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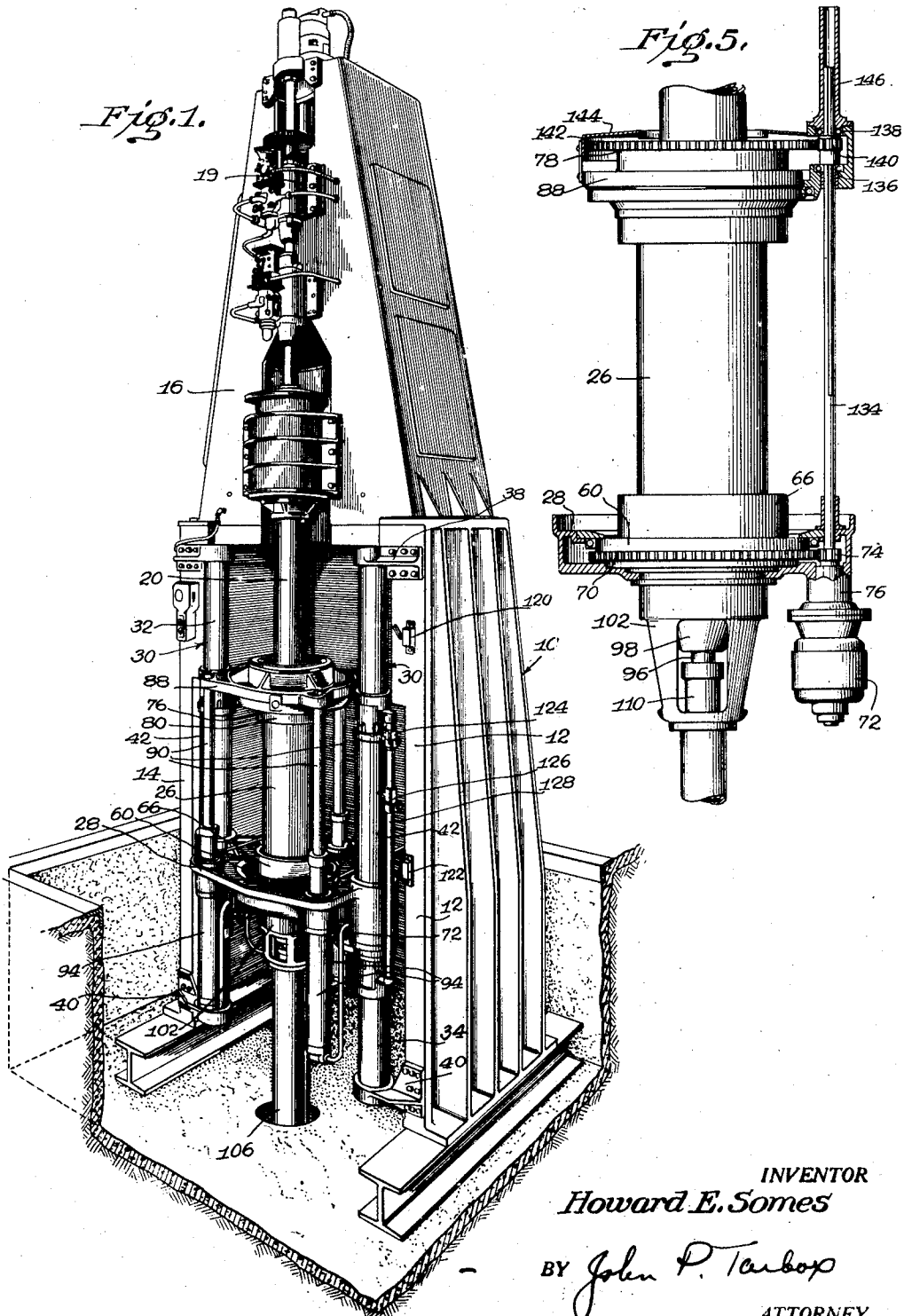
H. E. SOMES

