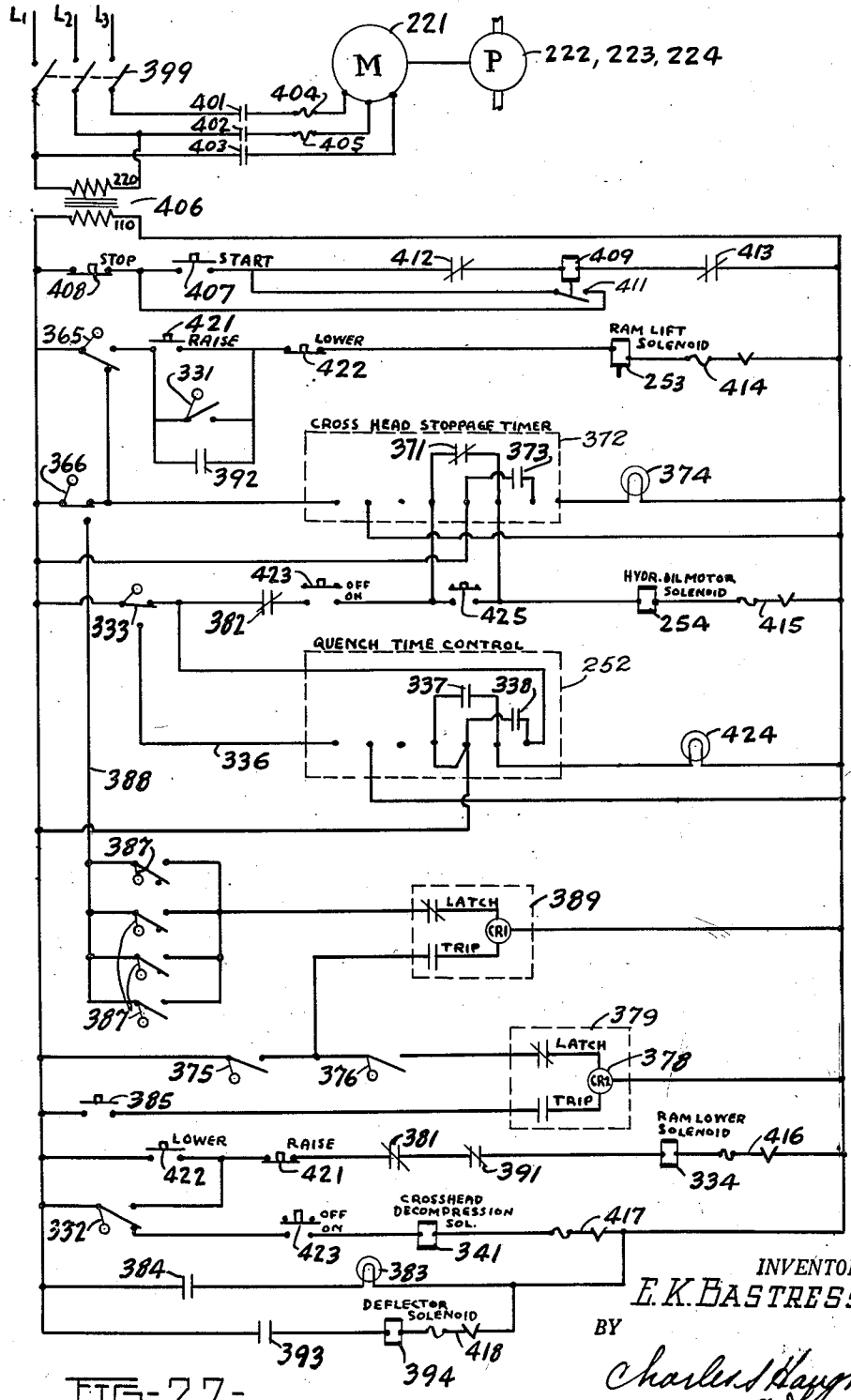


FIG-27-

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METAL ARTICLE TREATING APPARATUS

Filed May 5, 1952 15 Sheets-Sheet 15

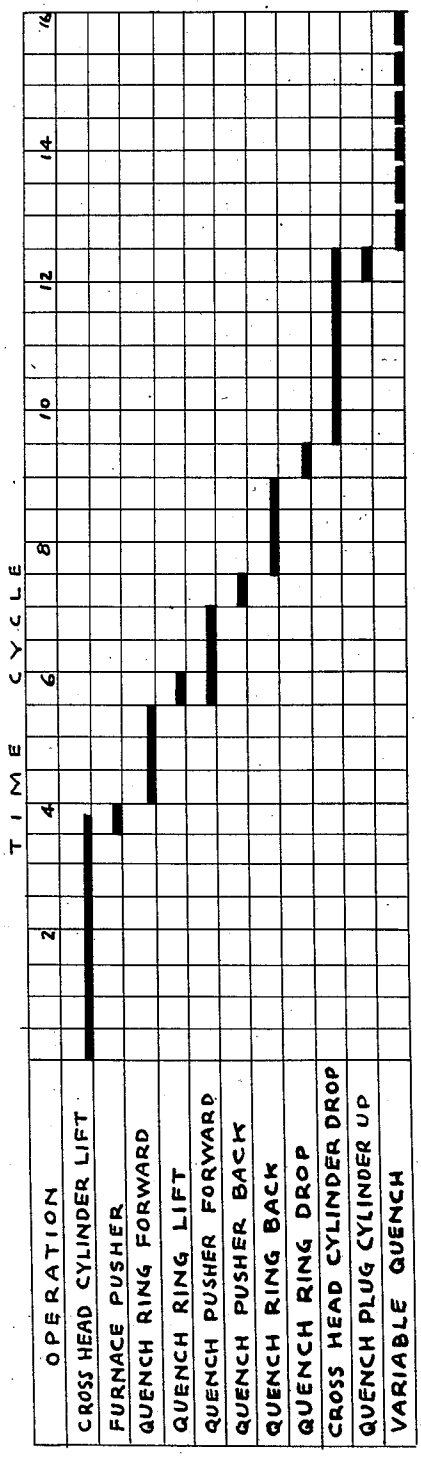


FIG-28-

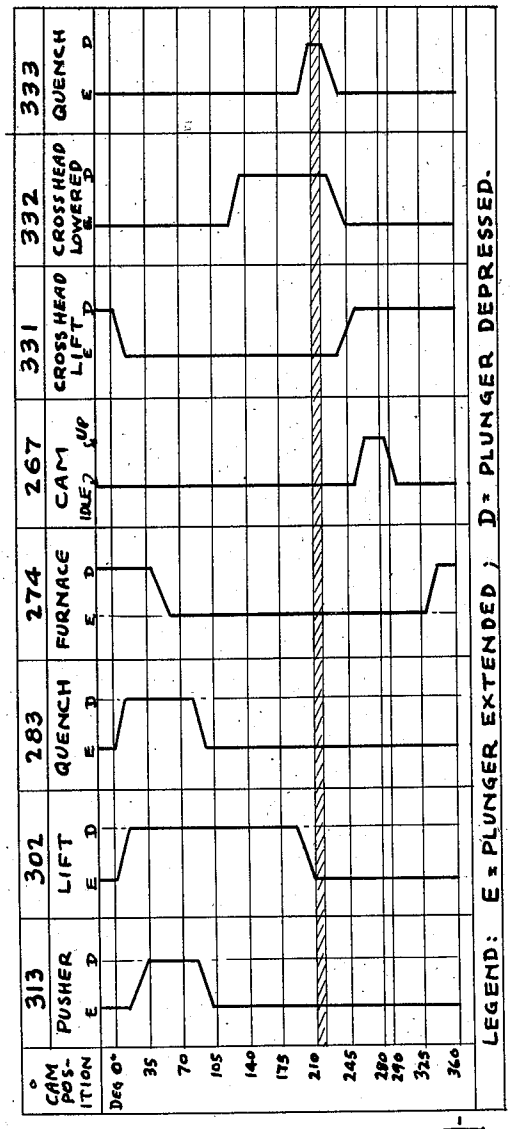


FIG-29-

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United States Patent Office 2,822,162
Patented Feb. 4, 1958

2,822,162

METAL ARTICLE TREATING APPARATUS

Ernest K. Bastress, Toledo, Ohio, assignor to Surface Combustion Corporation, Toledo, Ohio, a corporation of Ohio

Application May 5, 1952, Serial No. 286,150

15 Claims. (Cl. 266—4)

This invention relates to means for treating metal articles, and more particularly to furnace and press quench mechanism for automatically heating and press quenching steel articles such as rings, gears, and the like.

