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(54) Hardening pipes.

(57) A method of and apparatus for hardening a heated pipe by applying a quenching liquid to the interior surface of the pipe through a tubular lance in line therewith and over which the pipe is moved, the lance having a terminal guide member generally matching the section of, but spaced from, the said interior surfac, in which the liquid is propelled through a series of jets passing through the wall of the lance at positions along the lance and being directed away from the terminal guide member, the angle of the jets progressively being more acute to the wall of the lance in the direction of movement of the pipe the further the jets are disposed from the guide members whereby to promote the entrainment of the atmosphere through the space between the guide member and the said interior surface such as to enhance the unidirectionality and uniformity in the flow of water in the said direction.

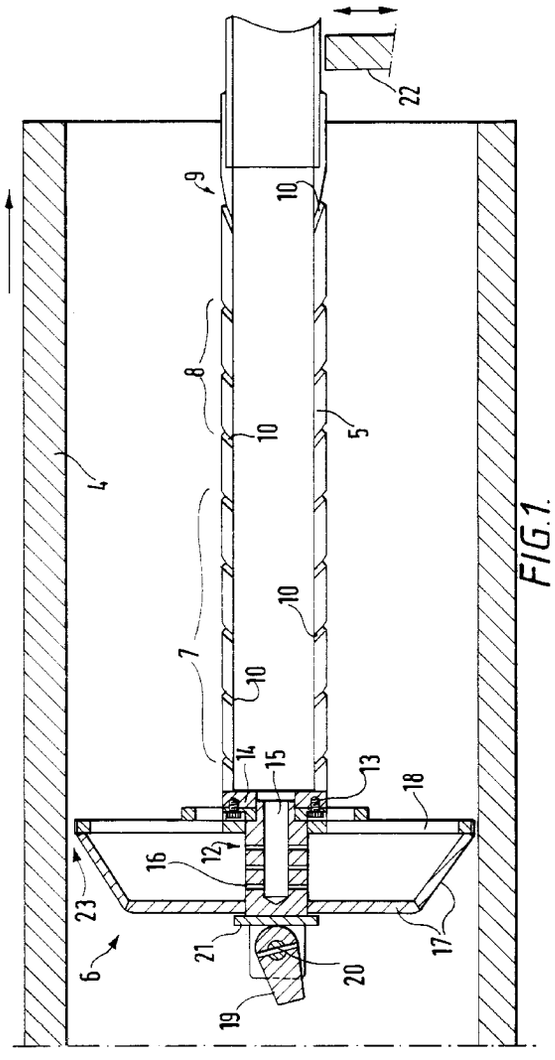

FIG.1.

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This invention relates to a method of, and apparatus for, hardening pipes, e.g. low alloy steel pipes, by cooling them from austenitising temperature (i.e. > A_3) with jets of cooling liquid (usually water) applied to the inner surfaces.

It is known that the hardening of steel pipe is affected by the rate of cooling of the steel and that to attain uniform hardness throughout the wall thickness of the pipe it is necessary to achieve a high rate of cooling. Further, it is known that non-uniform hardening can be caused by an insufficient or badly distributed water supply. It is also known that the water supply should be such as to prevent the formation of a layer of steam and that the water flow must not cause precooling before the pipe enters the intense cooling zone. In this regard, hitherto, quenching water has been introduced to the bore of the pipe through a long tube or lance having a series of orifices near one end to distribute the water over the tube surface as the hot pipe is simultaneously fed forward and rotated around it. The cooling water is caused to flow along the pipe in the same direction as its motion, and to prevent flow in the opposite direction a mechanical seal prevents leakage in the upstream direction. The success of such a seal is dependent on closely matching the shape and the dimensions of the seal and the bore of the pipe.

It is an object of this invention to provide an improved method of hardening pipe.

This invention provides in one aspect a method of hardening a heated pipe by applying a quenching liquid to the interior surface of the pipe through a tubular lance in line therewith and over which the pipe is moved, the lance having a terminal guide member generally matching the section of, but spaced from, the said interior surface, characterised in that the liquid is propelled through a series of jets passing through the wall of the lance at positions along the lance and being directed away from the terminal guide member, the angle of the jets progressively being more acute to the wall of the lance in the direction of movement of the pipe the further the jets are disposed from the guide member, thereby promoting the entrainment of the atmosphere through the space between the guide member and the said interior surface and enhancing the unidirectionality and uniformity in the flow of water in the said direction.