2,361,976

HEAT TREATING APPARATUS

Filed Aug. 2, 1940

3 Sheets-Sheet 1



INVENTOR

Howard E. Somes

BY John P. Tarbox

ATTORNEY

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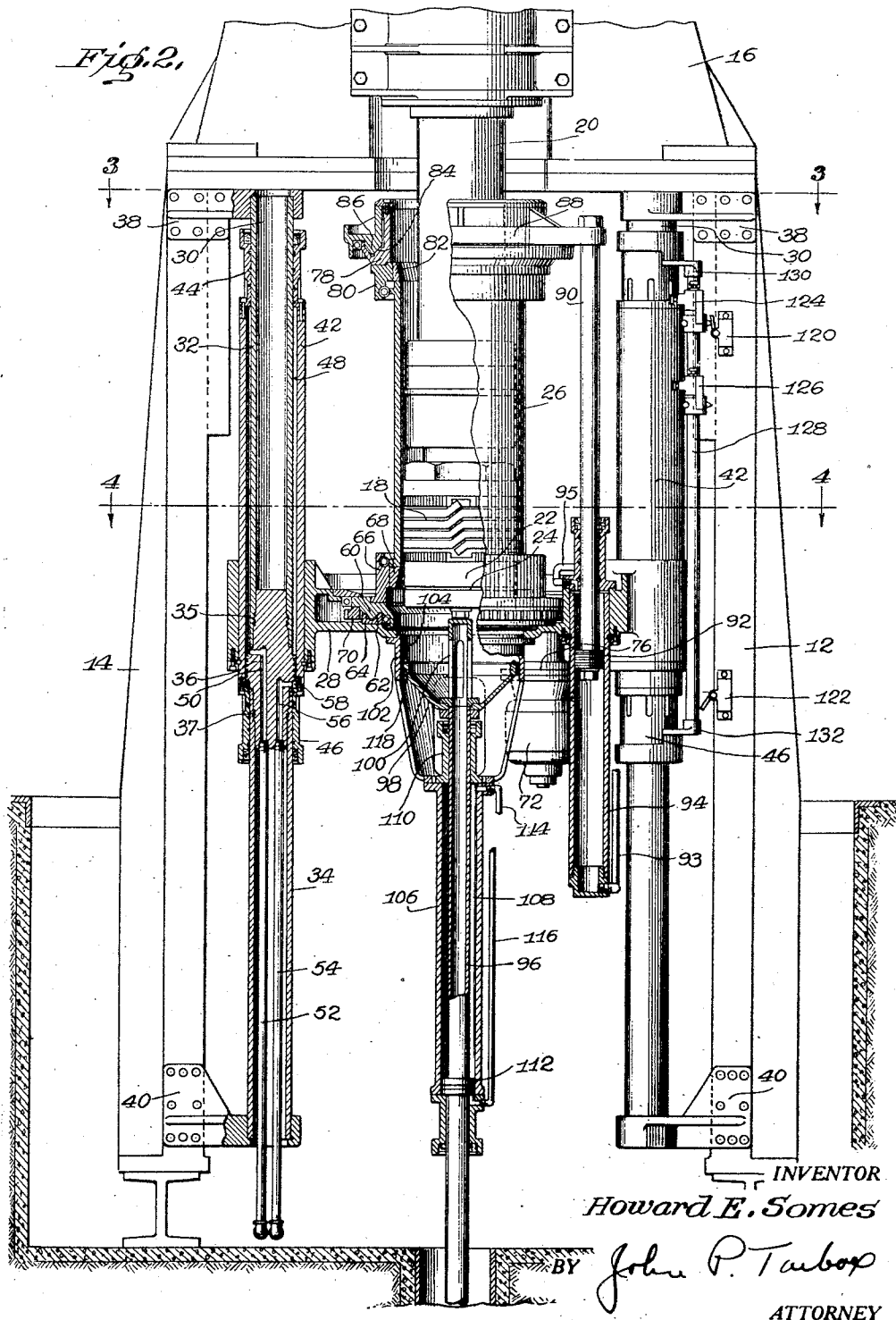
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Fig. 3.

