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[54] **METHOD AND APPARATUS FOR HARDENING
PIPES INTERNALLY AND EXTERNALLY**
14 Claims, 7 Drawing Figs.

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153; 266/6 R, 6 PC, 4 A, 2 R

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ABSTRACT: An apparatus for hardening long pipes internally and externally has a tank arranged to be filled with a cooling medium and being sufficiently large to receive the pipe on its interior, a cooling medium nozzle disposed near one end of the tank and supplied with cooling medium; the nozzle has a body and a tip arranged for introducing cooling medium in the pipe in such a manner that a part of the tip is within and peripherally spaced from the end of the pipe at which the cooling medium is introduced, whereby cooling medium may be drawn from the exterior of the pipe to the interior through the space thus defined; and pipe loading and unloading means for delivering a pipe into the tank and for supporting it in the tank while it is being hardened and for subsequently unloading the pipe after it has been hardened.

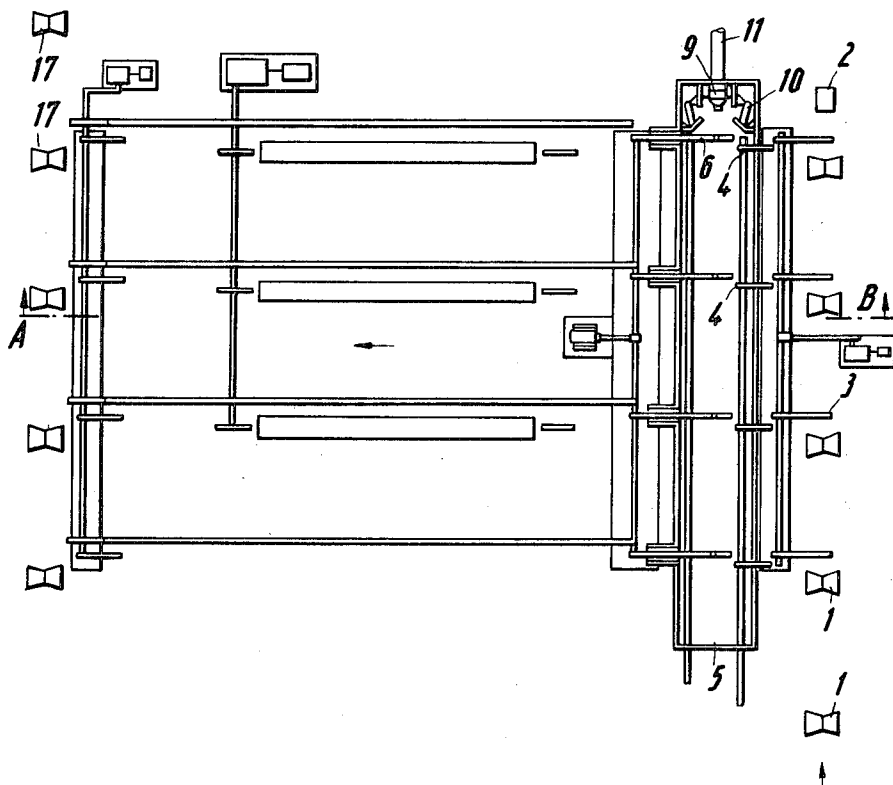


Fig. 2
(A - B)