It is known to heat steel articles in a controlled atmosphere furnace, and to individually press quench the articles from the furnace to provide desired dimensional stability in the articles during quenching. The various human factors involved in transferring work from the furnace to the press, and in operating the press, taken with the excessive and variable exposure of the articles to the atmosphere, results in non-uniform articles and a relatively high proportion of rejected articles. This invention provides for virtual elimination of the human factor in this operation, and for many improvements as will hereinafter appear.

In the drawings forming a part of this disclosure,

Fig. 1 is an elevation of a steel heating (hardening) furnace, quench press, and associated mechanism according to this invention.

Fig. 2 is a longitudinal vertical section of the furnace showing article conveying apparatus therein.

Fig. 3 is a section in plan of the furnace taken along the line 3—3 of Fig. 2.

Fig. 4 is an elevational cross-section of the furnace.

Fig. 5 is a front elevation of the furnace charging mechanism.

Fig. 6 is a side elevation of the furnace charging mechanism.

Fig. 7 shows the furnace charging mechanism in plan.

Fig. 8 is a front elevation of the quench press.

Fig. 9 is a side elevation of the press.

Fig. 10 is a partial sectional view in plan of the press.

Fig. 11 is a partial rear elevation of the press.

Fig. 12 is a partial section of the press quench mechanism.

Fig. 13 is a partial section of mechanism for moving the quench ring and plunger.

Fig. 14 is a side elevation of press loading mechanism.

Fig. 15 is an end elevation of mechanism of Fig. 14.

Fig. 16 is a plan view of the press quench ring.

Fig. 17 is an elevation of the quench ring.

Fig. 18 shows an elevational section of a plunger stripper mechanism along the line 18—18 of Fig. 16.

Fig. 19 is an elevational section of the press quench chute.

Fig. 20 shows a detail of the press cross-head.

Figs. 21 through 25 illustrate safety mechanism for the press.

Fig. 26 is a hydraulic schematic diagram for the mechanism of Fig. 1.

Fig. 27 is an electrical schematic diagram for apparatus illustrated.

Fig. 28 is a graphic illustration of the time cycle of operations.

Fig. 29 is a graphic illustration of the cam designs on the timing cam shaft.

This invention provides a furnace and quench press for producing press quenched articles which comprises means for delivering a succession of substantially identical and identically aligned articles to each of several channel-like conveyors through the furnace, the articles in one conveyor not necessarily being identical to the articles in another conveyor, although for purposes of this illustration they may all be presumed equal in size, shape and alignment; means for delivering articles individually to each of several quench press loaders, preferably through a duct containing a protective gas atmosphere, loading each article onto one of several press quench stations in a position corresponding to its position as it was delivered to the furnace conveyor, simultaneously press quenching each of the articles while applying individually controlled pressure to each article, and subsequently discharging the articles from the press.

The press itself provides a compounded hydraulic cylinder means for moving a plurality of quench plugs or dies rapidly each into engaging position with an article, and under low press pressure, and means for applying high pressure individually to each of the quench plugs.

Quench oil valves are provided for rapidly supplying large volumes of quench oil simultaneously with the application of high pressure to the articles quenched, and the valves are constructed to reduce to a minimum dripping of oil onto hot articles as they are being positioned for quenching. Provision is made for forcing the press to balk and reverse, eliminating the press quench part of the normal automatic cycle, if the quench plug, or die, fails to properly seat on any one of the articles to be press quenched, thus safeguarding the quench plug or die as well as avoiding mutilation of the misplaced article or quenching without proper pressure of other simultaneously quenched articles. All such articles leaving the press unquenched are automatically segregated from normally quenched articles, and the automatic operation of the apparatus is not otherwise interrupted.

Many other specially desirable features are provided as will appear.

Referring to Fig. 1, the preferred apparatus embodying the present invention comprises a heating furnace 35 and a quench press 36 for press quenching articles delivered thereto from the furnace. A furnace charging mechanism is generally indicated at 37 for charging articles delivered thereto by a delivery hopper 38. A furnace discharge chute 39, shown in Fig. 3, delivers articles heated in the furnace to the press 36 for quenching. Quenched articles are discharged from the press through a chute 41 to a belt conveyor 42 in a quench tank 43 by which the articles are discharged from the quench tank and delivered to other mechanism for such further processing as may be required. Hydraulic and control mechanism are contained in a housing 44 from which suitable electrical and hydraulic conduits run under a catwalk 45 to the furnace and press mechanism for operating the latter.

Referring more particularly to Figs. 2, 3, and 4, the furnace comprises a steel shell or binding 46 lined with suitable insulation 47 and refractory 48. Heat is supplied to the furnace by radiant tubes 51 which are internally heated, by combustion of fuel therein by burners not shown. The radiant tubes are of the return bend, or U, type. They are supported at the bend on tube support brackets 52, and at the firing and exhaust ends in a removable bung 53 by means of which the tubes may be removed from the furnace or access to the interior of the furnace may be had. It will thus appear that the furnace is heated by radiant means so that it is possible to maintain in the furnace a protective gaseous atmosphere for the work therein. Such an atmosphere may consist of a

gas containing primarily about 20% carbon monoxide, 40% hydrogen and 40% nitrogen, with relatively small, but usually carefully controlled, amounts of carbon dioxide, hydrocarbons and water vapor as is well known. Inlets **54** in the furnace wall are provided for admission of atmosphere gas into the furnace.

Articles W, to be heated and press quenched, such as gears, rings and the like, hereinafter referred to as rings, are conveyed through the furnace in a manner which allows exact control of the number, frequency, and position of rings discharged from the furnace. In this case the rings W to be heated and subsequently press quenched are conveyed through the furnace in channel shaped work support rails **55** which are each an assembly of a back piece **56**, top and bottom center pieces **57** and **58** and top and bottom front pieces **61** and **62** forming between them the desired open sided duct or channel through which the rings may be pushed. The clearances between the rings W and the rails **55** are such as to allow the rings to be pushed without binding, yet not so excessive as to invite displacing a ring from a line straight through the rail. Inasmuch as a pusher mechanism **37** is provided to advance the rings in adjacent rails alternately, adjacent rails are paired and discharge into a common funnel-piece, the chute **39**. All rings entering each pair of rails should be of the same size, but sizes discharged from different chutes **39** may vary, as will appear. At the end of each rail, a built-up lip **64** is provided to prevent rings from discharging into the chute except when positively pushed over the lip by the pusher mechanism. Rings enter the rails on edge and properly aligned, each with its internal taper or other characteristic of shape similarly aligned, and are conveyed to the chute in that manner. A turning device for turning the rings on their side as they leave the furnace is provided in the form of a tubular screw **65**. The rails **55** are supported in the furnace on cross-supports **66**, and at the charge end on a water-cooled bracket **67**, and are free to expand towards the discharge end on the supports **66**. The chute **39** comprises two tongues **68**, each of which lies between the vertical sides **56** and **62** of a rail to maintain lateral alignment therewith, but is axially spaced from the bottom piece **58** of the rail to provide for longitudinal expansion of the rail in the furnace. The relative vertical alignment of the chute with respect to the rails is maintained by proper location of the chute on its support on the furnace shell **46**.

Referring more particularly to Figs. 5, 6 and 7, the furnace charging mechanism **37** comprises pusher heads **71** in each of the rails **55** for pushing against rings in the rails. Rings are delivered to the rails in advance of the head **71** when the head is in a back position, by way of a chute **72** from the delivery hopper **38**, and as the head **71** moves to a forward position and pushes rings before it, rings in the chute **72** ride on the head **71**. When the head **71** returns to a back position, a new ring W falls in front of the head in the rail ready for the next push.