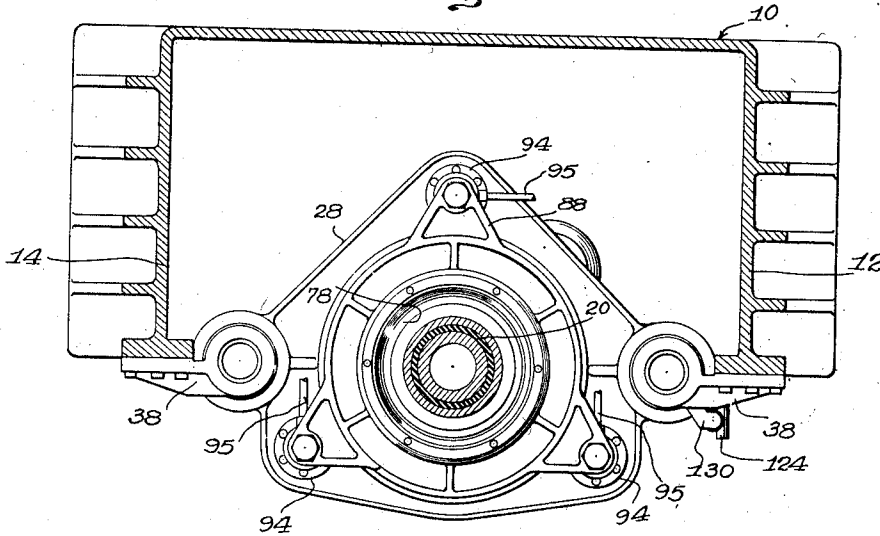
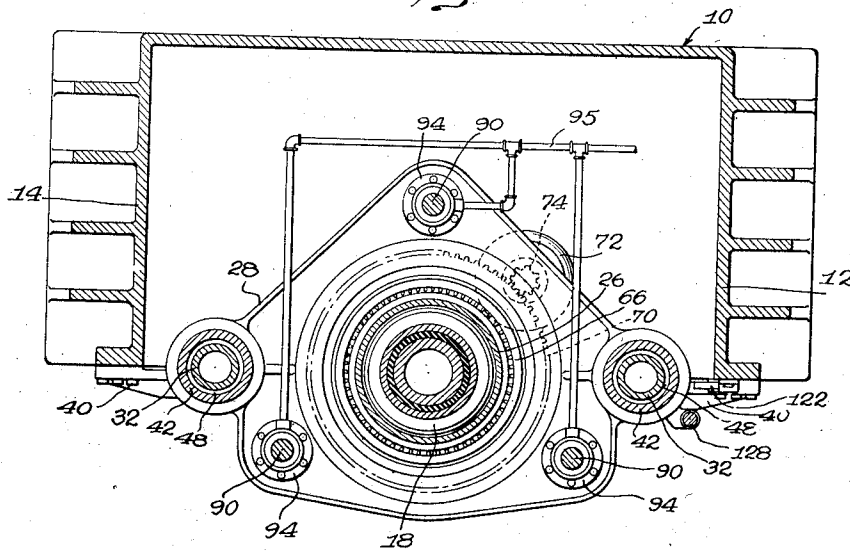


Fig. 4.



INVENTOR

Howard E. Somes

BY *John P. Tarbox*

ATTORNEY

UNITED STATES PATENT OFFICE

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HEAT TREATING APPARATUS

Howard E. Somes, Detroit, Mich., assignor to
Budd Induction Heating, Inc., Philadelphia,
Pa., a corporation of Michigan

Application August 2, 1940, Serial No. 349,400

17 Claims. (Cl. 219—13)

This invention relates to heat treating apparatus and more particularly to a novel work support mechanism adapted for progressive operation in conjunction therewith.

In the heat treatment of elongated objects, it is preferable in many instances to heat treat a small zone of the object at a time and progress that zone gradually along the length of the object. The present invention is directed to a fluid pressure system for gradually feeding an object for such progressive treatment and to fluid pressure means for securing such an object in its work support. The present invention constitutes an improvement over the apparatus disclosed in a copending application Serial No. 164,320, filed September 17, 1937, now Patent No. 2,281,331, issued April 28, 1942.

It is an object of the invention to provide a fluid pressure feeding device for progressively moving a workpiece during operation thereupon with precision.

