Nov. 18, 1941. B. H. URSCHEL 2,263,022

MACHINE FOR SHAPING HEATED METAL ARTICLES

Original Filed Sept. 4, 1937 4 Sheets-Sheet 1

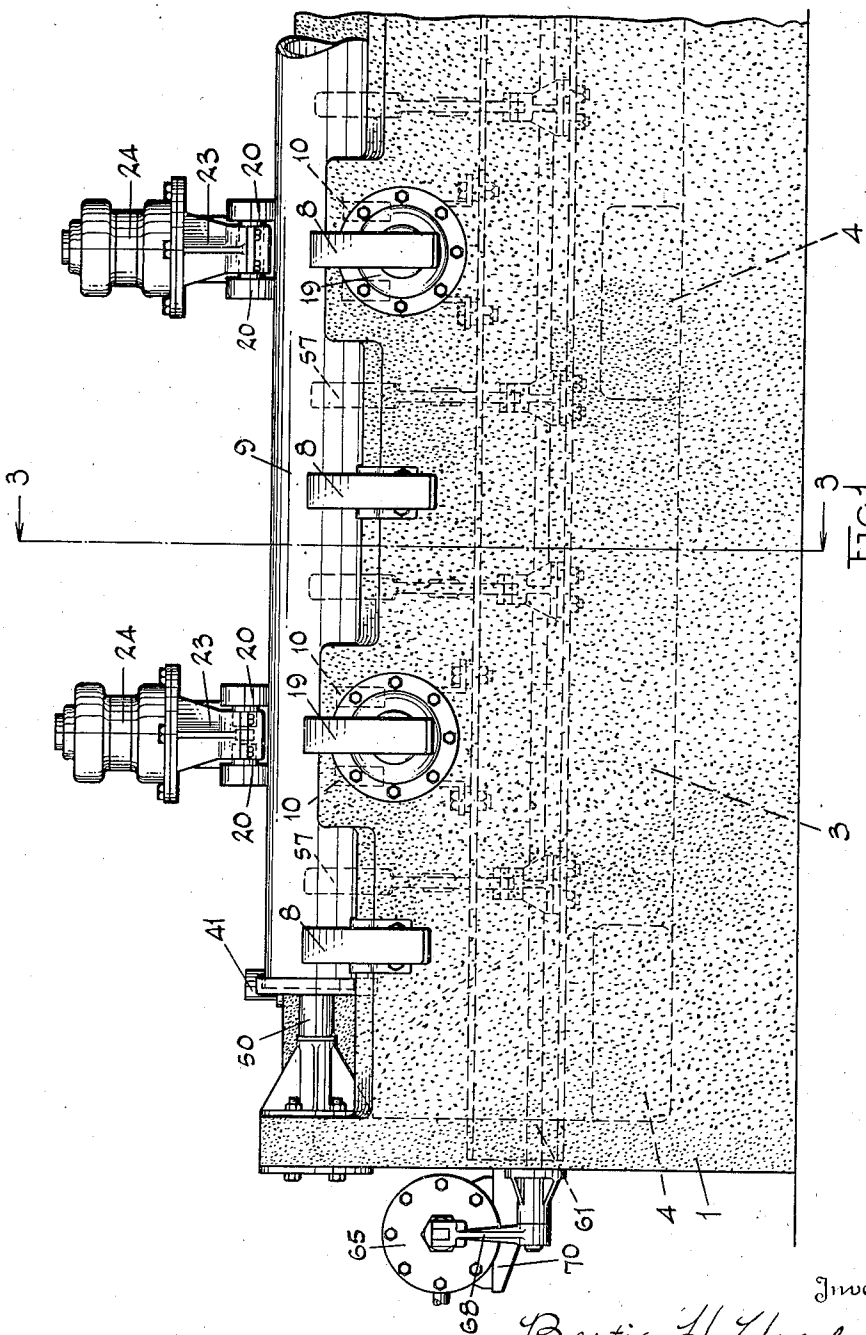


Fig 1

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Original Filed Sept. 4, 1937 4 Sheets-Sheet 2