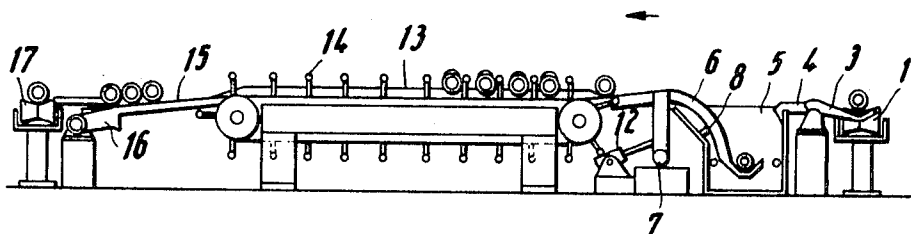
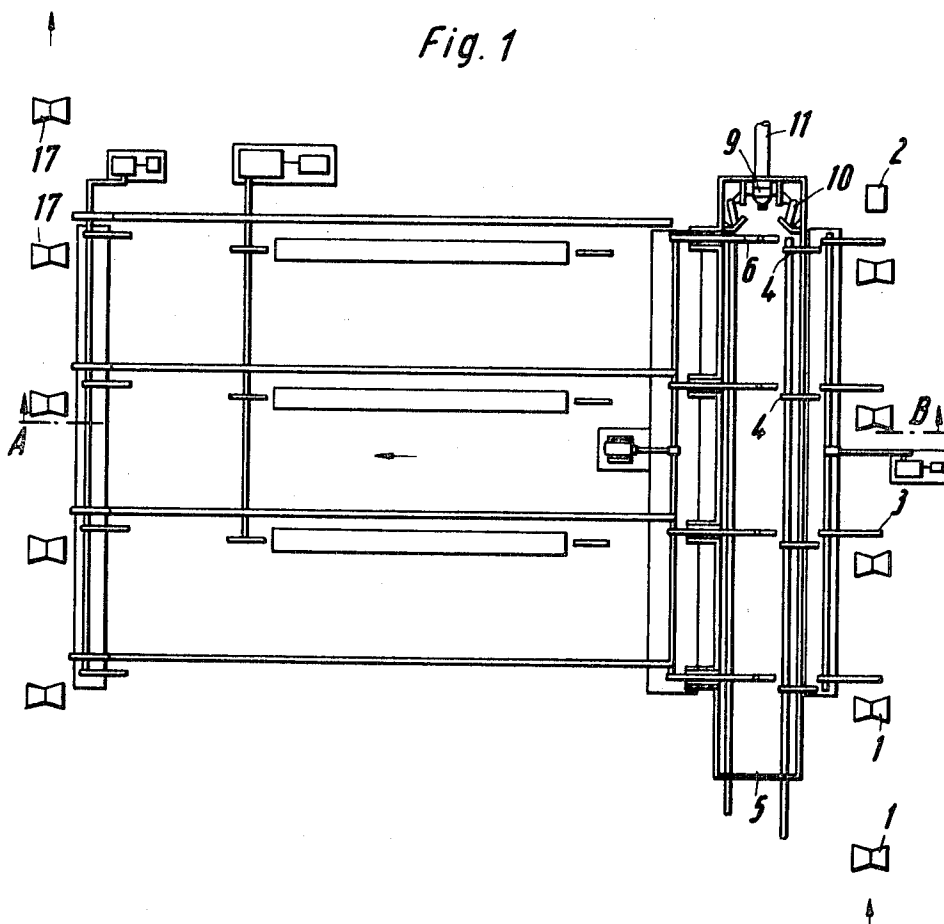