Another object of the invention is to provide a fluid pressure clutching device for rigidly securing a workpiece in position during the progressive feeding thereof relative to a heat treating tool.

A further object of the invention is to provide in conjunction with the aforementioned features a common drive for spaced work support members for rotation of work carried thereby, from both ends.

The above and other novel features of the invention will appear more fully hereinafter from the following detailed description when taken in conjunction with the accompanying drawings. It is expressly understood, however, that the drawings are employed for purposes of illustration only and are not designed as a definition of the limits of the invention, reference being had for this purpose to the appended claims.

Referring to the drawings wherein like reference characters indicate like parts,

Figure 1 is a perspective view of a heat treating machine in which the improvements of the present invention have been incorporated.

Figure 2 is a front elevation of the feeding and clutching apparatus partially shown in section.

Figure 3 is a transverse section taken substantially on the line 3—3 of Figure 2.

Figure 4 is a transverse section taken substantially on the line 4—4 of Figure 2 and

Figure 5 is an illustration of a slight modification showing the manner of extending the drive

to both ends of the work carried by the work support.

Referring to Figure 1, there will appear a frame 10 having spaced parallel upright side members 12 and 14 and a top member 16. Depending from the top member 16 and centrally between the frame members 12 and 14 is an electromagnetic induction heat treating head 18, the same being supported from the frame 16 through a heavy arbor 20 through which electrical connections are made to the coil, the details of which do not form a part of the present invention. Associated with the heat treat coil 18 is a quenching nozzle 22 having an annular quenching orifice 24.

Heat treatment of the internal bore of cylindrical objects such as the cylinder sleeve indicated by the reference character 26 is accomplished by moving the sleeve relative to the heat treating head and quench so that a zone of the sleeve is progressively heated and quenched as the relative movement takes place. In order to support the sleeve 26 for movement relative to the head 18 which during treatment is preferably stationary in the arrangement shown, there is provided a table 28 movable vertically upon stationary guide rods 30. The stationary guide rods are constituted by a pair of hollow piston rods 32 and 34 joined together by a piston 36 through threaded connections 35 and 37 and secured at their free ends upon brackets 38 and 40 mounted at the top and the bottom of the side frames 12 and 14. The table 28 is secured to a cylinder sleeve 42 reciprocable upon the piston 36 and slidable at its ends upon the piston rods 32 and 34, the cylinder 42 being provided with cylinder head guide blocks 44 and 46 for this purpose.

To elevate the cylinders 42 upon the guide rods 30 and with reference to the piston 36, fluid pressure is admitted into the annular space 48 between the cylinder 44 and the piston rod 32 through the port 50 in the piston 36, the latter being connected to a suitable source of fluid supply through the pipe line 52.

Lowering of the table 28 is accomplished through the introduction of fluid through the pipe 54 and the port 56 in the piston 36, the port 56 emerging below the piston 36 and being adapted to supply fluid to the annular space 58 between the cylinder 42 and piston rod 34.

The table 28 is provided with a rotatable chucking device 60, the same being centered by a complementary annular groove 62 and ridge 64 arranged upon the table 28 and the rotatable chucking device 60, respectively. The chucking device carries thereon an annular chucking re-

ceptacle 66 adapted to receive the lower end of the cylinder sleeve 26 and hold the same against rotation through any suitable means. The receptacle also is provided with radial laminated iron magnetic extension elements 68 to minimize end effects and to assure uniform heat treatment from end to end. The chucking device 60 is rotated through an annular gear 70 positioned adjacent the annular ridge 64 and driven by a drive motor 72 and pinion 74, the motor being supported from a depending integral bracket 76 formed as a part of the table 28.

The upper end of the cylinder sleeve 26 is supported in a similar upper chucking device 78, the same being provided with a chucking receptacle 80, the latter having magnetic end pieces 82. The chucking device 78 through the interengaging annular recess and annular ridge 84 and 86, respectively, is rotatably supported upon the non-rotatable upper chucking support member 88. The member 88 in turn is supported upon a plurality of parallel piston rods 90, the lower ends of which are provided with pistons 92 reciprocable in corresponding cylinders 94 arranged in the table 28, by means of which the member 88 may be moved away from the table 28 to facilitate the insertion or removal of cylinder sleeves 26 prior to and subsequent to heat treatment.

