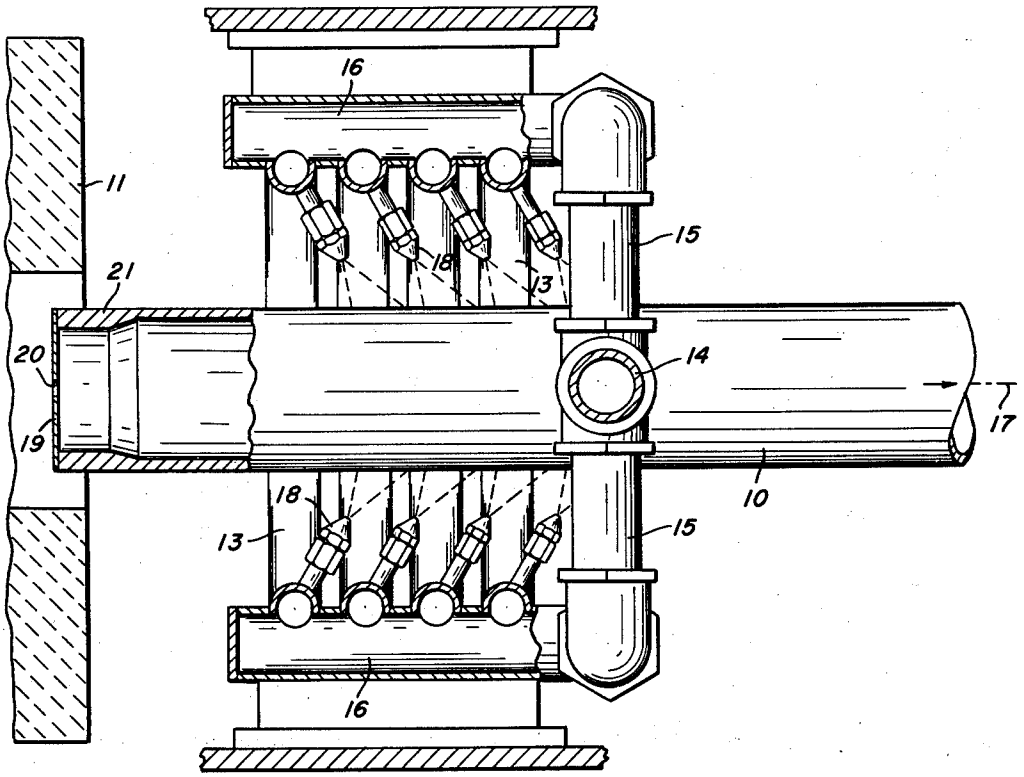
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METHOD OF QUENCHING PIPE

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METHOD OF QUENCHING PIPE

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This invention relates to the hardening of metal pipe by heating it above its transformation temperature, then progressively quenching it at a rate sufficient to produce conversion to the desired metallurgical structure. More particularly, the invention relates to a method for obtaining uniform tensile strength in a length of pipe, especially at the trailing end thereof.

Metal pipe may be hardened by progressively quenching it from above its transformation temperature by the method and apparatus of Scott Patent No. 2,776,230. In accordance therewith, an axially moving length of pipe is heated progressively as required, in a sectional barrel-type furnace. As it leaves the exit end of the furnace, the pipe progressively passes through a liquid-spray quenching ring or rings. The spray of uniformly dispersed droplets discharged at an acute angle to the pipe surface, effectively penetrates the steam film thereon and maintains a high cooling rate with a minimum of back flow along the pipe, which would cause pre-cooling or injury to the furnace lining. Thus, when a pipe of steel containing about .30% C and 1.6% Mn is passed axially through a furnace and heated to its transformation range of about 1475° F. and thereafter passed axially through a liquid-spray quenching ring, there is cooling at a rate such as to cause conversion of a greater portion of the steel to a martensitic structure. Since the spray is applied in the direction of pipe travel, spray enters the open trailing end of the pipe length with resultant inside quenching. This inside quenching is often too severe and causes the formation of quench cracks.

In many instances, inside quenching of the ends of pipe lengths presents no problem, since the short quench-affected end portion of the pipe is cut off. This however, is not always permissible. One example is a pipe length having thickened or upset ends. Here, the economics or minimum length limit of an upset do not permit even a short end portion to be cut off. In fact, not much more than an end-facing operation can be performed on a quench-hardened pipe length, to produce a salable product.

Covering the trailing end of a pipe length with a plate or other means has been found effective to keep out the spray. Towever, this means does not permit the formation of substantially all matensite in the trailing end. Rather, martensite is formed nearest the quench surface, then bainite at approximately the mid-wall portion with increasing amounts of free ferrite toward the inside surface. The softer constituents, especially free ferrite, result in lower yield strengths and the product does not meet the required specifications.

It is therefore an object of this invention to overcome these difficulties by the use of an improved form of cover plate secured to the trailing end of a pipe length, specifically a cover plate having a hole therein.

A more specific object is to progressively quench harden metal pipe substantially uniformly after continuously welding onto the trailing end of the pipe length, a thin plate having a relatively small hole in the center thereof.

In accomplishing these and other objects of the invention, I have provided an improved process and structure, a preferred form of which is shown in the accompanying drawing. The single figure is a horizontal section showing the upset trailing end of a pipe length having welded

thereto a cover plate of invention. This end is leaving the exit end of a furnace and is about to enter a liquid-spray quenching ring.