The pusher head **71** is actuated by a rod-and-yoke member **73** which is in turn secured to a slideable bracket **74** which is securely held to a slide way on a cross-head **75** by a hinged gate **76** which is securely held in place by fast-threaded screw **77**. Thus the pusher heads are normally actuated by the motion of the cross-piece **75**. An upper cross piece is secured to alternate pusher heads, one in each pair of rails, and a lower cross piece is secured to pusher-heads in the remaining rails in the pairs. By moving one cross-pece forward as the other moves back, four rings are advanced to and discharge through the respective chutes **39**. Upon reversal of the motion of each cross-piece each of the other rails in the respective pairs of rails will discharge a ring through the respective chutes **39**. By so utilizing 8 rails to discharge rings in groups of four, it is possible to reduce the length of the furnace without reducing the time the individual rings each remain in the furnace.

The means for moving the cross-pieces **75** comprises a hydraulic cylinder **81** which actuates a rack **82** between pinion **83** and idler roller **84**, the pinion **83** in turn moving on a shaft **85** supported on bearings **89**, and which moves a similar pinion **83** on the other end of the shaft **85**, and the pinions **83** turn pinions **86** on shafts **87**, which are supported in bearings **88**, and pinions **91** on the other ends of shafts **87** turn in racks **92** on cross-pieces **75**. As the pinions **91** move racks **92**, thus moving cross-pieces **75**, the cross-pieces move in opposite directions in their respective slide ways **93**. Thus as the hydraulic cylinder moves the rack **82** upward, the lower group of pusher heads **71** move back to allow an additional ring to enter the respective rails, and simultaneously the upper pusher heads **71** move forward to advance the rings in the corresponding rails one position therein and to move the last ring in those rails over the lips **64** therein and into the discharge chutes **39**.

Referring now more particularly to Figs. 8, 9, 10 and 11, the press comprises a base **101**, two vertical columns **102** and **103**, and a top **104** forming the structural frame for the press. The base, columns and top are maintained in alignment by suitable keys **105** at the joints by bolts **106** passing through the columns. A slide rail member **107** is bolted to each of the vertical columns to serve as a way for a cross head **108** of the press. The cross head comprises upper and lower cross elements or bars **111** and **112** supported on side bars **113** and **114** which are adapted to be moved on the rail members **107**. The cross head is moved up and down on the slide rails **107** by a main cross head hydraulic cylinder **115** and its ram **116**, the cylinder being supplied with hydraulic fluid through upper and lower conduits **117** and **118**. Alignment of the cross head with respect to the slide rails may be adjusted by adjustment of suitable wedge blocks **121** movable by bolts **122** to adjust the cross head in any lateral direction, or, to some small degree, to adjust the angular alignment of the cross-head with stationary parts of the press.

The quench press is designed to simultaneously quench four rings which may, but need not, be identical. Each of the rings is on an individual base and secured under individually applied hydraulic pressure. There are therefore provided four quenching stations or positions, and the cross-head is provided with means for delivering hydraulic pressure from a single source of pressure, and without flexible connections, to four individual movable dies or, in this case, plugs. The upper cross bar **111**, which as a part of the cross-head **108** is moved by the main hydraulic cylinder **115**, is secured to the ram **116** thereof as by bolts **123** in attaching plate **124** shown in Fig. 20. The ram **116** is axially drilled to pass hydraulic fluid from the main cylinder **115** through a central ram passage **125**, (Fig. 20), through pipe **126** through the hollow portion of the fabricated upper cross bar **111** to a quench plug hydraulic cylinder manifold **127** through a needle type flow control valve **128** which adjustably controls the rate of flow of hydraulic fluid therethrough to the manifold **127**. A parallel fluid path from pipe **126** to manifold **127** is provided through combination swing-gate type check valve and needle valve **131** which allows flow of hydraulic fluid only from the pipe **126** to the manifold **127**. Hydraulic fluid from the manifold **127** is delivered by pipes **132** to each of four quench plug hydraulic cylinders **133**. The combined area of the four quench plug cylinders **133** is less, preferably about 10% less, than the area of the main cylinder **115** so that the force exerted by the main cylinder exceeds that of the individual cylinders. When the individual quench plug cylinders are engaged, their respective rams **134** will float in the cylinders **133** and thus exert equal pressures, or pressures corresponding to the areas of the respective cylinders **133**, the cross-head remaining in a fully down position.

Referring more particularly to Figs. 12 and 13, the press base **101** comprises a spherically seated adjustable anvil **135** for each quenching station, each such anvil being provided with a ring member **136** for centering the article, or ring, to be quenched on the anvil. A quench oil releasing valve **137** is provided for each anvil, and upon operation discharges quench oil upwards through a central passage **138** in the anvil. The quench oil valve **137** comprises a hollow body **141** secured to the anvil by bolts **142** and adapted to receive quench oil from a conduit **143** through an aperture in the valve body **141**. A vertically movable fluted valve plunger **144** disposed in the valve body **141** and having an end extending upwards through the anvil closes off quench oil when it is in its raised position, the upper shoulders of the flutes **145** resting against the underside of the anvil and serving as a stop for upward motion of the valve plunger. In its upward position, the top of the plunger **144** is below the level of the surface of the anvil so that rings may be slid onto and off from the anvil with the quench oil turned off. The valve **137** is opened by a valve operating rod **146** which moves the valve plunger **144** downward against a spring **147** to start the oil quench cycle, opening the fluted passages in the plunger to flow of quench oil from the conduit **143**. The bottom of the spring **147** is seated on an apertured spring retainer **148** in the valve body.

A quench plug **151** for each quenching station is supported on the lower end of a floating rod **152**, the floating rod being vertically movably supported on the lower cross bar **112** of the cross-head **108**. Each quench plug will be adapted to press quench the particular size of ring being positioned thereunder. The valve operating rod **146** is supported in a center passage through the plug **151** and the floating rod **152**, and it is prevented from dropping out of that passage by a shoulder on the operating rod which rests on the upper surface of the quench plug **151**. The floating rod **152** is slotted at about the upper end of the operating rod **146**, and an operating rod stop member **153** supported from the lower cross bar **112** by brackets **154** extends through the slot in the floating rod with clearance to allow the floating rod to move vertically up or down freely with respect to the stop member **153**, and the stop member **153** acts as a stop for relative upward motion of the operating rod with respect to the lower cross bar **112**. As the cross head **108** moves downward, the floating rod **152** is in a downward position, and so also is the valve operating rod **146**. When the valve operating rod comes to rest on the valve plunger, it moves upwards within the floating rod until it rests on the operating rod stop member **153**, then it is forced downward with further downward motion of the cross-head and its lower cross bar, this further downward motion serving to move the valve plunger **144** downward and releasing the quench oil for upward flow through the oil passage **138** in the anvil and for outward and upward flow through grooves in the surface of the quench plug **151**.

A second source of quench oil for the ring W to be quenched in the quench station on the anvil is provided by a quench ring **155**. Four quench rings, one for each quenching station, are mounted in a quench ring frame **156** in such a manner as to provide a quench oil manifold **157** for each ring in a passage formed by an annular groove in the quench ring frame next adjacent the outer surface of the quench ring **155**. Quench oil is supplied to the quench oil manifold **157** by a flexible, or flexibly jointed, conduit **158** and an internal oil passage **161** in the quench ring frame communicating with each of the four quench oil manifolds **157** therein. An access plate **159** is provided for each quench oil manifold.