Beneath the table 28 there is provided a drainage system for the quenching fluid emerging from the nozzle 24, the drainage system comprising a central drain pipe 96, a conical diaphragm 98 at the upper end thereof and a gauging or stop member 100 to assure proper spacing between the heat treating head and the diaphragm 98. The distance between the heat treating head with the quenching nozzle 24 and the diaphragm 98 restricts the length of the internal wall zone of the sleeve 26 which is subjected to quenching so as to also secure uniformity of treatment. An inverted bell-shaped extension 102 having an internal diameter 104 substantially similar to the internal diameter of the cylinder sleeve 26 being treated is projected against the underside of the table 28 and cooperates with the conical diaphragm 98 to prevent escape of the quenching fluid except through the drain pipe 96, the diaphragm 98 being provided with a peripheral resilient metallic packing 118.

Assuming that heat treatment is to be effected, the apparatus is positioned substantially as is shown in Figure 2, the high frequency heating current is applied to the coil 18, and quenching fluid is caused to flow through nozzle 24, whereupon hydraulic liquid trapped in the space 48 is permitted to exhaust through the port 50 and pipe 52 at a uniform rate so as to permit the table 28 to move downwardly with the cylinder sleeve at a uniform rate past the heat treating head 18 and quench 24. At the same time, the inverted bell 102 which is mounted upon a cylinder 106 telescopically arranged about the drain pipe 96 is forced downward with the table 28 against fluid pressure trapped in and ready to be exhausted from the annular space 108 between the cylinder 106 and the drain pipe 96 and the cylinder head 110 on the end of the cylinder 106 and the piston 112 carried by the drain pipe 96. By the use of air pressure admitted through the pipe 114 to the upper end of the annular space 108, the bell 102 may be held in yielding engagement with the underside of the table 28 through the movement of the table 28 in a downward direction during heat treatment, while return movement is provided for by the introduction of fluid 76

pressure through the pipe 116 into the lower end of the cylinder 106 on the underside of the piston 112.

In order to limit the upward and downward movement of the table 28, limit switches 120 and 122 are positioned on the frame member 12 and are adapted to be engaged by the cams 124 and 126, respectively, the cams being adjustably positioned upon the rod 128 extending parallel to and supported from the cylinder heads 44 and 46 of the cylinder 42 through brackets 130 and 132. The limit switches may cut off the flow of fluid to the annular spaces 48 and 58 above and below the piston 36, in any suitable manner, not shown.

Where long sleeves are to be heat treated and the depth of heat treatment considerable so that in the zone undergoing such heat treatment the structure is temporarily materially weakened, it is preferable that the sleeve be rotated from both ends so that no torsional drag or twist will be imposed upon the sleeve while it is undergoing treatment. In order to provide for such operation, a modified form such as shown in Figure 5 may be employed, the motor 72 being provided in such arrangement with extended splined shaft 134 extending to and through bearings 136 and 138 in the member 88, the splined shaft being provided with a pinion 140 meshing with a gear 142 arranged upon the upper end of the upper chucking device 78. A suitable guard 144 around the gear 142 is provided as well as a sleeve extension 146 arranged around the projecting end of the splined shaft 134.