Fig. 1



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Fig. 3

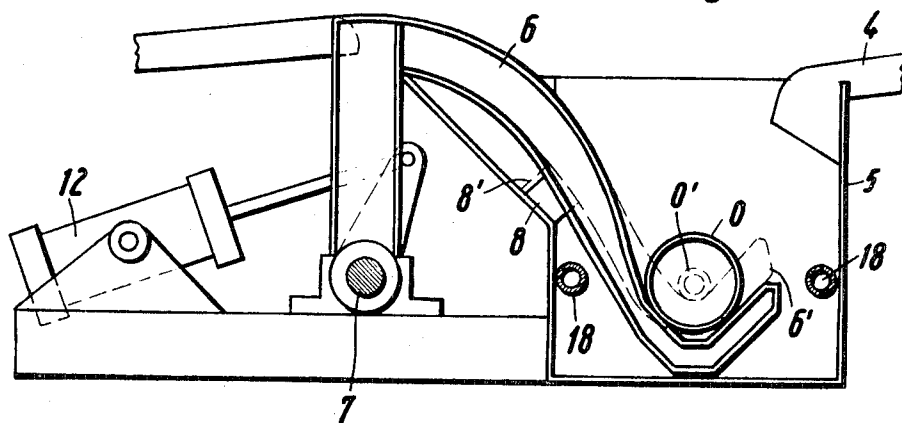
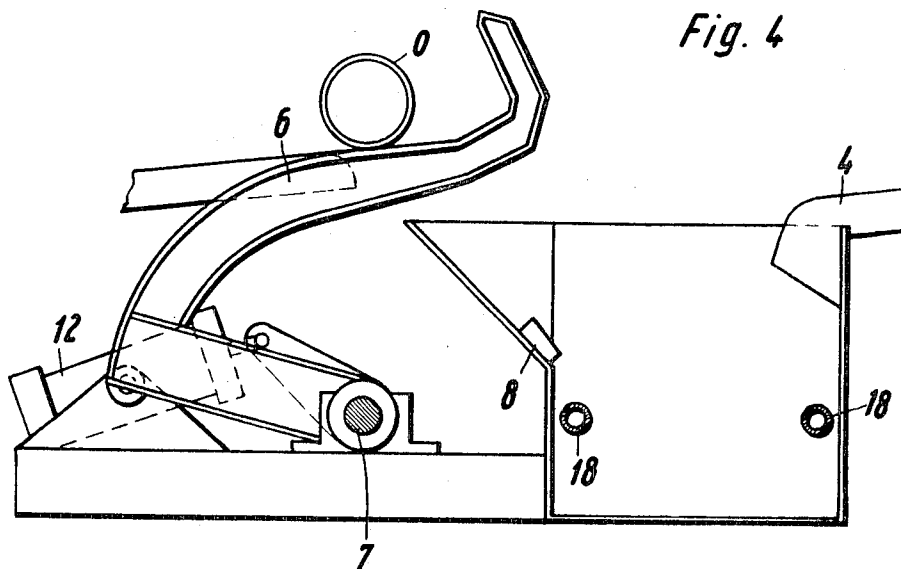