The quench ring **155** is annular in shape and is provided with a circular series of valve thimble holes **162** adapted to receive vertically movable annularly grooved valve thimbles **163**. The annular grooves **164** in the thimbles **163** serve as passages for quench oil from the manifold **157** through inlet and outlet holes **165** and **166** provided in the quench ring. These holes are so aligned with the thimbles that when all thimbles in a quench ring are in a down position, as shown in Fig. 12, a passage for quench oil is opened from the manifold **157** to the interior of the quench ring through each annular groove in each thimble, thus rapidly flooding the interior of the quench ring with quench oil. The thimbles are each normally suspended in the holes **162** in the quench ring by springs **167** in such a position as to prevent flow of quench oil through inlet and outlet holes **165** and **166** in the quench ring. The springs force the thimbles **163** up against a valve operating ring **168** which in turn normally rests against retainers **169** which are bolted to the frame **156**. It may be said that the valve operating ring rests on the several thimbles of a quench ring. During a quench period the valve operating ring is moved downward to move the thimbles and thus open the valves of the quench ring to admit quench oil to the quenching station. Valve ring operating bolts **171** carried on structure forming an extension of the operating rod stop member **153** depress the valve operating ring simultaneously with the movement of the valve plunger **144** by its operating rod **146**, both being operated by downward movement of the cross head.

As the cross head is raised the oil quench valves are closed by their respective springs. The quench valves (thimbles) in the quench ring are so close to the outlet holes that very little quench oil remains in the quench ring to drain away. The floating rod **152** falls by gravity until the top wall of its internal slot rests on the top of the operating rod stop member **153**, and the operating rod also falls by gravity until its shoulder comes to rest on the shoulder of the quench plug. The upward movement of the cross head also allows the rams for the quench plug hydraulic cylinders to fall to the bottom of the cylinders, this leaving a clearance of a substantial fraction of an inch between the rams **134** and the floating rods **152**. When the cross head reaches its raised position, sufficient clearance is provided between the quench ring frame **156** and the rod **146** to permit the frame to be moved horizontally to slide the 4 now quenched rings W off the anvil and its centering ring **136**.

As the floating rods **152** move upwards, the quenched rings W may be "frozen" onto the quench plugs **151**, as illustrated in Fig. 18, a view taken on line **18—18** of Fig. 16. Provision is made for mechanically stripping the rings from the quench plugs by adjustable stripper stops **179** which are hingedly secured by bolts **180** to a portion of the frame **156**. Bolts **188** passing through slots in the stops **179** are used to adjust the position of the stops to allow the rods **152** to pass upwards and retain and strip from those rods the rings W.

The horizontal motion of the quench rings is obtained by a hydraulic cylinder **172**, more clearly shown in Figs. 8 and 17, having hydraulic conduits **173** and **174** thereto. The ram **175** of this cylinder moves a rack **176** between an idler roll **177** and a pinion **178** on a shaft **181** which is secured to the press base **101**, the shaft in turn moving pinions **182** on either end of the shaft **181** which in turn mesh with racks **183** under rollers **184** at either side of the quench ring frame **156** to move the same laterally, or horizontally, from over the quench station. As the quench ring frame is moved by the cylinder **172** and its rack and pinion apparatus the quench ring frame is supported by a shoe **185** on a slide **186** to provide close clearance between the quench ring and the anvil. This is primarily to guide the rings W as they are pulled off the anvil and dropped over the side thereof into the press discharge chute **41**. The clearance is preferably sufficiently close between the anvil and the quench ring to force most of the quench oil to flow over the top of the quench ring and down the chute **41** into the oil quench tank **43**. When the quench ring frame **156** is moved to its discharge position, the racks **183**

extend over the catwalk 44, so a guard pipe 187 is provided on a yoke 198 to enclose those racks in their extended position.

The quench ring frame is raised, before returning to its starting position over the anvils, to clear new work that was positioned on the anvils while the just quenched rings W were being moved to the chute 41. To raise the quench ring frame 156 a hydraulic cylinder 191 moves a rack 192 which turns a pinion 193 on shaft 194, supported on bearings 195. Crank arms 196 on the shaft 194 turn with the shaft to raise a yoke 198 by extension rods 197, thus raising the tracks 186 on the yoke upon which the quench ring frame slides.

The rings W are loaded onto the quench press anvil by a press loader mechanism 78 which comprises a loader head 201 shown in plan in Fig. 16 and in elevation in Figs. 14 and 15. As the rings slide down the furnace discharge chute 39, through its screw outlet 65, they drop onto a loader table 202 and slide up to the quench ring frame 156 which, in its normal, or quench, position acts as a stop for rings from the furnace discharge chute. The rings may rebound from the quench ring frame, but will be confined by the sides of the table 202 and the loader head 201. It will be understood that as rings are pushed one at a time by the furnace loader into the rails 55, they discharge one at a time through each individual discharge chute 39. The rings are discharged onto the loader table at about the end of the quench cycle, and after the ring has been stopped by the quench ring frame, the frame is moved by hydraulic cylinder 172 to discharge the now quenched ring W within its quench ring 155. As the frame reaches the end of its discharge travel, a loader hydraulic cylinder 203 moves a rack 204 which moves between a guide roller and a pinion 206 to turn a shaft 207 in bearings 209 which in turn moves arms 208 on either end of the shaft and thus moves a pusher bar 211 linked thereto and guided on rails 212. The four loader heads 201 in loader tables 202 are moved by bolts 213 secured to the pusher bar 211, the bolts moving in slots provided in the loader tables. The limit of motion for the loader heads which stops them when the rings are properly centered on the anvils 135 is provided by an adjustable stop 214 against which an arm on the pinion 206 comes to rest. The stop comprises a screw 214 which is adjustable through a handle 215 on the front of the press through sprockets 216 and 217 and chain 218. Residual oil on the anvil after the quench operation is drained through a passage 219 in the anvil, so that the anvil is substantially dry when the next succeeding ring is moved in position thereon.

The furnace and press just described in some detail will ordinarily operate on an automatic cycle which is electrically controlled and hydraulically operated. The electrical and hydraulic elements of the apparatus which are a mechanical part of the furnace or press are shown thereon in their normal operating relationships, and are also shown, or represented, on the hydraulic and electrical diagrams constituting Figs. 26 and 27 respectively. Such electrical and hydraulic apparatus as hydraulic pumps, motors therefor and controls thereon, together with the usual control-panel type of apparatus is represented in Figs. 26 and 27, but will be located in the hydraulic and electrical housing 44 as shown on Fig. 1, with the necessary conduits running under the catwalk 45 to the furnace and press.

To operate the apparatus just described, an electric pump motor 221 drives a high pressure ram pump 222 and a low pressure ram pump 223 which together form the pumping source for hydraulic oil to operate the main ram hydraulic cylinder 115 and the quench plug hydraulic cylinders 133. The motor 221 also drives, on a common shaft 224, a hydraulic controls pump 228 which furnishes oil under pressure to operate various control motions and pilot valve cylinders of the apparatus, and also a hydraulic motor 231 for a timing cam shaft 232. The preferred operating pressures for the three pumps are about 400 p. s. i. for the controls pump 228, 300 p. s. i. for the low pressure pump 223 and 1000 p. s. i. for the high pressures pump 222. Of course any other pressure which will properly and safely operate the necessary hydraulic equipment and provide suitable pressures during quenching will suffice.

Hydraulic oil is drawn from a sump tank 225 through a strainer 226 and a conduit 227 by the controls pump 228 and is delivered through a controls oil manifold 233 to various cam operated valves, pilot oil operated hydraulic valves and to the hydraulic motor 231 whose speed is controlled by a suitable needle valve type speed control valve 235. An electrically operated solenoid valve 236 is provided for automatically starting and stopping the hydraulic motor 231, and a manual value 237 is also provided to manually stop the hydraulic motor. The hydraulic oil discharge from the hydraulic motor runs through a conduit 238 back to the sump tank 225. The hydraulic motor, through a speed reducer 234, drives a timing cam shaft 232 whose cams operate hydraulic valves and electrical controls and thereby control the sequential operation of the furnace and press mechanism.

Hydraulic oil for operating the main hydraulic cylinder 115 is drawn from the sump tank 225 through a strainer 242 and a conduit 243 by low pressure pump 223 and high pressure pump 222, both of which are of the positive displacement type.

Rotation of the cam shaft, through a reducer 234, controls movements under normal operation to follow the following preferred sequence, as illustrated in Fig. 28, by suitable cam positions as illustrated in Fig. 29, it being understood that some obvious changes in timing, sequence, or overlapping of movements may be tolerated:

(1) The cross head is held in fully raised position by ram 116.