The operation of the apparatus should be clear from the foregoing description. In loading the apparatus with a sleeve 26 it will be understood that the heat treating head 18 with its quench 22 may be retracted upwardly through the operation of the fluid pressure cylinder 19 a sufficient distance so as to clear the upper chucking device 78 when the table 28 is at the lower end of its movement. If desired, instead of moving the head upward through the cylinder 19, the table 28 and drain 96 could be lowered to a point sufficiently below the lower limit of travel during heat treatment to produce the same effect or resort could be had to movements of both. A sleeve 26 is inserted into the lower chuck 66 and fluid pressure thereafter admitted into the top of the cylinders 94 through the pipe line 95 to bring the upper chucking fixture 78 down upon the upper end of the cylinder sleeve 26 to thereby hold the same rigidly and concentric with the axis of the machine. Thereafter hydraulic liquid is introduced into the annular space 48 between the piston rods 32 and cylinders 42 through the port 50 and pipe 52 to raise the table 28 to the upper end of its limit at which point the limit switch 120 acts to cut off the supply of further liquid. At the same time, the drain bell 104 is raised upon the drain pipe 96 by the introduction of fluid pressure through the pipe 114 into the annular space 108 between the cylinder 106 and drain pipe 96. Thereafter power is supplied to the coil and quenching fluid to the quenching nozzle and at the same time hydraulic liquid is released from the annular space 48 and driven into the annular space 58 at a prescribed rate to assure a uniform speed of the cylinder sleeve 26 downwardly, and at the same time rotation of the sleeve is effected through energization of the motor 72. Upon the downward stroke approaching the limit of its movement the limit switch 122 acts to arrest further movement and to cut

off the power from the heating coil 18. After a prescribed dwell period rotation is stopped, the quenching fluid is cut off and thereafter fluid pressure is admitted to the lower ends of the cylinders 94 through the pipes 93, thereby separating the chucking devices 78 and 66. Thereupon, by raising the heating head 18 through the actuation of the fluid pressure cylinder 19 or by lowering the table carriage 28 and drain connection, the cylinder sleeve 26 may be removed and another added.

In practice, progression of the cylinder during heat treatment takes place at a rate in the order of an inch to two inches per second and through the use of high frequency currents, the heating effect of the coil is limited to a shallow depth dependent upon the power input, the frequency and the rate of movement of progression. It will be observed that the annular spaces 48 and 58 which control the downward movement of the table 28 are relatively small in cross-section so that high hydraulic pressures are required for operation, which pressures, and due to the small quantity of fluid employed, render the apparatus substantially insensitive to changes in viscosity due to temperature changes and further make it easy to regulate the rate of movement by regulating the pressure applied behind a fixed orifice. The pressure, being relatively great, can be accurately controlled.

There has thus been described a novel work supporting mechanism for use in conjunction with apparatus of the class described. The apparatus is capable of accurate operation such as is essential in electromagnetic induction heat treatment and is capable of relatively fast operation so that production rates may be relatively great. Additionally, the apparatus will be seen to be capable of exactly duplicating its operation each time whereby assurance may be had that uniform heat treatment results are obtained from consecutive and large quantities of workpieces treated by the apparatus.

Although a single modification of the invention with one alternative arrangement thereof has been illustrated and described, it is to be understood that the invention is not to be limited thereto but may be employed in other equivalent mechanical and electrical arrangements and forms. As many changes in construction and arrangement may be made as will be apparent to those skilled in the art, reference will be had to the appended claims for a definition of the limits of the invention.

What is claimed is:

1. In a heat treating apparatus, a frame having spaced upright parallel supports, a heat treat head centrally supported with respect to said supports, a pair of spaced apart parallel piston and guide rods vertically secured to said supports at each end, a piston on said rods intermediate the ends thereof, a cylinder reciprocable upon each of said rods, a work table secured to said cylinders having a revolvable work holder therein, means carried by the table for rotating said work holder, a second work holder spaced from said table, means for revolvably supporting said second holder, and being reciprocally carried by said table, and means for supplying fluid to opposite sides of said pistons to elevate or lower said table.

2. In a heat treating apparatus, a work table having a central aperture therein, a revolvable work support thereon having a central aperture therein adapted to hold one end of a cylindrical

workpiece, a work support adapted to hold the other end of the workpiece, means for revolvably carrying said last mentioned work support, and fluid pressure means for moving the work supports toward and away from one another and conduit means adapted to engage said table from the underside thereof and adapted to cover said table aperture.

3. In a heat treating apparatus, a work table, a revolvable work support thereon adapted to hold one end of a cylindrical workpiece, a work support adapted to hold the other end of the workpiece, means for revolvably carrying said last mentioned work support, a plurality of cylinders arranged in said table around said first-named work support, pistons in said cylinders, and piston rods extending from said pistons to said work support carrying means.