Fig. 4

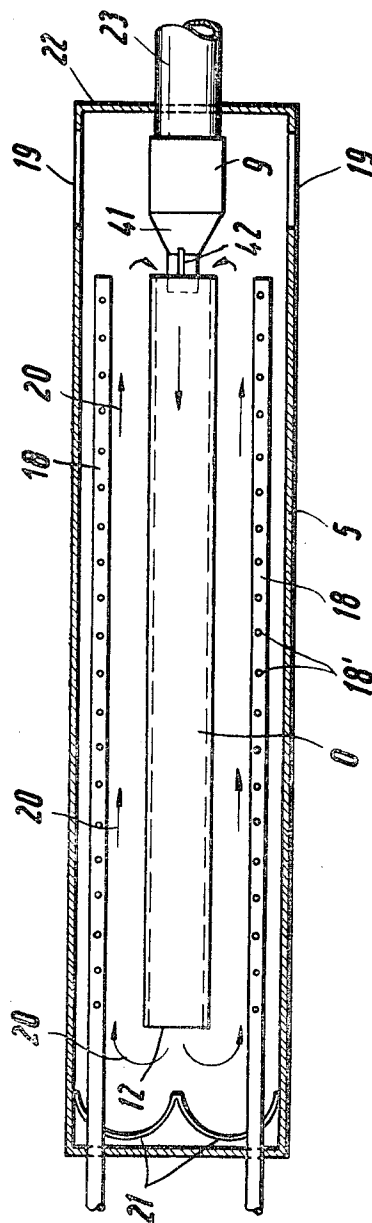


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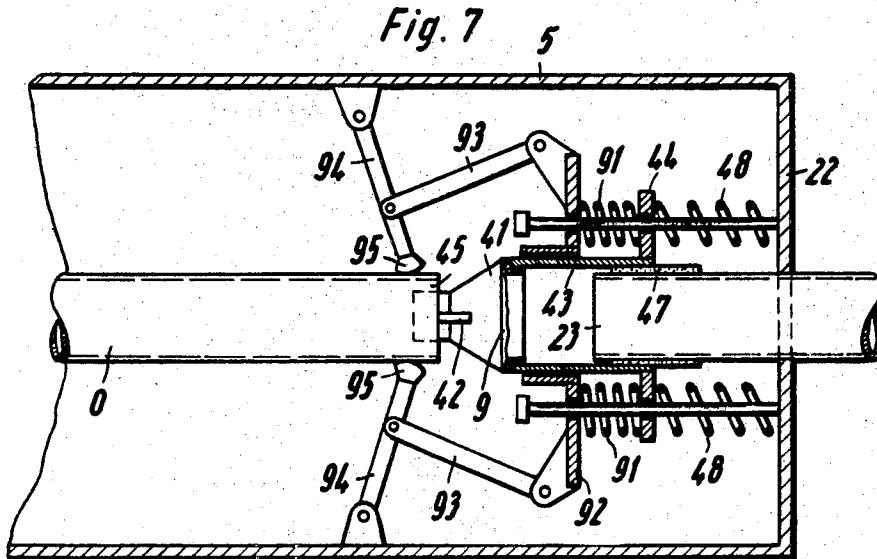
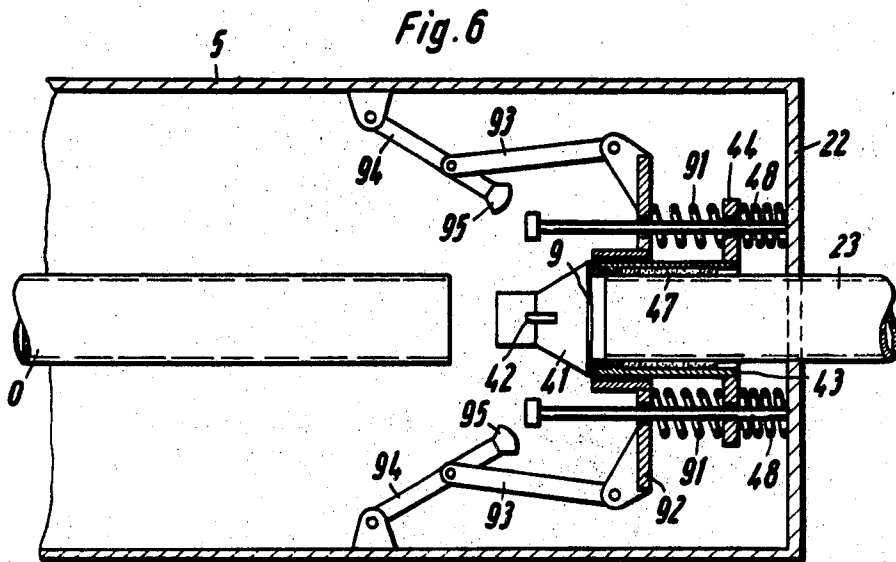
Fig. 5



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METHOD AND APPARATUS FOR HARDENING PIPES INTERNALLY AND EXTERNALLY

This invention relates to a method and a apparatus for hardening pipes, internally and externally.

It is known to harden long pipes from the inside by passing a cooling liquid through the interior of the pipe. Uniform hardening around the periphery can be accomplished by means of another known process by passing the cooling liquid along the internal surface of the pipe helically and at high speed.

Apparatus is also known for hardening the internal and external surfaces of pipes, in which the pipe to be hardened is immersed in the cooling liquid. Finally, in the case of apparatus in which the cooling liquid is passed into the interior of the pipe through a swirling nozzle, it has been proposed to provide additional external cooling by immersing the pipe in a bath of cooling medium. The nozzle is sealed to one end of the pipe by means of an actuating cylinder.

In the known methods, a cooling liquid is passed, in part, at high speed through the pipe, but externally, when the pipe is immersed in the liquid, it is merely brought into contact therewith, so that it is only during the actual immersion procedure that a certain amount of mixing of the external cooling water is produced by the movement of the pipe. In most cases, this form of external cooling is adequate but it has been found that in the hardening, in particular of thick-walled or very long pipes, or in pipes of noncircular cross section, difficulties may occasionally arise.

An object of the present invention is to provide apparatus whereby even pipes of this kind can be satisfactorily through-hardened.

According to the invention, apparatus for hardening long pipes is therefore constructed such that the tip of the nozzle is located, during operation, partly in the interior of the end of the pipe and is so dimensioned and held in position in relation to the pipe to be hardened that a gap remains between the nozzle and the end of the pipe, the said gap making it possible for additional cooling liquid from the container to enter the pipe.

Particular preference is given to one embodiment of the invention, in which at least one stop element for abutting against the end of the pipe is mounted on the nozzle.