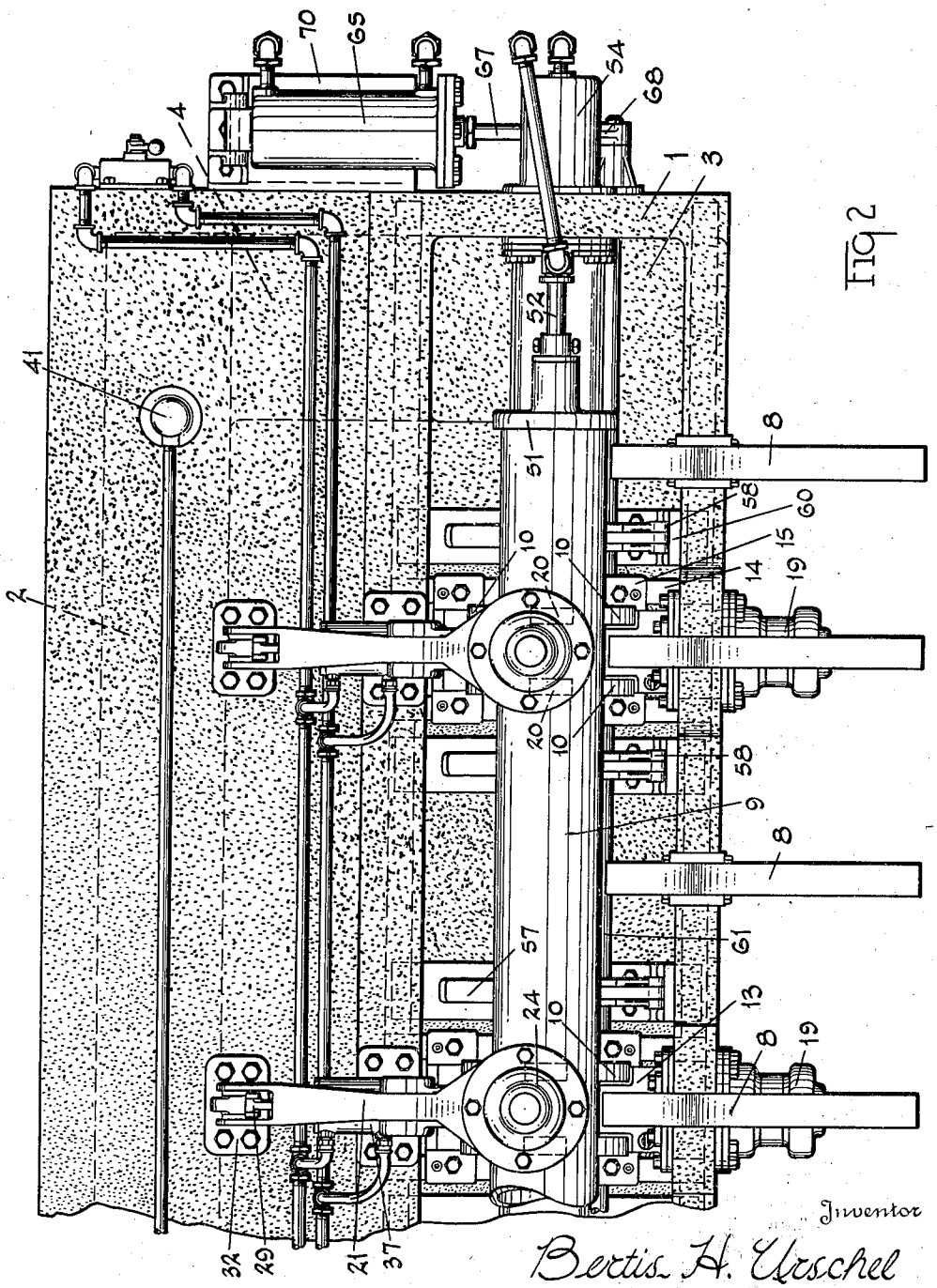


Fig 2

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MACHINE FOR SHAPING HEATED METAL ARTICLES

Original Filed Sept. 4, 1937 4 Sheets-Sheet 3

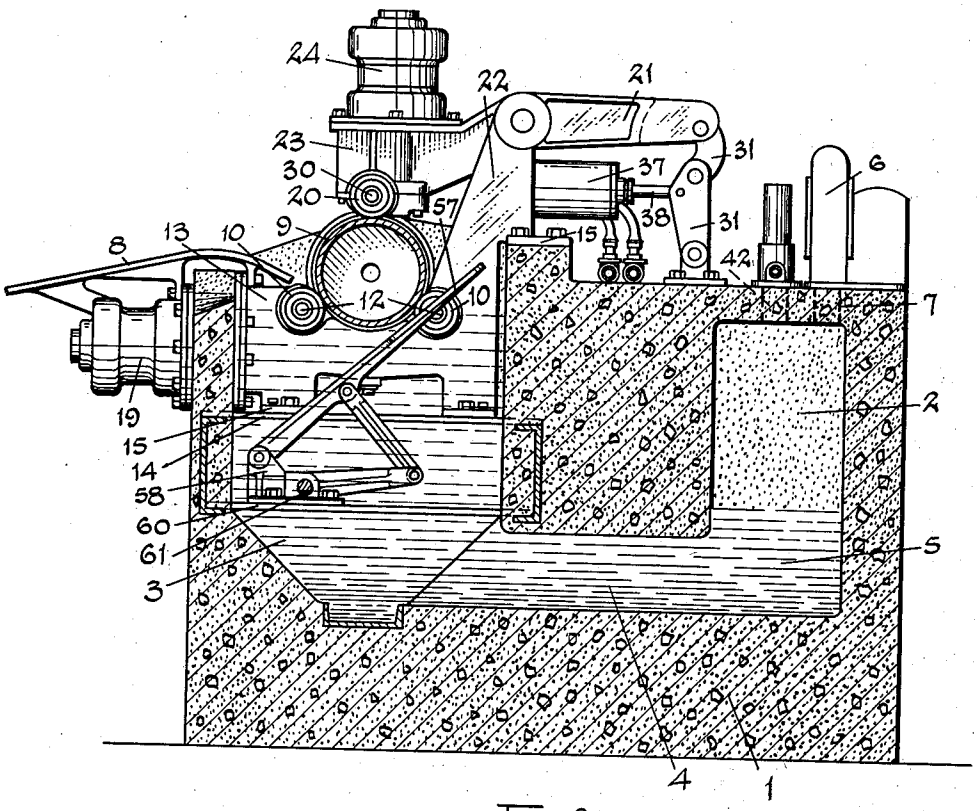


Fig 3

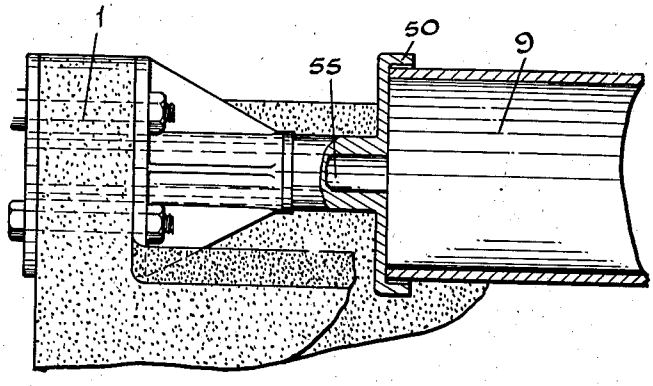


Fig 4

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MACHINE FOR SHAPING HEATED METAL ARTICLES

Original Filed Sept. 4, 1937 4 Sheets-Sheet 4