(2) The furnace pusher heads 71 deliver new work into the furnace under the control of hydraulic pusher cylinder 81 and eject hot work through chute 39 to the quench machine 36, on its press loader 78.

(3) The quench ring frame 156 slides to unloading position moved by hydraulic cylinder 172, dropping rings W into the quench tank 43 through chute 41.

(4) The quench ring frame is lifted by hydraulic cylinder 191.

(5) The quench press loader 78 delivers hot rings W to the press hydraulic cylinder 203, locating them on the anvils in the quench position or station.

(6) The quench press loader returns.

(7) The quench ring frame returns to its normal position under the quench plugs.

(8) The quench ring frame drops to its position above the anvils.

(9) The cross head cylinder 115 lowers the cross head, and the quench plugs seat on the anvils. Further movement causes the quench plug cylinders 133 to back up and increases the pressure therein, as well as operating the quench valves to flood the work W with quench oil.

(10) As the cross head reaches the lower end of its stroke the hydraulic motor 231 is stopped and a quench timer 252 is started.

(11) At the end of the quench period, which may be varied by adjustment of the quench timer, the hydraulic motor 231 again begins to rotate the cam shaft 232, and the cross head and the quench plugs are raised. This stops flow of quench oil and strips the rings from the quench plugs, the rings then falling back on the anvil within the quench ring.

(12) The cross head is held in fully raised position by ram 116 and the automatic operation cycle is repeated.

The automatic cycle above described preferably re-

quires about 20 seconds, of which 12½ seconds are used for the various motions and the quench time is set to 7½ seconds.

As is observed from a study of the hydraulic diagram of Fig. 26, all movements by hydraulic cylinders except those involving the cross head cylinder **115** are performed on oil delivered from controls pump **228**, while the oil volume for ram cylinder **115**, and quench plug cylinders **133**, is furnished by ram pumps **222** and **223**.

In automatic operation the hydraulic system performs as follows:

Operation 1.—A cross head lift solenoid valve **248** is energized by a solenoid **253** and the hydraulic motor solenoid valve **236** is energized by a solenoid **254** to start the hydraulic motor **231**, thus starting the automatic cycle. The hydraulic motor rotates the cam shaft through the speed reducer **234** on oil volume from the hydraulic controls pump **228**, the speed of rotation being controlled by speed control valve **235**. The oil delivery from ram pumps **222** and **223** through the hydraulic valve **246** is to the lower, or rod, end of the ram cylinder **115** through conduit **255** and check valve **256** therein to conduit **118** and through a check valve portion of valve **251**, to raise the ram **116** and the attached cross head **108**. Solenoid **253** moves solenoid valve **248** to the right thus delivering oil from manifold conduit **233** through conduit **247**, through the solenoid valve **248**, through a conduit **258** to hydraulic pilot cylinder **261** which moves the hydraulic cross head valve **246** to the left, exhausting hydraulic oil from hydraulic pilot cylinder **262** through conduit **263**, solenoid valve **248**, and conduit **264** to the sump tank **225**, diagrammatically indicated by T.

As the main ram **116** moves up, hydraulic oil discharges from the upper or head end of the cross head cylinder **115** through the central ram passage **125** and speed control needle valve **128** and the combined needle and check valve **131** to the head ends of the quench plug cylinders **133** as they are extended by gravity, and through the cross head valve **246** and conduits **117** and **265** to sump tank **225**.

Operation 2, or 2a.—The furnace pusher pushes one set of four rings on the extension stroke of the furnace loader hydraulic cylinder **81**, or another set of four rings on the withdrawal stroke of cylinder **81** as already described. This is provided by cam **266** on a 50% speed reduction gear **259** driven by gear **260** on shaft **232**, the cam moving valve **267** to one of its two positions to shift valve **268** to one of two positions by pilot cylinders **269** and **270**. To move valve **267** one way each revolution of the cam shaft, a reduction gear is shown, but an indexing type of valve may be used. In one position of valve **268**, when pilot oil pressure is applied to pilot cylinder **269**, oil under pressure is directed through conduit **271** to the rod end of cylinder **81** with conduit **272** discharging oil from the head end thereof through a cooler **280** to the tank **225**, and in the other position valve **268** shifts the porting and reverses flow through conduits **271** and **272**. Cam **273** on the cam shaft **232** moves hydraulic valve **274** to direct oil delivery from the manifold **233** to the furnace pusher hydraulic cylinder **81** through valves **268** and **275**. Valve **275** is held open by a cam **276** on the cross head only when the cross head is fully raised, so the furnace pusher cylinder is thus allowed to operate only when the cross head is raised. A needle valve **277** and a shut-off valve **278** are provided respectively in conduit **279** between valves **274** and **275** to control the speed at which the pusher cylinder **81** may operate, and to provide for preventing motion of the cylinder **81** during manual operation of the quench press as may be required for adjustment of dies, motions and the like. The shut-off valve is provided primarily so that the adjustment of the needle valve need not be disturbed during manual operations. A check valve **281** is provided in conduit **279** to prevent leakage from causing premature movement of the furnace pusher when valve **275** has been shifted to its off, or alternate, position.

Operation 3.—A cam **282** on the cam shaft operates a hydraulic valve **283** on valve **288** to open a pilot oil line **284** from a pilot cylinder **287** to the sump tank **225**. When the cross head cylinder **115** is in fully raised position, valve **285** is depressed to open a pilot oil conduit to a pilot cylinder on valve **288** to oil pressure. This shifts valve **288** to a second position directing flow of oil from manifold **233** through conduit **173** to the head end of the quench ring frame slide cylinder **172** for its extension stroke, sliding the quench ring frame from over the quench positions. As the cylinder **172** extends, valve **291** is operated by a cam **292** on rack **176** blocking flow of pilot oil through conduit **272** to solenoid valve **248** to prevent any further movement of the cross head while the quench rings are out of position. The speed of the extension and return strokes of cylinder **172** is controlled by a needle valve **293** in conduit **295**, a shut-off valve **294** also being provided for purposes of manual operation for set-up and the like.

Operation 4.—When the quench ring frame cylinder **172** is fully extended, valve **296** is shifted by cam **297** on rack **176** to direct pilot oil to pilot cylinder **298** to shift valve **301** to its second position. Valve **302** is depressed by a cam **303** on the cam shaft to direct delivery of oil through valve **301** and freely through the check valves **304** and **305** to the head end of quench frame lift hydraulic cylinder **191**. The rod end of cylinder **191** is open to drain to the sump tank **225** through valve **301**. Rate of travel during extension and return strokes of cylinder **191** is determined by the setting of needle valve **306** in conduit **307**, a shut-off valve **308** also being provided. A check valve **311** prevents reverse flow in conduit **307** from cylinder **191** through valve **302** (Figs. 14 and 17).

Operation 5.—A cam **312** on the cam shaft depresses a valve **313** to direct oil delivery through valve **314** and normally closed valve **315** (which has been opened by the extension of cylinder **203**) to the rod end of the quench press loader cylinder **203** to begin its delivery, or extension, stroke. Maximum speed of cylinder **203** during delivery and return strokes is governed by the setting of a needle valve **316** in conduit **317**, a shut-off valve **318** also being provided. As valve **313** is held depressed by the cam **312** on the camshaft, the quench press loader cylinder **203** continues its delivery stroke. A cam **321** moved by loader cylinder **203** begins to depress the plunger of valve **315** to start restricting discharge of oil from the head end of cylinder **203** to provide a deceleration action for the ring loader for the press, constituting the valve **315** a deceleration valve for the loader. As cylinder **203** approaches the end of its delivery stroke deceleration valve **315** is closed completely, and final movement to complete the stroke and positioning of the rings W on the anvils is controlled by discharge of oil from the head end of cylinder **203** through a needle valve **322**, which thus provides a minimum speed for the delivery stroke of the loader cylinder **203**.

Operation 6.—The cam shaft releases valve **313** to direct pump delivery of oil freely through check valve **323** to the head end of the press loader cylinder **203** and to open the rod end thereof to the sump tank **225** to begin the return stroke of the loader heads **201** (Figs. 14 and 17).