The invention makes use of the injector action of the nozzle supplied with cooling water at high pressure. This produces a suction which draws water from the container into the gap between the nozzle and one end of the pipe, thus causing a strong flow in the container. This flow, which passes over the external wall of the pipe in a direction opposite to the flow in the interior of the pipe, favors the hardening process and thereby facilitates a better through-hardening of the pipes. Moreover, as the inner flow is linear, tubes of rectangular cross section, for example, may likewise be hardened with good results. The apparatus according to the present invention may, of course, be used on pipes of conventional quality and dimension, as well as on those having special qualities or dimensions.

In another development of the invention, the body of the nozzle comprises a tubular sleeve portion adapted to be mounted for axial sliding movement on a cooling agent pipeline which projects into the container coaxially with the pipe to be hardened.

Movement of the nozzle from its rest position into its operating position may be effected in known fashion by means of an actuating cylinder and, according to one advantageous form of the invention, the pressure of the cooling liquid flowing through the nozzle causes the nozzle to move into its operating position against the action of a spring.

It is usually of advantage to have a clamping device mounted in the container to hold the pipe, so that the latter cannot move away from the nozzle under the action of the jet of cooling medium emerging from the nozzle.

For the purpose of improving the flow conditions, deflecting plates may be incorporated, at the end of the container remote from the nozzle, to deflect the flow emerging from the pipe.

Finally, apertured conduits or spray pipes, and feeding cooling liquid preferably to both sides of the pipes to be hardened, may be arranged in the container. In this way, additional turbulence may be produced.

In order that the device may be used for pipes of different diameters, the tip of the nozzle is interchangeable in one embodiment of the invention. This may be accomplished, for example, by screwing the tip to the tubular sleeve portion.

Another object of the invention is to provide apparatus for hardening long pipes, in which the cooling medium tank contains only such elements as are of importance to the actual hardening process, so that the said tank may be made relatively small. In a small tank, it is easier to produce a flow or turbulence which, in water hardening, is of great importance for the destruction of the films of steam formed.

The invention therefore provides that the pipe-unloading device has a plurality of unloading arms capable of being swung vertically and distributed along the length of the tank, the approximately V-shaped ends of the said arms also constituting the supports for the pipe during the hardening process: when swung upwards, the said arms allow the hardened pipe to roll off on to the mechanism for carrying it away.

By combining the support with the unloading device, a separate pipe support built into the tank becomes unnecessary. Moreover, adaptation to different pipe diameters is obtained in that, according to one preferred development of the invention, the depth of immersion of the unloading arms is adjustable. In one embodiment of the invention, the adjustment may be accomplished in that interchangeable stop members are provided, for example, in the tank, to limit the depth of immersion of the unloading arms. This eliminates the need for adjusting the height of the nozzle, which can therefore be made stationary, leaving only the mouth of the nozzle to be adapted to the diameter of the pipes. Furthermore, a stationary device for holding the pipe during the hardening process may be incorporated in the tank.

A further development of the invention is characterized in that the pivot for the unloading arms lies outside the tank approximately on a level with the cooling medium nozzle in the tank. Upon being lifted out, the pipe thus moves upwards through 90° of a circle and is then gently transferred to the adjacent device for carrying it away.

The lifting out and transfer of the pipe takes place relatively quickly, and the water still remained in the pipe cannot always all run back into the tank. This is of no particular importance in the case of an inexpensive cooling medium such as water. On the other hand, the hardened pipes should as far as possible contain no water. It is therefore provided that the part of the mechanism for carrying away the hardened pipes which is adjacent the pipe-unloading device shall constitute a runoff table transporting the pipes transversely and inclined transversely to the direction of transportation.

Finally, in order to keep the cooling tank free of loading devices also, it is provided that the final portion of the pipe-loading device shall be in the form of a sloping rolloff bed which ends a substantial distance above the pipe support, allowing the pipe to be hardened to fall freely thereon.

According to one preferred embodiment of the invention, the flow pattern in the tank may be favorably influenced by providing the cooling medium tank with at least one overflow aperture in the region of the end where the nozzle is situated. Overflow apertures are preferably arranged immediately adjacent the end wall and on both sides.