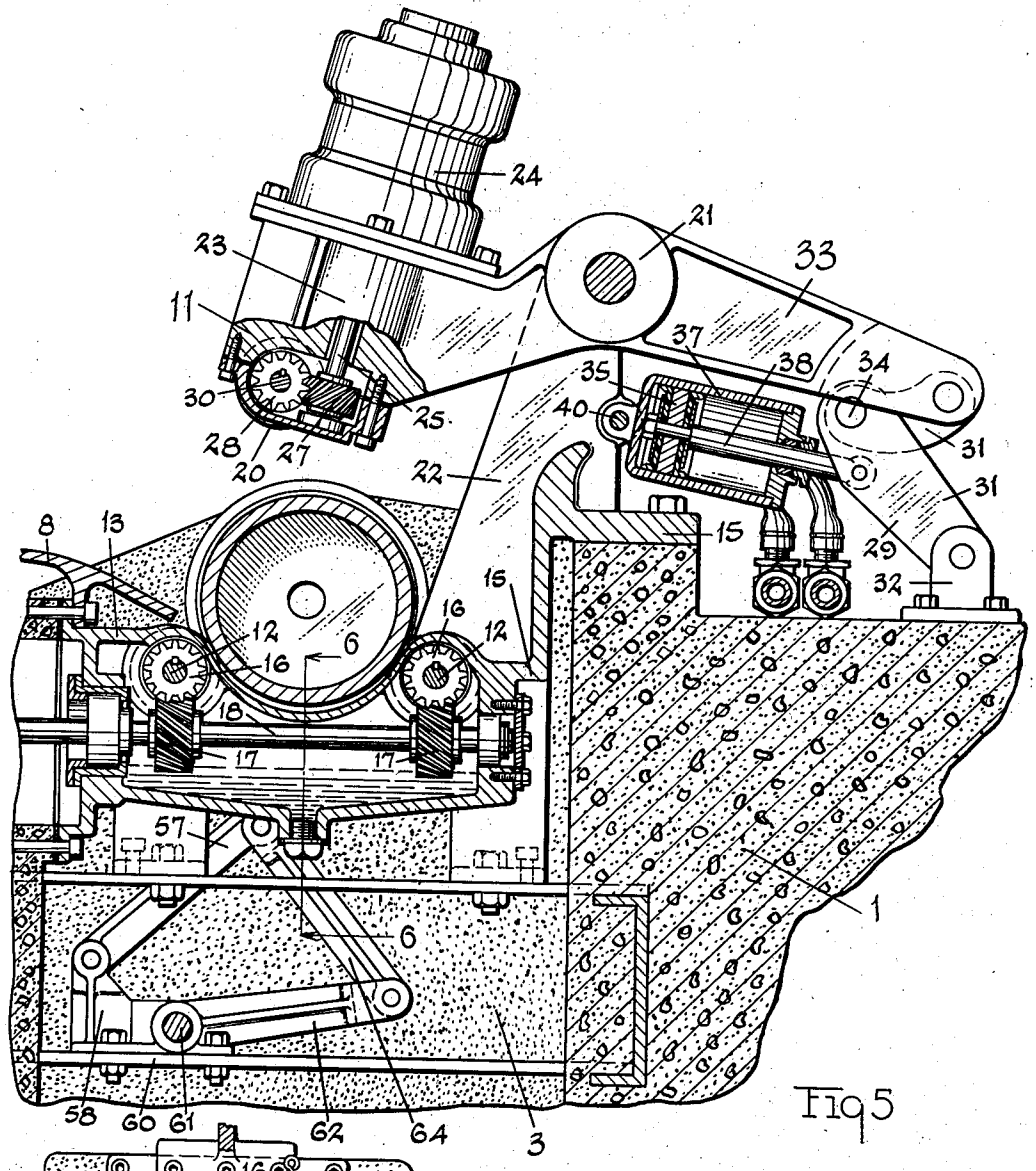


Fig 5

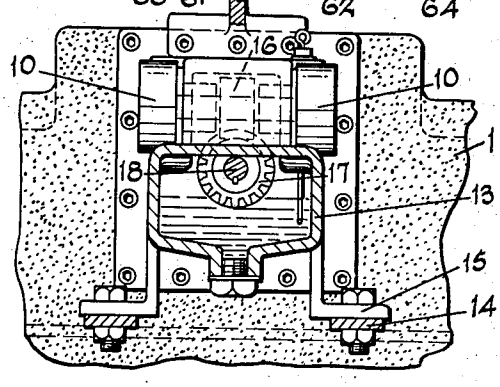


Fig 6

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UNITED STATES PATENT OFFICE

2,263,022

MACHINE FOR SHAPING HEATED METAL ARTICLES

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Original application September 4, 1937, Serial No. 162,428. Divided and this application September 8, 1939, Serial No. 294,000

6 Claims. (Cl. 266—6)

My invention has for its object to provide an efficient means for shaping metal articles, wherein the shaping pressure may be increased as the articles approximate their final form. The invention is particularly advantageous in its use to maintain the shape of articles formed of iron during the heat treatment of the articles. The invention prevents warpage as the temperature changes, which, in the final cooling stages, requires an exceedingly high pressure.