This invention provides in another aspect apparatus for hardening a heated pipe by applying a quenching liquid to the interior surface of the pipe comprising a tubular lance over which in use the pipe is moved whilst the lance is disposed in line therewith, characterised in that the lance has a leading terminal guide member arranged generally to match the section of, but spaced from, the interior surface of the pipe to be quenched, the lance is provided with a series of jets passing through the wall of the lance at positions along the lance and being directed away from the terminal guide member, the angle of the jets progressively being more acute with respect to the wall of the lance in a direction away from the terminal guide member the further the jets are disposed from the guide member.

Preferably, the pipe is rotated as it progresses, thus describing a helical path.

The terminal guide member may be in the form of a truncated cone freely rotatable about the axis of the lance and it may be readily demountable to accommodate pipes of different diameter.

The quenching liquid may be water and the interior quenching may be accompanied by exterior quenching in order to achieve uniform through wall hardness.

Should internal cooling only be adopted the invention may be utilised to produce a controlled hardness profile across the pipe wall thickness, with increasing hardness at the bore; alternatively, when used in conjunction with external quenching the invention can be utilised to achieve uniform through wall hardness.

This invention eliminates the need for a close mechanical seal, prevents unwanted ingress of cooling water on to the hot surface of the pipe upstream of the intended cooling zone, assists in the removal of water downstream of the cooling zone and reduces the hazard of uneven cooling due to the entrapment of steam between the wall of the pipe and the cooling water proper.

Some embodiments of the invention will now be described by way of example with reference to the accompanying drawings in which:-

Figure 1 is a longitudinal sectional view of one embodiment of the present invention;

Figure 2 is a detail of an adaptor sleeve which permits the water distribution pattern to be varied; and

Figure 3 is a detail illustrating a further method of altering the water distribution pattern.

Referring now to Figure 1 a heated pipe 4 moves in the direction shown over a tube or lance 5 along which cooling water is propelled in the direction shown towards a terminal guide member 6. The lance has, on its outer surface, groups of grooves 7,8,9 each including a number of nozzles 10 inclined at various angles to the axis of the pipe in a direction such that the emerging water is projected towards the pipe surface with a major component of its velocity carrying it in the same direction as the axial movement of the pipe. The number of groups and the number of grooves in each group may vary but the principle is always observed that each successive group proceeding from the end of the nozzle tube adjacent to the terminal guide member 6 in the direction of movement of the pipe, contains nozzles inclined at the same angle and that the angle of divergence from the axis of the pipe becomes more acute in each successive

group.

The terminal guide member is in the form of a truncated cone freely rotatable about a flanged extension piece 12 the flange of which is attached by screws 13 to a lance end plate 14. The extension piece has an axial bore 15 to which water is admitted from the lance and a series of radial holes 16 permits the passage of a quantity of cooling water from the pressurised lance to provide cooling for the guide cone which is exposed to radiant heat from the advancing pipe 4.

More particularly, the terminal guide cone has a solid front plate and conical outer surface 17 and a skeletal rear plate 18 through which the cone cooling water can escape.

The exposed end of the extension piece 12 is reduced in diameter and slotted to house a cam lever 19 mounted on a pivot shaft 20. The cam is turned to lock a flat retaining key 21 against the shoulder of the extension piece thereby providing the means by which the terminal guide cone is retained on this extension piece.

The cam lever and retaining key act as a quick release mechanism permitting easy changing of the terminal guide member when a large change in pipe diameters has to be accommodated.

In operation, the lance is supplied with pressurised water, and the head of the lance is held approximately on the centre line of the advancing pipe by a support 22. The hot pipe advances, supported on skewed rollers (not shown) which give it a helical movement, i.e. advancing axially and rotating on its own axis simultaneously. The guide "cone" is used to assist entry of the fixed lance into the end of the advancing pipe. When the lance is fully within the pipe, the support 22 is withdrawn and the head of the lance is supported on the inner surface of the pipe by the peripheral surface of the guide cone which rotates on the extension piece 12.