4. In a heat treating apparatus, a frame having spaced upright parallel supports, a heat treat head centrally supported with respect to said supports, a pair of spaced apart parallel piston and guide rods vertically secured to said supports at each end, a piston on said rods intermediate the ends thereof, a cylinder reciprocable upon each of said rods, a work table secured to said cylinders having a revolvable work holder therein, a second work holder spaced from said table, means for revolvably supporting said second holder and reciprocally carried by said table, means carried by the table for rotating both of said work holders comprising a shaft parallel with the axis of said work holder having a spline thereon and means associated with said second work holder splined upon said rod for rotating said second work holder.

5. In a heat treating apparatus, a frame having spaced upright parallel supports, a heat treat head centrally supported with respect to said supports, a pair of spaced apart parallel piston and guide rods vertically secured to said supports at each end, a piston on said rods intermediate the ends thereof, a cylinder reciprocable on each of said rods, a work table secured to said cylinders having a revolvable work holder therein, said work table and cylinders constituting a carriage, a second work holder mounted on said carriage and reciprocable towards and away from said table, and means for supplying fluid to opposite sides of said pistons to elevate or lower the said table.

6. In a heat treating apparatus, a frame having spaced upright parallel supports, a heat treat head centrally supported with respect to said supports, a pair of spaced apart parallel piston and guide rods vertically secured to said supports at each end, a piston on said rods intermediate the ends thereof, a cylinder reciprocable upon each of said rods, a work table secured to said cylinders, a second work holder spaced from said table, and reciprocally carried by said table, and means for supplying fluid to opposite sides of said pistons to elevate or lower said table.

7. In a heat treating apparatus, a heat treat head, a main carriage, a second carriage spaced from said main carriage, means for reciprocally supporting said second carriage on said main carriage, means for effecting relative reciprocal movement between said carriages, a pair of spaced work holders, one being supported by one carriage and the other being supported by the other carriage and being arranged to engage and hold the opposite ends of a work piece to be heat treated, said workholders and heat treat head having a common axis, guide members for guid-

ing said main carriage for movement along said common axis, and means for reciprocating said main carriage on said guide members relative to said heat treat head.

8. In a heat treating apparatus, a heat treat head, a main carriage, a second carriage spaced from said main carriage, means for reciprocally supporting said second carriage on said main carriage, means for effecting relative reciprocal movement between said carriages, a pair of spaced work holders, one being supported by one carriage and the other being supported by the other carriage and being arranged to engage and hold the opposite ends of a workpiece to be heat treated, said workholders and heat treat head having a common axis, guide members for guiding said main carriage for movement along said common axis, means for reciprocating said main carriage on said guide members relative to said heat treat head and means for rotatably supporting said work holders on said carriages, and means for rotating at least one of said work holders.

9. In a heat treating apparatus, a heat treat head, a main carriage, a second carriage spaced from said main carriage, means for reciprocally supporting said second carriage on said main carriage, means for effecting reciprocal movement between said carriages, a pair of spaced work holders, one being supported by one carriage and the other being supported by the other carriage and being arranged to engage and hold the opposite ends of a workpiece to be heat treated, said workholders and heat treat head having a common axis, guide members for guiding said main carriage for movement along said common axis, means for reciprocating said main carriage on said guide members relative to said heat treat head and means for rotatably supporting said work holders on said carriages, and means carried by one of said carriages for effecting rotation of at least one of said work holders.

10. In a heat treating apparatus, a heat treat head, a main carriage, a second carriage spaced from said main carriage, means for reciprocally supporting said second carriage on said main carriage, means for effecting relative reciprocal movement between said carriages, a pair of spaced work holders, one being supported by one carriage and the other being supported by the other carriage and being arranged to engage and hold the opposite ends of a workpiece to be heat treated, said workholders and heat treat head having a common axis, guide members for guiding said main carriage for movement along said common axis, means for reciprocating said main carriage on said guide members relative to said heat treat head and means for rotatably supporting said work holders on said carriages, and means for effecting rotation of both said work holders.