The invention provides a means whereby a relatively light shaping pressure may be applied to ferrous articles while the articles are at a high temperature and metal is relatively pliable to prevent deformation of the article and a greatly increased pressure may be applied as the articles chill and become more rigid. The invention is, thus, advantageously applicable in the heat treatment of hollow bodies.

The invention provides a machine whereby pipes may be rapidly straightened, heat-treated, and cooled to rigidity while maintaining the pipes straight. The invention eliminates the necessity of reheating for straightening and temperature-drawing pipes distorted by localized prehardening of wall portions of the pipes.

The invention consists in other features and advantages that will appear from the following description and upon examination of the drawings forming a part hereof. Structures containing the invention may partake of different forms and may be varied in their details and still embody the invention. To illustrate a practical application of the invention, I have selected an article-straightening machine as an example of the various structures that contain the invention and shall describe the selected structure hereinafter, it being understood that certain features of my invention may be used to advantage without a corresponding use of other features of the invention and without departing from the spirit of the invention as presented in the claims. The particular structure selected is shown in the accompanying drawings.

This application is a division of application Ser. No. 162,428, filed September 4, 1937, and issued as Patent No. 2,188,257 for a Machine for heat-treating metal articles.

Fig. 1 of the drawings illustrates a side view of one end part of the article-straightening machine. Fig. 2 illustrates a top view of the other end part of the machine. Fig. 3 illustrates a view of a section taken on the plane of the line 3—3 indicated in Fig. 1. Fig. 4 illustrates a rotatable clamping member for closing the end of a hollow article that is heat-treated in the machine. Fig. 5 is an enlarged, transverse sectional view through one of the pressure units of the machine. Fig. 6 is a view of a section taken on the plane of the line 6—6 indicated in Fig. 5.

The supporting structural parts or bed 1, of the machine shown in the drawings, may be formed of concrete. It is provided with a closed reservoir part 2 and a trough part 3, which are connected together by a plurality of large passages 4. The parts 2 and 3 are partially filled with a liquid 5, such as water, and a pneumatic, pressure-producing means, such as an electrically-operated blower 6 of a type sufficient to create a pneumatic pressure of 8 or 10 ounces, is connected to the reservoir part 2 through a suitable opening, such as the opening 7, for lowering the water in the reservoir part 2 by the pressure of the blower 6 and causing the water to move through the passages 4 into the trough part 3 to raise the level of the water in the trough part when the blower operates and to return to the reservoir part and lower the level of the water in the trough part when the blower ceases to operate or when its pressure is reduced.

The machine is designed for heat-treating and straightening pipes that may be of any length, such as from 20 to 40 feet long and 6 to 12 inches in diameter. The large passages 4 produce immediate and undisturbed transmision of the water from the reservoir part 2 into the trough part 3 and enables the liquid 5 to quickly and uniformly rise in the trough part 3 when greater-than-atmospheric pressure is produced in the reservoir, and to quickly return the water to the reservoir when the additional pressure ceases.

The pipes are heated, by a suitable furnace, to a temperature above the critical temperatures of the steel or alloys of steel, of which the pipes may be formed, in the manner well known in the art of steel tempering. They are directed or conveyed to the machine, singly, by any suitable means, such as over tracks 8 that direct each pipe 9 onto suitably aligned pairs of rollers 10 that rotatably support the pipe while in the machine.

In order to heat-treat and shape extremely long pipes, the machine is provided with a plurality of units 11 distributed along the trough part 3 of the machine, and comprises means for rotating each pipe as it is heat-treated, and a pressure mechanism for engaging the pipe. The pairs of rollers 10 are supported on short shafts 12 located in the gear housings 13. The rollers 10 are located exterior the side walls of the hous-

ings 13 and the shafts 12 are supported in suitable bearings located on or formed in the side walls of the housings 13. The housings 13 are secured to bars 14, which may be embedded in the bed 1, and are provided with suitable frame and flange parts 15 that enable bolting the units to the bed, such as by stud bolts partially embedded in the concrete of the bed. The shafts 12 of the units are driven by gear wheels 16 that are connected to the shafts and mesh with the gear wheels 17 secured to the shafts 18. The shaft 18 of each unit is rotatably supported in the end walls of the housing and extends through the side wall of the trough and is connected with an electric motor 19, supported exterior to the bed 1, for driving the shafts 18 and 12 and rotating the rollers 10 and the pipe 9.