Operation 7.—The camshaft releases valve **283** to open pilot cylinder **287** to pressure from manifold **233**. The area of pilot cylinder **287** is approximately four times that of pilot cylinder **286** at the other end of valve **288** hence valve **288** is shifted by differential pressure, porting delivery of the pump **228** to the rod end of quench ring frame slide cylinder **172** for its return stroke.

Operation 8.—When the quench ring frame slide cylinder **172** is fully returned at the end of operation 7, valve **296** is shifted by cam **297** to direct oil to pilot cylinder **298** to move valve **301** to its first position as shown,

The camshaft holds valve 302 depressed to direct oil through valve 301 to the rod end of the quench ring frame lift cylinder 191. However, discharge of oil from the head end of cylinder 191 is blocked at valve 326 until quench press loader cylinder 203 has completed approximately one-half of its return stroke, at which point its cam 327 releases the plunger of valve 326 to open discharge from quench ring frame lift cylinder 191 to tank 225 through valves 326, 328 (a relief pressure type valve) and 301 with valve 328 furnishing back pressure for the control of the cylinder 191 for this stroke.

Operation 9.—The cam shaft 232 operates electrical limit switch 332 to energize solenoid 334 of cross head solenoid valve 248 to begin the press stroke. This operation will be further explained under Press Operation.

Operation 10.—When operation 9 has been completed, the cam shaft operates limit switch 333, a limit switch having a normally open and a normally closed contact, to de-energize the solenoid 235 of the hydraulic motor solenoid valve 236, thus stopping rotation of the camshaft 232 and connecting a circuit 336 (Fig. 27) through a quench timer 252, closing contact 337 and initiating the quench period. During this period the cross head solenoid 334 of valve 248 is kept energized to keep the rings W under ram pressure during quenching.

Operation 11.—At the end of the quenching period, contact 337 of the quench timer 252 opens and contact 338 closes to energize the solenoid 235 of the hydraulic motor solenoid valve 236. This starts camshaft 232 turning and first releases limit switch 333 and second releases limit switch 332. When limit switch 332 is released, the normally closed contacts in this switch will energize a solenoid 341 of a cross head decompression solenoid spring loaded valve 342 to bleed pressure from the head end of cross head cylinder 115 to the sump tank 225 through conduit T, the rate of flow being controlled by a speed control needle valve 343. Continued movement of the camshaft will operate limit switch 331, a normally open switch, to energize solenoid 253 of cross head solenoid valve 248, causing the cross head to rise and lift the quench plugs. Cam 266 on the camshaft rotates valve 267 to shift it to its alternate position. Valve 267 remains in one position during an entire cycle, then is moved by cam 266 to its other position, thus causing the furnace pusher to extend only during one cycle and to return only during the next cycle. The valve 267 is thus in position for operation 2 of the next succeeding cycle.

Press operation.—In operation 9, with solenoid 334 of cross head solenoid valve 248 energized, combined delivery of pumps 222 and 223 is to the head end of cross head cylinder 115. Discharge from the rod end of the cylinder is through valves 251, check valve 344 and cross head hydraulic valve 246 back to the head end to extend the cylinder regeneratively. Valve 251 assures back pressure to hold the cross head cylinder in the up position and also provides control of the cylinder during the extension, or press, stroke. As the cross head cylinder 115 approaches fully extended position, cam 345 depresses valve 346 to direct pilot pressure through conduit 348 to open hydraulicly operated valve 347. Discharge from the rod end of the cross head cylinder 115 is then through valves 347 and 248 to the sump tank, through stand pipe T, and the cylinder continues to extend at about one-half speed. Cam 289 releases valve 285 with the first downward movement of the cross head, blocking the pilot oil connection to pilot cylinder 286 of valve 288 to prevent accidental movement of the quench ring slide cylinder 172 during the quenching operation. When the plug cylinders 133 through their rods 134 contact the anvil, discharge from their head ends is metered through valve 128 to the head end of the cross head cylinder, it being recalled that the sum of the effective areas of the plug cylinders 133 is about 90% of the area of the cross head cylinder 115. Due to increased pressure during this part of the operation, a hydraulic loaded and operated relief valve 351 opens at about 300 p. s. i. to unload the delivery of pump 223 to the sump tank 225, and pump 222 continues to deliver its volume until its discharge pressure exceeds the setting of a relief valve 352, also a hydraulicly operated valve, its setting preferably being about 1000 p. s. i. Discharge from the head ends of the plug cylinders 133 permits the cross head cylinder to continue its stroke to fully extended position where it will be held by high pressure delivery from pump 222, as controlled by valve 352, during the quenching operation. A pressure gage 353 is provided to indicate the pressure existing in the manifold conduit 244.

The pressure delivered by the controls pump 228 is controlled by a relief valve which is preferably set to maintain about 400 p. s. i., discharging excess oil through a cooler 280, or a check valve 356, to the sump tank 225. A pressure gage 355 is provided to indicate the pressure maintained by relief valve 354 in the controls manifold 233.

For purposes of adjustment, certain manual operations are provided for. Manual hydraulic motor shut-off valve 237 may be closed to prevent automatically cycling the apparatus, valve 237 then making pilot oil available to operate valve 246. A manual control lever 357 is used to depress valve 283 to extend quench ring frame slide cylinder 172, shifting the quench ring frame to unloading position. The main cylinder 115 must of course be raised at this time. Releasing the manual control lever 357 will then return the frame slide cylinder automatically to its position under the quench plugs.

Valve 314 may be depressed by manual control lever 358 to cause the quench press loader cylinder 203 to make a delivery stroke, and releasing the lever 358 will cause the cylinder 203 to return automatically. Solenoids 253 and 334 on cross head solenoid valve 248 may be energized by push buttons 361 and 362, respectively, to raise and lower the cross head. Valve 245 is fully open during automatic cycle, but may be used to control the rates of extension and return of the cross head cylinder 115. Shut-off valves 318, 308, 294 and 278 are provided for use during manual operations of the press to avoid upsetting the adjustment of speed control valves 316, 306, 293 and 277.

Several safety features are incorporated in the apparatus as shown: the quench ring frame cannot slide forward unless the cross head is in the fully raised position and the valve 285 is fully depressed; the cross head cannot drop while the quench ring frame is in the "unloading" position, and valve 291 is depressed; the quench ring frame cannot lift unless the frame is in the unloading position, cylinder 172 fully extended and valve 296 is depressed; the quench ring frame cannot drop unless it has returned to the position under the quench plugs and valve 296 is released, and the quench press loader has returned past any point of possible interference and valve 326 is depressed; the furnace pusher operates only when the cross head is in fully raised position and valve 275 is depressed; and the quench press loader, cylinder 203, may operate only after the quench ring frame has moved sufficiently toward the unloading position to avoid possible interference, for example about 6½ inches, at which point a hydraulic valve 363 is operated by the rack 176 to open a fluid conduit 364 to the rod end of cylinder 203.

Electrical safety interlocks for the cross head are also provided. If the cross head remains at its upper or lower position for a period exceeding the setting of a timer 372 (Fig. 27), as actuated by limit switches 365 and 366 (Fig. 26) when depressed by respective cams 367 and 368, the hydraulic motor driving the cam shaft will be stopped by the timer breaking a normally closed contact 371 in the circuit to the solenoid 254 for the valve 236. A signal light 424 indicates when contact 371 is closed. The time setting of the timer 372 is preferably about one second longer than the setting of the quench timer 252 so that if the cross head does not move up

promptly after a quench, the opening by the timer stops the hydraulic motor 231 and thus the entire automatic cycle operation. The timer 372 also closes a normally open contact 373, closing a circuit to a red signal light 374.