The action of the inclined jets of water is to quench the inner surface of the pipe and to propel the water along the inner wall at high speed in the same direction as the pipe's axial movement. As progressively more jets of water come into contact with the pipe wall, the volume of water to be removed increases and as the length of pipe passing beyond the quench area increases the resistance to flow increases. The purpose of varying the angles at which the nozzle holes are drilled in the lance is to ensure that the water is accelerated throughout the quench area thus ensuring that it leaves the quench zone with sufficient velocity to ensure that it will flow clear of the pipe end without forming surges. Surges would result in pressure fluctuations at the start of the quench zone and cause leakage past the guide cone.

The high velocity, closely spaced jets entrain part of the atmosphere within the pipe immediately behind the guide cone. The resultant drop in pressure in this area causes a flow of air, and/or products of combustion from the heating furnace, to be drawn through the gap 23 between the head of the guide cone and the bore of the pipe. The presence of this gap is essential to generate a relatively high velocity through the gap, thus preventing a reverse flow of cooling water, and at the same time preventing the formation of a vacuum high enough to impede the free flow of water along the pipe which would cause surging, steam entrapment and reverse flow conditions.

The correct pressure, velocity, flow rate, lance diameter and acceptable gap range between the guide and the pipe wall is determined by calculation and experiment.

In Figure 2 there is illustrated a sealing collar 24, one or more of which can be slipped over the end of the lance after removing the extension piece 12. By locating the sealing collar(s) in appropriate location(s) over selecting grooves, and locking them in position by locking screws 25 the spray pattern may be modified at will to meet variations in quenching requirements, e.g. the desired quenching profile for different steel compositions. The illustration shows the collar positioned over one groove only but it may be designed to cover several grooves. In all cases loss of water from the ends is prevented by the presence of resilient "O" rings 26 located in grooves in the inner surface of the collar.

Figure 3 illustrates another method of modifying the flow pattern by first removing the extension piece and fitting a flanged sleeve 27 designed to cover one or more grooves at the end of the lance. This arrangement is less flexible but has the merit of more secure fixing by using screws 28 passing through holes drilled to match those in the flanged extension piece 12. Again, a resilient "O" ring 29 located in a suitably sized groove will prevent leakage of water from the end of the flanged sleeve.

Although this invention has been described with reference to the particular embodiments illustrated, it is to be understood that various modifications may readily be made without departing from the scope of the invention. For example, the shape and size of the lance nozzles may be changed as also may the terminal guide member and its locking mechanisms. Likewise the groove/nozzle seals adopted may be different from that shown in Figures 2 and 3, e.g. a simple form of resilient "O" ring may be sited over a selected groove and clamped in position by a hose clip or the like.

Claims

1. A method of hardening a heated pipe by applying a quenching liquid to the interior surface of the pipe through a tubular lance in line therewith and over which the pipe is moved, the lance having a

terminal guide member generally matching the section of, but spaced from, the said interior surface, characterised in that the liquid is propelled through a series of jets passing through the wall of the lance at positons along the lance and being directed away from the terminal guide member, the angle of the jets progressively being more acute to the wall of the lance in the direction of movement of the pipe the further the jets are disposed from the guide member, thereby promoting the entrainment of the atmosphere through the space between the guide member and the said interior surface such and enhancing the unidirectionality and uniformity in the flow of water in the said direction.

2. A method as claimed in claim 1 wherein the pipe is rotated as it progresses over the lance.

3. A method as claimed in claim 1 or 2 wherein the quenching liquid is water.

4. A method as claimed in claims 1, 2 or 3 wherein the interior quenching of the pipe is accompanied by exterior quenching.

5. Apparatus for hardening a heated pipe by applying a quenching liquid to the interior surface of the pipe comprising a tubular lance over which in use the pipe is moved whilst the lance is disposed in line therewith characterised in that the lance has a leading terminal guide member arranged generally to match the section of, but spaced from, the interior surface of the pipe to be quenched, the lance is provided with a series of jets passing through the wall of the lance at positions along the lance and being directed away from the terminal guide member, the angle of the jets progressively being more acute with respect to the wall of the lance in a direction away from the terminal guide member the further the jets are disposed from the guide member.