The pairs of rollers 10 of each unit are spaced apart so as to engage the pipe at points angularly located 120° apart, and a pair of pressure rollers 20 is disposed, by a pressure mechanism 33, at points intermediate the rollers 10, as measured on the circle of the exterior cylindrical surface of the pipe. The pressure rollers 20 are located on levers 21 supported on brackets 22, which may be secured to or form integral parts of the housings 13. The levers 21 are each provided with a head 23 on which an electric motor 24 is mounted. A shaft 25 is rotatably supported in the head 23 and is connected to the motor 24. A gear wheel 27 is connected to the shaft 25 and meshes with a gear wheel 28, which is secured to shaft 30. The shaft 30 is, also, rotatably supported in the head 23. The pressure rollers 20 are located on the ends of the shafts 30 of the units so as to engage the pipe 9 when the heads 23 are lowered by the movements of the levers 21. The pressure rollers, located on the ends of the shafts 30, are disposed in the same planes as the supporting rollers, located on the shafts 12, and, upon application of pressure, they counteract each other and hold the parts of the pipe between the opposed rollers in alignment, as the pipe cools. The motors 19 and 24 coact to rotate the pipe at a relatively high speed to insure, through the rollers, progressive and gradual bending the pipe to straighten the pipe and, also, to produce uniformity of chilling in heat-treating the pipe.

A suitable means is provided for independently manipulating each lever and exerting a pressure that is transmitted through the rollers 20 to the pipe. In the form of construction shown, one end of each lever is provided with a toggle joint 29 comprising the links 31, one of which is pivotally connected to a bracket 32 that is secured to the bed of the machine. The links 31 are connected together by a suitable pin 34, which forms the central joint of the toggle construction. Inasmuch as the pairs of rollers 10 of the machine are located in axial alignment, the pressure of the rollers 20 on the heated pipe will operate to progressively axially align the parts of the pipe and, thus, straighten the heated pipe.

The pressure mechanism 33 is operated by a piston 35 and a cylinder 37. The piston 35 is connected, by means of the piston rod 38, with one of the links 31 to exert a pressure to move the central joint of the toggle toward a position of alignment with the pivot points of connection with the lever 21 and the bracket 32 mounted on the bed 1 and, thus, progressively force the parts of the pipe in axial alignment and straighten the pipe. The cylinder 37 is pivotally connected by means of the pin 40 with the bracket 22 to enable oscillatory movements of the cylinder 37 and the piston rod 38 in conformity to the swinging movements of the link 31, to which the piston rod 38 is connected. The cylinders 37 of the units of the machine are connected to a source of supply of fluid under pressure, which may be manually controlled by a suitable valve. The passages in the control valve to the cylinders may be suitably restricted to produce simultaneous movements of the levers 21 to move the rollers 20 against the pipe, and the parts toward the rollers 10, located in the machine, with a relatively light, initial pressure to produce gradual shaping of the pipe while it is rotated by the motors.

When the heated pipe has been placed in the trough, the pipe is rotated and the blower 6 is operated to raise the level of the liquid 5 and produce contact between the liquid and pipe. The temperature of the pipe is quickly reduced to below the higher critical temperature, such as to about 1000° Fahrenheit or drawing temperature, depending upon the steel characteristics of which the pipe is formed, and the operation of the blower is immediately discontinued and the level of the liquid in the trough is lowered. The toggles 29 are automatically extended by the reduction in the diameter of the pipe while being subjected to the pneumatic pressure in the cylinders 37. The toggles, thus, produce a progressively increased magnification of the pneumatic pressure of the cylinders in the transmission of the pressure to the rollers 20 as the walls of the pipe contact and increase in rigidity. The slight extension of the toggles, permitted by the reduction of the diameter of the pipe when the central joint approximates alignment with the end centers of the toggles, produces a pressure that is sufficient to prevent warping during continued cooling. The rapidly increasing pressure overcomes the increasing resistance to straightening of the pipe as its rigidity increases.