The cross head 108 (Figs. 21–25) cannot reach the lower limit of travel unless the quench ring frame has dropped to the quench position. A limit switch 375 is provided on the press which is operated when the quench ring frame is in its quench position, its cylinder 172 fully returned, and the frame lift cylinder 191 is also in its returned position. A limit switch 376 is provided which is operated by a cam 377 on the cross head before any part of it or the quench plug assembly could strike the quench ring frame in the raised position. Thus if limit switch 375 is made before limit switch 376 is broken, a latch coil 378 (Fig. 27) of a relay 379 will be energized through limit switches 375 and 376, breaking normally closed contact 381 of the relay 379, thus breaking the electrical circuit to solenoid 334 of valve 248, preventing lowering of the cross head further; breaking normally closed contact 382 of relay 379, breaking the electrical circuit to the solenoid 254 of the hydraulic motor valve 236 and thus stopping further hydraulic cycle operations controlled by the cam shaft 232. A signal light 383 is also energized by the relay as it closes a normally open contact 384 in the circuit to the light 383. The furnace and press operator may, after correcting the indicated trouble, reset the relay 379 by a reset push button 385.

Another safety provision is illustrated by Figs. 21, 22, 23, 24 and 25. On each of the floating rods 152 for each of the four quench plugs there is a ring type cam 386 which actuates a limit switch 387 on the lower bar 112 of the cross head 108 as the floating rod 152 rises with respect thereto. When the cross head 108 reaches very nearly the end of its downward stroke, it trips the limit switch 366, breaking the normally closed circuit to the cross head stoppage timer 372 as hereinbefore described and also closing a normally open contact to line 388 forming a series circuit through the four limit switches 387 in parallel with each other, and thence through the latch coil of a relay 389. If any of the normally open limit switches 387 is closed before limit switch 366 breaks the circuit 388 through a limit switch 387 to the latch coil of relay 389, as illustrated in Fig. 25, then a normally closed contact 391 in the circuit to solenoid 334 of valve 248 is broken, a normally open contact 392 is closed to energize solenoid 253 of valve 248, causing the ram 116 to balk and reverse and raise the cross head 108, and a normally open contact 393 in a circuit to a deflector solenoid 394 is closed.

Closing of the circuit to the solenoid 394 energizes it and causes it to move a deflector 395, illustrated in Fig. 19, from the position shown in full lines to the position shown in broken lines. The deflector 395 is loaded by a spring 396 and counter balanced by a weight 397 to return it to its first position when the solenoid 394 is de-energized.

With the compounded hydraulic cylinders 115 and 134 where cylinder 133 is mounted on the rod, or ram, of cylinder 115, the rod 134 of the lower cylinder is in its extended position as the cross head is moved downward. By properly locating limit switch 366 to be actuated by the cross head before the individual quench rods are seated correctly, but so that if any of the rods do not seat properly (due to a misplaced ring W) one of the limit switches 387 will be depressed by relative movement of a quench rod with respect to the cross head, it is possible to cause the main ram to balk and reverse if any one of the several quench plugs does not properly seat on the ring W under it while yet under low pressure of the ram, about 300 p. s. i. In case of a balk, the rings are not quenched, but are automatically discharged from the press in the usual way and moved into the chute 41 where the deflector 395 is now in position to deflect all the unquenched rings into a pan 398 where they may be inspected, and if desirable re-charged into the furnace 35 in the usual way. When the quench ring frame again seats in its normal position under the quench plugs, limit switch 375 is depressed, closing the trip coil circuit to relay 389 which in turn de-energizes the deflector solenoid and allows the deflector 395 to return to its normal position, thus re-opening the chute 41 to the quench tank 43.

In Fig. 19 the quench ring frame 156 is shown in its unloading position in full lines, and the pusher head 75 is shown loading a new ring W on the anvil 135 within the centering ring 136. The quench ring frame is also shown in broken lines in its raised position as it is returned to its normal quench position.

The electrical circuit diagram of Fig. 27 has been in part described as its functional elements entered into control of motions hereinbefore described. A few details to be filled include the three 220 volt lines L1, L2 and L3 which feed through a cutoff switch 399 and contacts 401, 402 and 403 and fuses 404 and 405 to the motor 221. A 220 v. to 110 v. transformer 406 provides current for the various electrical safety and operating controls described. A magnetic starter of the usual type for the motor 221 is provided, with start and stop buttons 407 and 408, and a solenoid 409 to operate a holding contact 411 and the contacts 401, 402 and 403 in the motor circuit. The usual overloads and fuses 412, 413, 414, 415, 416, 417 and 418 are provided in each solenoid circuit.

Push buttons 421 and 422, respectively, are provided to raise and lower the cross head manually, either of which closes one circuit and opens the other to the respective solenoids 253 and 334 which control manual and automatic operation of valve 248. An off and on main control switch 423, is provided in the circuit through the normally closed contact 371 of timer 372 and through solenoid 254 of hydraulic motor valve 236 to effectively stop all automatic operations. The switch 423 also closed the circuit to the solenoid 341 of the decompression valve 342 when the switch is in the on position.

A push button 425 is also provided to operate the solenoid 254 of the hydraulic motor valve 236 when the cross head timer 372 normally closed contact 371 is opened, and the main switch 423 is in its on position, provided that limit switch 333 has closed the circuit thereto.

When the furnace and press apparatus has been operating automatically and it is desired to shut down, it would appear that a considerable number of rings would ordinarily be left in the furnace in the rails 55. It is not practical to try to manually empty the work onto the press to complete the quenching operation for all such work, so the furnace is preferably emptied of work by turning fast threaded screws 77 and opening the hinged gate 76, sliding the pusher heads 71 and associated elements out of the rails, and inserting into each rail a long hand hook, not shown, which may be easily slid along the open face of the channeled rails 55, then turned to engage the last ring W next adjacent the lip 64. The hook is then withdrawn, and the rings are discharged from the rails 55 through a slot 69 therein provided, falling into an oil filled quench tank 70. This quenching of the rings is for the purpose of reducing surface oxidation, and any distortion due to this free quench is eliminated by subsequent normal press quenching.

The apparatus described has for the first time made practical automatic multiple quench press operation in conjunction with a heating furnace. The human element is eliminated and the product resulting from the automatic operation is unusually uniform and clean. The rings W are hooded under atmosphere almost up to the instant the quench oil floods them, thus being exposed to atmospheric air for a matter of only a few second. In the example illustrated, such exposure is but 8 seconds, but it is obviously possible to extend the time of protective

atmosphere covering by further shielding press motions under a hood.

The apparatus shown produces quenched work barely discolored by oxidation, hence further atmosphere gas protection was not found to warrant the trouble of providing the additional shield required. Such a shield could easily take the form of a flexible or telescoping, joint between the quench ring frame and the chute 39 and the hot rings would then never be exposed to air. The apparatus shown and the method of operation which is illustrated is believed well adapted to produce the desired superior results.

I claim:

1. The combination which comprises a furnace for heating metal articles to be press quenched, the articles each having a first surface with a given configuration and a second surface having a configuration differing from the first, a press for press quenching the articles after heating in the furnace, a first article engaging element on said press for engaging the first surface of an aritcle and generally conforming thereto, a second article engaging element on said press and movable with respect to said first element for engaging the second surface of the article and generally conforming thereto, an intermittently operated furnace loader for loading articles into the furnace, a furnace conveyor for conveying articles through the furnace and maintaining the orientation of the articles as introduced into the furnace, means transferring articles from said furnace conveyor to a press loader station with a fixed orientation with respect to the orientation in said furnace conveyor, an intermittently operated press loader for loading work onto the press in position to be press quenched with a fixed orientation with respect to that in said transfer means to engage said first article engaging element with said first surface and said second article engaging element with said second surface, discharge mechanism for discharging articles from the press, ram means in said press for applying pressure to said elements and an article engaged thereby, quench fluid supply means for supplying quench fluid to the articles while under pressure from the ram means, and control means for automatically and cyclicly operating with predetermined timing and in predetermined sequence, first, the furnace loader to advance articles into and through the furnace and individually onto the press loader, second, the press loader to individually load articles onto the press to be press quenched, third, the ram means and the quench fluid supply means to individually quench the articles under pressure, and fourth, the discharge mechanism to discharge the articles from the press, said furnace loader, furnace conveyor, press loader, ram means, quench fluid supply means and discharge mechanism thus mutually cooperating to process a series of uniformly heat treated press quenched articles.