6. Apparatus as claimed in claim 5 wherein jets are disposed around the wall of the lance.

7. Apparatus as claimed in claim 5 or 6 wherein the jets are disposed in a series of groups progressively along the lance, the angle of the jets within each group to the wall of the lance being substantially the same.

8. Apparatus as claimed in any one of claims 5 to 7 wherein the jets are comprised by inclined bores projecting from within the lance to grooves around the outer periphery of the lance.

9. Apparatus as claimed in any on e of claims 5 to 8 wherein the terminal guide member is freely rotatable about the axis of the lance.

10. Apparatus as claimed in any one of claims 5 to 9 wherein the terminal guide member is in the form of a truncated cone.

11. Apparatus as claimed in any one of claims 5 to 10 wherein the terminal guide member is connected to the interior of the lance for the provision of cooling water from the lance to the terminal guide member.

12. Apparatus as claimed in any one of claims 5 to 11 wherein means are provided for readily demounting the member from the lance for the accommodation of pipes of different diameter.

13. Apparatus as claimed in any one of claims 5 to 12 including an annular member arranged to be fitted about the lance to close off at least one jet whereby to provide variation in the pattern of application of quenching liquid to the interior surface of the pipe.

14. Apparatus as claimed in claim 13 wherein the annular member comprises a collar arranged to fit about the lance and including, about its inner surface sealing means whereby to close off at least one jet and prevent egress of quenching liquid therefrom.