In order to raise the level of the liquid 5 to the same predetermined depth in the trough in each succeeding operation, and to maintain the level during the pressure of the pneumatic, pressure-producing means, a plurality of valves 41 are disposed at spaced points along the bed 1 of the machine above the reservoir part 2. The valves 41 are provided with suitable pneumatic, pressure-actuatable elements that are slidably supported in the casings of the valves. The valves are connected to the reservoir part 2 of the machine through the openings 42 to operate the valves by a predetermined pressure produced in the reservoir by the blower 6 and open suitable ports, and limit the extent of the pneumatic pressure produced by the pneumatic, pressure-producing means in the reservoir, and, thus, limit the rise of the level of the liquid 5 in the trough part of the machine.

When the heated pipe is first introduced into the machine, its ends are closed by means of clamping members 50 and 51 that cover the ends of the pipe 9 and prevent the entrance of the liquid of the trough into the pipe when the level of the liquid is raised. The clamping member 50 is rotatably supported in one end wall of the trough part of the machine and in substantially axial alignment with the pipe 9 when it has received its initial straightening immediately subsequent to the introduction of the pipe into the trough. The clamping member 51 is rotatably supported on the other end wall of the trough part and is connected in a cylinder 54, that

may be pneumatically operated to press the clamping member 51 against one end of the pipe during the rotation of the pipe, and shift the pipe lengthwise to engage the clamping member 50. Both ends of the pipe are covered by the clamping members to prevent entrance of the water into the interior of the pipe which would, otherwise, prevent uniformity of the temperature control. Thus, only the exterior surface of the pipe contacts with the water, which operates to surface-harden the pipe. In order to prevent collapse of the pipe by the change in temperature, the clamping member 50 has a stem or tubular part 55 that extends through the end wall of the trough part 3, in which the clamping member 50 is rotatably supported, which enables air to enter the pipe, through the tubular part 55 of the clamping member, and maintain atmospheric pressure within the pipe during the heat-treatment.

When the heat-treatment is completed, the pipe may be discharged by a suitable mechanism for raising the pipe 9 from the rollers 10 and moving it on to the ends of the tracks 8. In the particular construction shown, a plurality of oscillatable arms 57 are pivotally supported upon suitable brackets 58 secured to the bars 60 having end parts that may be embedded in the concrete, of which the bed 1 is formed. The arms 57 are operated by means of a shaft 61, to which are connected a plurality of arms 62. The arms 62 are connected to the arms 57 by means of links 64. The shaft 61 is actuated by means of pistons located in cylinders 65, which are located at opposite ends of and exterior to the trough part 3 of the machine. The cylinders 65 operate the piston rods 67, which are connected to the shaft 61, by means of arms 68. The cylinders 65 are connected to brackets 70 by suitable pins, as shown in Fig. 2, to enable the cylinders to oscillate in accordance with the oscillation of the arms 68 upon operation of the shaft 61. The brackets 70 are supported on the end walls of the bed. The cylinders 65 may be connected with a source of supply of air under pressure by suitable valves, which may be manually actuated to operate the shaft 61 to dispose the pipe on the tracks 8, when it is desired to eject the pipe 9 from the machine. Preferably, the tracks 8 are downwardly inclined from the points in the tracks to which the pipe is moved by the arms 57 to enable it to roll from the trough.

Thus, in the operation of the machine, the pipes to be heat-treated are sequentially placed on the rollers 10 and air is introduced into the cylinders 37 to produce gradual depression of the heads 23 as the rollers 10 and 20 are rotated by the motors 19 and 24, to gradually axially align the parts of the heated pipe 9 and to dispose the ends of the pipe in alignment with the clamping members 50 and 51. Air, under pressure, is then introduced into the cylinder 54, which closes one end of the pipe by the clamping member 51 and operates to move the pipe axially against the clamping member 50, which covers the other end of the pipe. The electric motor of the blower 6 is then operated. At the expiration of a predetermined time, as may be determined by the operation of a suitable timer, the operation of the blower is electrically disconnected and ceases to operate. When the blower ceases to operate, air, at atmospheric pressure, will be transmitted through the blower to the reservoir. The level of the liquid in the trough part is lowered by the difference in the head of the liquid in the trough and the reservoir parts, both being subject to atmospheric pressure. The pipe is then ejected by the operation of the arms 57, which are actuated by the shaft 61.

During the drawing of the temper of the steel and to prevent warping during the cooling of the pipe, the contraction of the wall of the pipe operates, automatically, to magnify the pressure exerted by the pistons on the toggles 29 to resist the distortion that might, otherwise, occur during the contraction of the pipe as rigidity of the pipe wall increases.