11. In a heat treating apparatus, a heat treat head, a main carriage, a second carriage spaced from said main carriage, means for reciprocally supporting said second carriage on said main carriage, a pair of spaced work holders, one being supported by one carriage and the other being supported by the other carriage and being arranged to engage and hold the opposite ends of a workpiece to be heat treated, said workholders and heat treat head having a common axis, guide members for guiding said main carriage for movement along said common axis, means for reciprocating said main carriage on said guide members relative to said heat treat head and means for rotatably supporting said work holders on said carriages, and means for effecting rotation of

both said work holders, said last-mentioned means including a gear set associated with each of said work holders, and a driving motor carried by one of said carriages having a shaft for driving said gear sets, said shaft having an axially slidable connection with the gear set of the other of said carriages.

12. In a heat treating apparatus, a heat treat head, a pair of spaced carriages, each having a work support, said work supports and heat treat head having a common axis and said work supports being engageable with the opposite ends of a workpiece to be heat treated, a plurality of guide rods extending from one of said carriages, a plurality of cylinder members carried by the other of said carriages in coaxial guiding relation with said guide rods, said guide rods and cylinders being parallel to said common axis, fluid pressure means associated with said cylinders for effecting relative reciprocable movement between said carriages, a frame member, coaxial slidably engaged cylinder and guide rod members carried by said frame member and one of said carriages and having their axes parallel to said common axis, and fluid pressure means associated with said last named cylinders for effecting reciprocating movement of said carriages as a unit relative to said heat treat head.

13. In a heat treating apparatus, a heat treat head, a main carriage, a second carriage spaced from said main carriage, means for supporting said carriages for relative movement toward and from each other, means for effecting relative reciprocal movement between said carriages, a work holder mounted on each carriage arranged to engage and hold the opposite ends of a workpiece to be heat treated, said work holders and heat treat head having a common axis, and means for reciprocating said carriages and a workpiece supported therebetween along said common axis relative to said heat treat head.

14. In a heat treating apparatus, a heat treat head, a main carriage, a second carriage spaced from said main carriage, means for supporting said carriages for relative movement toward and from each other, means for effecting relative reciprocal movement between said carriages, a work holder mounted on each carriage arranged to engage and hold the opposite ends of a workpiece to be heat treated, said work holders and heat treat head having a common axis, means for guiding said main carriage for movement along said common axis, and means for reciprocating said main carriage relative to said heat treat head.

15. In a heat treat apparatus, a heat treat head, a piston and guide rod associated with said head, a piston on said rod intermediate the ends thereof, a cylinder surrounding said piston and reciprocable upon said rod, a main carriage secured to said cylinder for movement therewith, a work holder mounted thereon, a second carriage mounted for movement relative to said first carriage, a second work holder mounted thereon, and means connecting said carriages for simultaneous movement relative to said heat treat head.

16. In a heat treating apparatus, a frame, a heat treat head supported from said frame, a main support, a second support axially spaced from said main support, means supporting said supports for relative reciprocal movement toward and away from each other in the axial direction of said heat treat head, a work holder carried by each of said main and second supports to engage and hold the opposite ends of a workpiece

to be heat treated, means for effecting relative reciprocal movement between said supports, said work holders and heat treat head having a common axis, means supporting on the one hand, said main and second supports and a workpiece supported therebetween and, on the other hand, said heat treat head for relative reciprocable movement along said common axis, and means for effecting said last-mentioned reciprocable movement.

17. In a heat treating apparatus, a pair of spaced parallel fluid pressure motors, each comprised of relatively reciprocable cylinder and guide rod parts, one of which has a piston intermediate the ends thereof and cooperable with the other part, a supporting frame, means rigidly se-

curing one of the corresponding parts of each of said motors to said frame, a first work support rigidly secured to the other corresponding parts of said motors, a second work support spaced from said first work support, said work supports being arranged to engage the opposite ends of an elongated workpiece, means reciprocably supporting said second support relative to said first support, a heat treat head centrally supported on said frame intermediate said motors in axial alignment with said supports, and means for supplying fluid under pressure to said motors to effect reciprocation of said supports and a workpiece supported therebetween axially relative to said heat treat head.

HOWARD E. SOMES.