An embodiment of the invention is illustrated in the accompanying drawings, wherein:

FIG. 1 is a plan view of a hardening apparatus;

FIG. 2 is a section on the line A-B in FIG. 1;

FIG. 3 and 4 show the operations of the unloading arm;

FIG. 5 shows a plan view of the tank;

FIG. 6 shows the nozzle in the rest position;

FIG. 7 shows the nozzle according to FIG. 6 in the operating position.

The red-hot pipes leave the hardening furnace in timed sequence, passing over roller train 1 towards the apparatus according to the invention. Pipe 0 runs up against a stop 2 and is then placed by ejection lever 3 of the loading device on a steep rolloff plane or bed 4, whence it rolls into a tank 5 filled with cooling liquid, falling on to the V-shaped ends of unloading arms 6 which swing about a pivot 7. An interchangeable stop 8, against which unloading arms 6 lie limits the depth of immersion of the said arms, thus defining the position of the pipe to be hardened and causing it to lie on a level with a nozzle 9.

In order to hold the pipe against the pressure of the cooling liquid issuing at high velocity from nozzle 9, preferably a whirling nozzle, a self-locking retaining or clamping device 10 is provided. The lever mechanism of this device is of a size such that it is unnecessary to change any parts for differences in pipe diameter. In this connection, one advantage of the invention is that, like nozzle 9, there is no need for pipe-retaining device 10 to be made adjustable in height. Pipeline 11, connected to nozzle 9 and located outside tank 5, is connected to a cooling medium pump, not shown. Excess cooling medium flows over the edge of tank 5 into a cooling medium container, also not shown, located under tank 5.

At the end of the quenching process, the duration of which may be automatically controlled by means of a suitable adjusted timing mechanism, nozzle 9 is moved back, if necessary, for a short distance and retaining device 10 is released. Actuated by 1 hydraulic cylinder 12, unloading arms 6, acting as the pipe support, now lift the cooled pipe up and transfer it to a rolloff table 13 which is slightly inclined transversely to the direction of transportation indicated by the arrows, so that the cooling water remaining in the pipe may run out. Rolloff table 13 has circulating dogs 14, the speed of which matches the period of residence of the pipe on the roll off table.

From rolloff table 13, the pipe passes to the intermediate storage 15, whence each pipe is passed individually to another roller train 17 by means of a lifter 16.

FIG. 3 and 4 illustrate the operation of unloading arms 6 on an enlarged scale. In FIG. 3, arm 6 is held by stop element 8 in the appropriate position for pipe 0. In the case of a smaller pipe 0', stop element 8' would have to be fitted.

FIG. 4 shows the unloading arm in the upward position. Spray pipes 18 with outflow apertures 18' are also provided in the tank, cooling medium also being fed to the tank through these pipes.

FIG. 5 show a cooling medium tank 5 with overflow aperture 19 located near the end wall. In conjunction with the special shape of injector nozzle shown in FIG. 6, overflow apertures 19 produce a strong flow indicated by arrows 20. Deflectors 21 are provided to deflect the cooling medium issuing at high speed from the pipe.

The apparatus shown in FIG. 5 for hardening a pipe 0 consists of an elongated container 5, through front-end wall 22 of which a cooling-agent pipeline 23 is introduced. Cooling agent pipeline 23 opens into a nozzle 9, tip 41 of which is introduced partly into the pipe 0. Tip 41 of nozzle 9 is provided with a stop element 42 which abuts against the pipe end and thus ensures that a gap 45 is always maintained between nozzle 9 and pipe 0, through which the cooling liquid from the container may enter the pipe. Arranged on both sides of pipe 0 are apertured conduits or spray pipes 18 which supply cooling liquid to the cooling bath from numerous outflow apertures 18', thus producing turbulence in the said cooling bath.

Incorporated into end 22 of the container remote from nozzle 9 are deflecting plates 21 which deflect the flow emerging from the pipe end. The flow conditions are indicated by arrows.

FIG. 6 and 7 show details of a preferred embodiment.

FIG. 6 shows the device in the rest position. Here nozzle 9 consists of tip 41 provided with stop element 42, and of a tubular sleeve portion 43. Tip 41 is joined to tubular sleeve 43 by a screwed connection so that tip 41 may be rapidly exchanged, i.e. may adapted to a pipe 0 of different diameter.