I claim:

1. In a machine for shaping heated elements, means for supporting a heated element and having a plurality of spaced pressure parts; a pressure member located in opposed relation to the supporting means and having a plurality of spaced pressure parts for pressing the element against the said means, the pressure parts of the said means and the member located in the same counteracting pressure planes; and an actuating means controlled by the contraction of the cooling element for automatically increasing the pressure of the member on the element and between the parts as the element cools.

2. In a machine for shaping cylindrical, heated elements, a plurality of rollers having raised cylindrical, spaced, pressure parts for supporting a substantially cylindrical, heated element; a plurality of pressure rollers having raised cylindrical, spaced, pressure parts and located in common counteracting pressure planes with the parts of the supporting rollers; means for rotating the rollers and the element; and an actuating means controlled by the contraction of the cooling element for automatically increasing the pressure of the pressure rollers on the element as the element cools until the external diameter of the element is substantially that of a true circle through the contact points of the circularly arranged parts with the element.

3. In a machine for shaping hollow, heated, cylindrical elements, a receptacle having a cooling liquid; a pair of rollers rotatively mounted in the receptacle having raised cylindrical, spaced, pressure parts for supporting a substantially cylindrical, heated element; a plurality of pressure rollers having raised cylindrical, spaced, pressure parts located in common counteracting pressure planes with the parts of the supporting rollers; means for rotating the rollers and the element; means for submerging the element in the cooling liquid; means including a toggle mounted on the wall of the receptacle for moving each pressure roller against the element; a source of substantially constant fluid pressure; and a fluid pressure means connected to the said source for actuating the central toggle joint of each toggle to progressively increase the resultant pressure of the pressure rollers and until the central toggle joint has moved to substantially in line with the end joints of each toggle.

4. In a machine for shaping cylindrical, hollow, heated elements, a receptacle; a cooling liquid located in the receptacle; a plurality of rollers for supporting a heated element in the receptacle; protruding cylindrical parts concentrically supported on the rollers; means for rotating the rollers; a lever; a plurality of pressure rollers carried by the lever for engaging the element, the pressure rollers located in common, counteracting pressure planes of the parts on the supporting rollers; a toggle for operating the lever; means for raising the level of the liquid in

the receptacle; a source of fluid pressure; and a fluid pressure actuating means connected to the source and to the central joint of the toggle to move the pressure rollers against the heated element and increase the pressure of the pressure rollers as the element contracts by cooling.

5. In a machine for shaping hollow, heated, cylindrical elements, a supporting frame; a pair of rollers rotatively mounted in the frame and having raised cylindrical, spaced, pressure parts for supporting a substantially cylindrical, heated element; a pressure roller having raised cylindrical, spaced, pressure parts located in common counteracting pressure planes with the said parts of the supporting rollers; means for rotating the rollers and the element; a lever fulcrumed on the frame for moving the pressure roller against the element; a toggle having one toggle part pivoted to the end of the power arm of the lever remote from the fulcrum and the other toggle part pivotally secured to the frame; a source of fluid pressure; and a fluid pressure means connected to the said source for actuating the central toggle joint to progressively increase the resultant pressure of the pressure rollers, as multiplied by the lever, until the central toggle joint has moved to substantially in line with the end joints of the toggle.

6. In a machine for shaping hollow, heated, cylindrical elements, a receptacle having a cooling liquid; a plurality of pairs of supporting rollers rotatively mounted in the receptacle having raised cylindrical, spaced, pressure parts for supporting a substantially cylindrical, heated element; a plurality of pressure rollers having raised cylindrical, spaced, pressure parts located in common counteracting pressure planes with the said parts of the supporting rollers; means for rotating the rollers and the element; means for submerging the element in the cooling liquid; a plurality of levers fulcrumed on the wall of the receptacle each lever operative to move a pressure roller against the element; a plurality of toggles, each toggle having one toggle part pivoted to one end of the power arm of a lever and the other toggle part pivotally secured to the receptacle; a source of substantially constant fluid pressure; and fluid pressure means connected to the said source for actuating the central toggle joint of each toggle to progressively increase the resultant pressure of the pressure rollers, as multiplied by the levers, until the central toggle joint of each toggle has moved to substantially in line with the end joints of the toggle.

BERTIS H. URSCHEL.