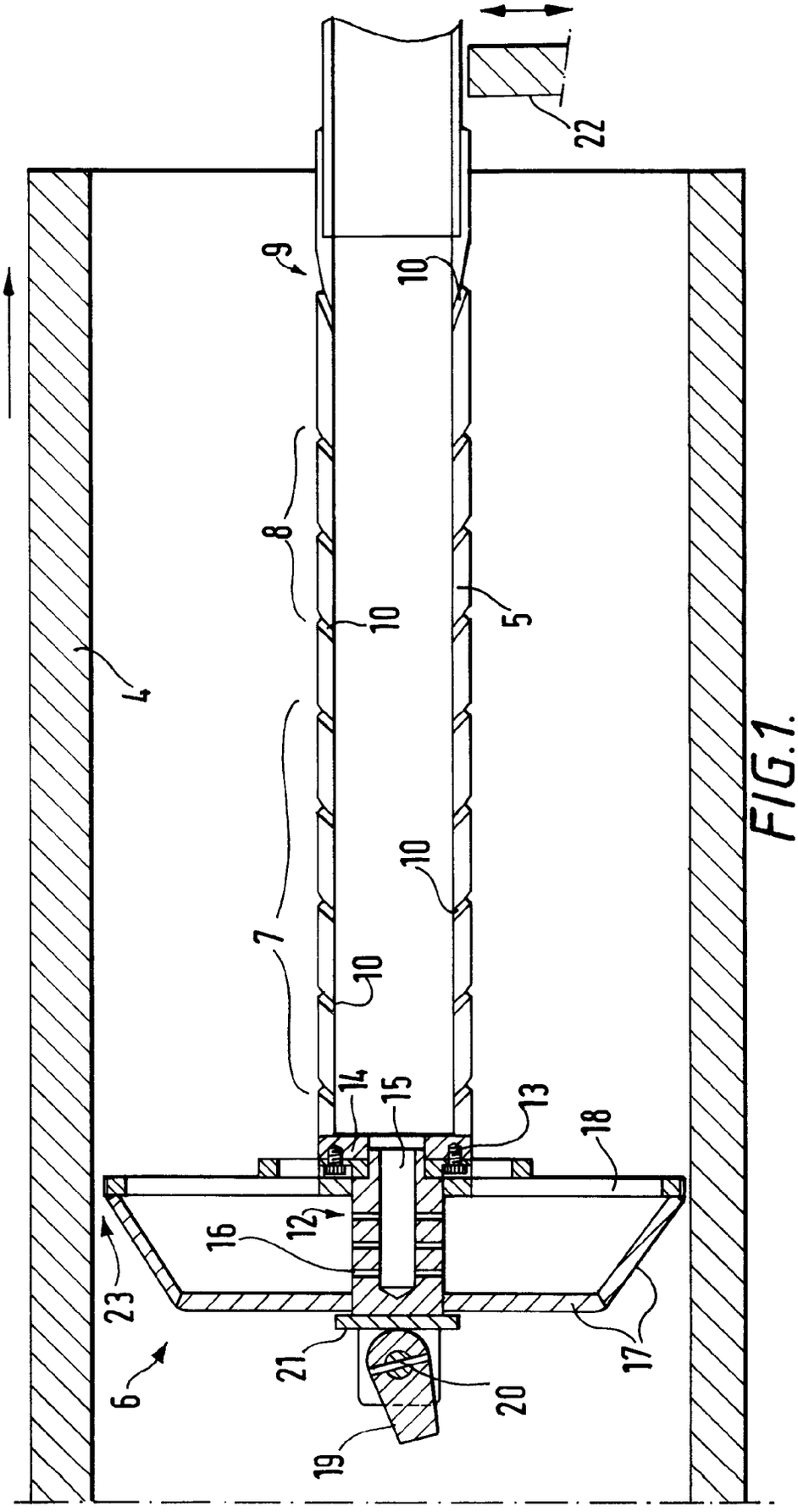

FIG.1.

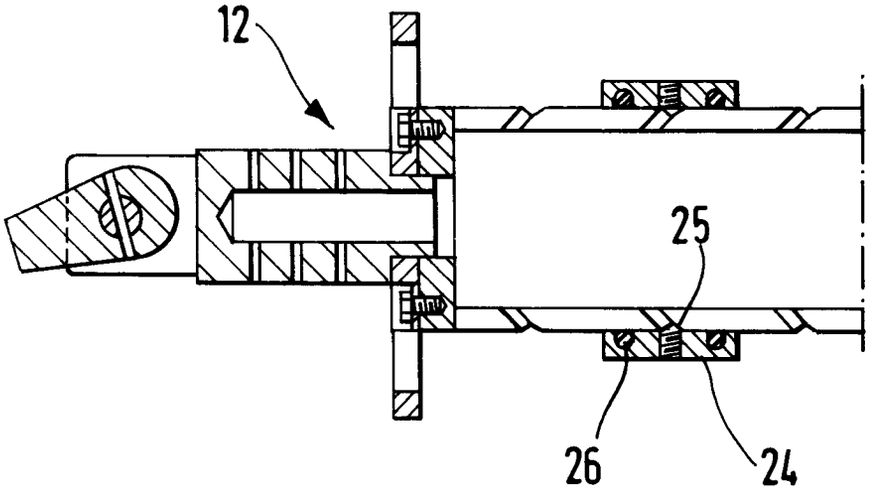

FIG. 2.

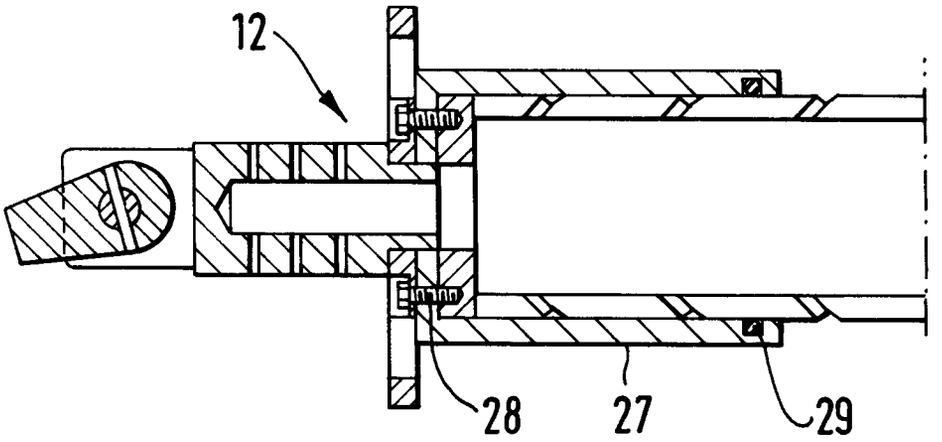

FIG. 3.