Provided between tubular sleeve 43 and cooling agent pipeline 23 is a self-lubricating plastic cover 47 attached to the said pipeline 23. Nozzle 9 is retained in its rest position by two springs 48. Additional springs 91 act between a flange 44 seated on tubular sleeve 43 and a guide piece 92 movably guided on the said tubular sleeve. Pivoted to guide piece 92 are two pressure levers 93, each pivotally joined at its other end to a clamping lever 94. Levers 94 carry clamp jaws 95 for holding pipe 0.

As soon as a pipe has assumed the position illustrated in FIG. 5, cooling liquid under high pressure is passed through cooling medium pipeline 23. The sharp reduction in the internal cross section of nozzle 9 causes the said nozzle to be moved towards pipe 0 by the cooling liquid fed under high pressure, like a piston acted upon by a pressure means, until stop element 42 engages the pipe end. The nozzle is then in the operating position illustrated in FIG. 7. In this position, the clamping device actuated by the forward movement of the nozzle, and consisting of parts 93, 94, and 95 holds the pipe fast.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. Apparatus for hardening long pipes internally and externally, the said apparatus comprising a long tank adapted to be filled with cooling medium, such as water, a cooling medium nozzle at one end of said tank adapted to be connected to a cooling medium pump, said cooling medium nozzle having a body and a tip for introducing cooling medium into the pipe, and means for holding the nozzle, in operation, so that part of the tip is within and peripherally spaced from the end of the pipe at which the cooling medium is introduced, whereby cooling medium may be drawn from the exterior of the pipe to the interior through the space thus defined, pipe-loading means for loading a pipe into the tank, pipe support and unloading means for supporting a pipe in the tank while it is being hardened and for unloading the pipe after it has been hardened, and means for conducting an unloaded pipe away from the tank, said pipe support and unloading means comprising a plurality of arms distributed along the length of the tank, means mounting said arms for vertical swinging movement about horizontal pivot means, said horizontal pivot means being located outside the tank approximately on a level with the cooling medium nozzle in the tank, and drive means for effecting such swinging movement of the arms when desired, said arms having substantially V-shaped ends.

2. Apparatus according to claim 1, characterized in that at least one stop element for abutting against the end of the pipe is mounted on the nozzle.

3. Apparatus according to claim 1, characterized in that the body of the nozzle comprises a tubular sleeve portion adapted to be mounted for axial sliding movement on a cooling medium pipeline connected to a cooling medium pump, which pipeline projects into the container coaxially with the pipe to be hardened.

4. Apparatus according to claim 3 including spring means for cushioning the nozzle in its axial sliding movement.

5. Apparatus according to claim 3 including clamps for holding the pipe, said clamps being connected to the tubular sleeve by a guide piece and levers.

6. Apparatus according to claim 1 characterized in that deflecting plates for deflecting the flow emerging from the pipe are provided in the end of the container remote from the nozzle.

7. Apparatus according to claim 1 characterized in that apertured conduits for supplying cooling liquid are provided in the container on both sides of the pipe to be hardened.

8. Apparatus according to claim 1 characterized in that the tip of the nozzle is interchangeable.

9. Apparatus as claimed in claim 1, including means for adjusting the extent of downward movement of said arms.

10. Apparatus as claimed in claim 9, wherein said means comprise interchangeable stop members.

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11. Apparatus as claimed in claim 1 characterized in that the means for conducting the unloaded pipes away from the tank has an initial part inclined transversely to the direction of movement of the pipes, whereby cooling medium is drained from the pipes.

12. Apparatus as claimed in claim 1, characterized in that a final portion of the pipe-loading means is in the form of a sloping rolloff bed terminating a substantial distance above the pipe support means and allowing the pipe to be hardened to

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fall freely on to the said support means.

13. Apparatus as claimed in claim 1, characterized in that the cooling medium tank has at least one overflow aperture in the region of said one end of the tank.

14. Apparatus as claimed in claim 13, characterized in that the overflow apertures are arranged immediately adjacent the end wall of the tank and on both sides.

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