2. The method of producing press quenched articles, the articles each having a first surface with a given configuration to be engaged by a first press element generaly conforming thereto and a second surface having a configuration differing from the first to be engaged by a second press element generally conforming thereto, which comprises moving the articles substantially continuously through a furnace to heat treat the articles to the desired temperature, simultaneously loading a plurality of said articles each in a quenching station of a multiple station quench press with an orientation in the station presenting said first surface to the first press element and the second surface to the second press element, and simultaneously press quenching the articles at each of the quenching stations.

3. In apparatus for producing press quenched articles, the articles having a first surface with a given configuration and a second surface having a configuration differing from the first, the combination with a substantially continuous furnace for heating the articles, of a plurality of channeled conveyors for advancing a plurality of rows of articles step by step at regular intervals along said channeled conveyors through the furnace and for maintaining a given orientation of said articles, a quench press having a plurality of quench stations each adapted to receive articles from only a corresponding row of articles in the furnace, a first article engaging element on said press for engaging and generally conforming to the first surface of an article, a second article engaging element on said press movable with respect to said first element for engaging and generally conforming to the second surface of an article, press loading means for transferring articles in step with the advance of articles through the furnace from said rows to each of said quench stations in an orientation on the stations corresponding to the prior position of the articles in the furnace enabling said first element to engage the first surface of the article and the second element to engage the second surface of the article, means responsive to the loading of the work on the quenching stations for individually and simultaneously press quenching the work transferred, and means for automatically unloading the press, said channeled conveyors, said quench press loading means, said means for press quenching the work and said means for automatically unloading the press thus mutually cooperating in the automatic heat treating, quenching and discharge of a series of uniformly processed articles.

4. The combination of a furnace and a quench press the furnace having inlets for admitting protective atmosphere, a plurality of channel-like conveyors extending through said furnace, means for delivering a succession of substantially identical and identically aligned articles to each of the channel-like conveyors, a plurality of quench press loaders, means including ducts containing a protective gas atmosphere for delivering articles individually from said conveyors to each of the quench press loaders with a fixed orientation with respect to their orientation in said conveyors, the press quenching station corresponding to each of said loaders, means for simultaneously loading each article onto one of the press quenching stations in a position corresponding to its position as it was delivered to the furnace conveyor, means for simultaneously press quenching the several articles in the quench stations and applying pressure to each article independently of each other article being simultaneously press quenched, and means for discharging the articles from the press.

5. A quench press comprising a frame, a base, a main ram, a main hydraulic cylinder on the frame for moving the main ram toward the base, a plurality of secondary hydraulic cylinders carried by the main ram, a fluid conduit from the main cylinder through the main ram to each secondary hydraulic cylinder, a secondary ram for each secondary cylinder and an axially movable floating rod for each secondary cylinder, the rods being guided on the main ram and each being adapted to press articles to be press quenched while they are supported by the base, said secondary cylinders being interconnected whereby the pressure on the secondary rams is equalized notwithstanding variations in the extent of movement of the several secondary rams.

6. A quench press comprising a frame, a base, a main ram, a main hydraulic cylinder on the frame for moving the main ram toward the base, a plurality of secondary cylinders carried by the main ram, a fluid conduit from the main cylinder to each secondary cylinder, a secondary ram in each secondary cylinder, and an axially movable floating rod for each secondary cylinder, the rods being guided on the main ram and each adapted to press articles on the base to be press quenched, the area of the main cylinder being larger than the total effective area of the secondary cylinders, said secondary cylinders being interconnected whereby the pressure on the secondary rams is equalized notwithstanding variations in the extent of movement of the several secondary rams.

7. In a quench press comprising a frame for press

quenching articles, in combination, a first hydraulic cylinder on the frame, a first ram for the cylinder, a second hydraulic cylinder carried by the first ram, a second ram for the second cylinder, the second ram being adapted to engage articles to be press quenched, a first cam operated switch on the frame, a cam on the first ram for operating the switch, a second cam operated switch on the first ram, a cam on the second ram for operating the second switch, and control means for operating the quench press to press quench articles when on the extending stroke of the first cylinder, the first switch normally being operated before the second switch and the second switch being operated before the first switch to reverse the direction of the first ram if the second ram does not properly engage an article.

8. In a quench press for simultaneously press quenching a plurality of articles, in combination, a base whereon the several articles are placed for press quenching, a plurality of secondary hydraulic cylinders, a secondary ram for each secondary cylinder, a cross head for supporting said secondary hydraulic cylinders, an axially movable floating rod for each secondary ram, a primary hydraulic cylinder, and a ram for the primary cylinder for moving the cross head, the rods being guided by the cross head and each being adapted to press an article on the base to be press quenched, the total force exerted by the secondary cylinders being less than the force exerted by the primary cylinder and the secondary cylinders being interconnected whereby the pressure on the secondary rams is equalized notwithstanding variations in the extent of movement of the several secondary rams.

9. In a quench press for quenching heated articles, in combination, a frame comprising a base whereon an article is placed for press quenching, a cross head, a hydraulic cylinder on the frame for moving the cross head toward and away from the base, an axially movable rod carried on said cross head into and out of engagement with an article placed on said base for press quenching, the rod moving relative to the cross head when the rod engages an article to be press quenched, first means responsive to relative movement of the cross head and the base, second means responsive to relative movement of the rod and the cross head, and control means for reversing the direction of motion of the cross head when upon moving the cross head toward the base the second responsive means is actuated before the first responsive means is actuated.

10. In a quench press for simultaneously and individually press quenching a plurality of articles, in combination, a frame comprising a base whereon the several articles to be press quenched are placed, a cross head comprising an upper bar and a lower bar, a first hydraulic cylinder on the frame for moving the cross head toward and from the base, a plurality of second hydraulic cylinders on the upper bar, a plurality of axially movable rods carried on the lower bar and each adapted to engage at one end an article to be press quenched and at the other end a second hydraulic cylinder, first means responsive to relative movement of the cross head and the base, a plurality of second means each responsive to relative movement of one of said rods and the cross head, and control means actuated by any one of the second responsive means for reversing the direction of motion of the cross head when upon moving toward the base one of the second responsive means is actuated before the first responsive means is actuated.

11. In a quench press according to claim 10, a chute for discharging articles from the press, discharge means for discharging articles from the base into the chute deflector means for deflecting articles in the chute, and means for actuating the deflector means when upon moving the cross head toward the base one of the second responsive means is actuated before the first responsive means is actuated.

12. In a quench press for press quenching articles, in combination, a base whereon articles are placed for press quenching, a quench ring surrounding the base for supplying quench fluid to an article thereon, a ram for applying pressure to an article on the base while surrounded by the quench ring, means for raising the ram from an article on the base, means for discharging the article from the base comprising means for slideably moving the quench ring and the article therein from the base, loader means for placing articles on the base when the quench ring is displaced therefrom, and means for raising the quench ring and returning it to its position surrounding the base while an article is on the base.

13. The combination according to claim 1 wherein said control means comprises means preventing the advance of work by the furnace loader when the ram means is not in a retracted position whereat work may freely be loaded thereunder.

14. The combination with a press for press quenching circular work with its axis aligned with the axis of the press ram, of a furnace for heating the work, a furnace conveyor comprising a bottom rail, a top rail and side guards for rolling the work through the furnace on the bottom rail with its axis generally horizontal, a furnace loader for advancing the work step by step into the furnace conveyor on its rim, and furnace delivery means for discharging the work from the conveyor at each step of its advance and positioning it under the press ram with its axis aligning with the generally vertical axis of the ram.

15. The combination with a press for press quenching circular work with its axis aligned with the axis of the press ram, of a furnace for heating the work, a furnace conveyor of a C cross-sectional shape for rolling the work through the furnace on its rim with its axis generally horizontal, a furnace loader for charging work into the conveyor on its rim, delivery means for discharging the work from the conveyor and positioning it under the ram with its axis aligned with the generally vertical axis of the ram and means for coordinating the functions and timing of the furnace loader and the delivery and positioning means.

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