Except for the cover plate, the single figure of the drawing is substantially the same as FIGURE 2 of Scott Patent No. 2,776,230, the broad method and apparatus of which I employ, and to which reference may be made. A pipe length **10** is progressively heated to its transformation range in a furnace **11**, then progressively passed through a liquid-spray quenching ring or rings **13**. Water or other quenching liquid under suitable pressure is supplied from any convenient source through a main **14**, branch pipes **15** and spaced headers **16** to quenching rings **13**, spaced along the axis **17** of pipe length **10** and normal thereto. Each ring **13** is fitted with a plurality of nozzles **18** spaced therearound. Each nozzle provides a diverging spray of liquid droplets to the pipe surface, the axes of the sprays constituting elements of an imaginary cone having its apex substantially on the pipe axis.

Prior to the above described progressive heating and liquid-spray quenching steps, a cover plate **19** is welded to the trailing end of length **10** preferably with a continuous bead of weldment along the periphery of the plate. Plate **19** has a vent hole **20** therein, preferably in the center thereof and of a small diameter relative to the plate diameter.

This arrangement has been found effective in quench-hardening a pipelength substantially uniformly, especially where the end has an upset **21**. The plate prevents water from entering the trailing end as it passes through the quenching spray. The vent hole is essential for better heating and cooling. It allows flame and hot gases to enter during heating. It allows hot air and gases to leave during quenching and admits a controlled quantity of water to proved a cooling rate sufficient to obtain the required metallurgical structure, without initiating quench cracks.

The preferred thickness of the plate is about 1/16". A thinner plate may burn through during welding. A thicker plate, because of the increased weight of metal may retard the required cooling rate of an upset pipe end. The periphery of the plate should be completedy welded to the end face of the pipe since, with a spot-welded plate, too much water may enter the end, causing quench cracks.

The diameter of the vent hole may vary with the size of the pipe. A vent hole about 1/4" diameter is preferred for upset drill pipe in a size range of 3½" to 4½" O.D. For this size range of pipe a 1/16" diameter hole has been found too small to effect the preferred transformation hardening; a 7/16" hole has been found too large, in that it admits too much water. A vent hole about 5/16" diameter is preferred 5" and 5½" O.D. upset drill pipe.

In carrying out the method of my invention, using the apparatus of Scott Patent 2,776,230, a length of 4½" O.D. internal upset drill pipe containing about .30% C, 1.6% Mn, .15% Si, 35% Mo and .06% V, having a wall thickness of .337", upset ends about 3¾" long and .906" maximum wall thickness, had a 4¼" diameter 1/16" steel plate welded throughout its periphery to one end of the pipe. The plate had a 1/4" diameter hole in its center. With the covered end trailing, the length was progressively heated to its transformation temperature of about 1475° F. and thereafter water quenched. After quenching and before tempering, the hole was enlarged by means of a pointed and tapered special steel hammer to about 1" in diameter. This larger opening in the plate insured circulation of hot gases during tempering to secure uniform finished properties. After tempering, the length met specifications and exhibited a substantially uniform tensile strength of more than about 135,000 p.s.i. The cover plate was cut off in the customary end-facing operation, about

½" of the original trailing end being removed due to welding fusement.

While the above example illustrates a preferred method of operation, other conditions of operation may be used without departing from the spirit of the invention. Any liquid spray directed at an acute angle to the direction of pipe travel may be used, that is effective to produce the desired metallurgical properties in the main portion of a pipe length. The vent hole may be off center or may comprise a plurality of smaller spaced holes, more particularly with an axially rotating pipe.

An axial vent hole and a plurality of spray nozzles having their axes constituting an imaginary cone with its apex on the pipe axis are preferred, since then a simple change, viz., in the vent-hole diameter, is usually all that is necessary when operating conditions are varied. Some of these variations include a change in pipe diameter, wall thickness, metal chemistry, axial speed during heating and quenching, number of spray rings used and quench-liquid pressure.

Although I have disclosed herein the preferred practice of my invention, I intend to cover as well any change or modification therein which may be made without departing from the spirit and scope of the invention.

I claim:

1. A method of hardening metal pipe comprising abutting against one end of a pipe a cover plate having a hole therein thereby to completely seal the inside diameter opening of said pipe end, heating said length above the critical temperature by passing the length through a heating zone with the covered end trailing, then as the length emerges from said zone, passing it through a liquid-spray quenching ring, said hole being dimensioned to dissipate heat from the inside of said trailing end to such an extent as to effect transformation hardening therein.

2. A method as defined in claim 1 characterized by continuously welding said plate to the end of the pipe length.

3. A method as defined in claim 1 characterized by said plate having said hole substantially on the axis of said pipe.

4. A method as defined in claim 1 characterized by said liquid spray comprising a plurality of circumferentially spaced, diverging sprays of liquid, the axes of said sprays constituting elements of an imaginary cone having its apex substantially on the pipe axis.

5. A method as defined in claim 1 characterized by the trailing end of said pipe length being upset.

6. A method of hardening metal pipe comprising continuously welding to one end of a length of pipe, the edge of a cover plate having an axial hole therein, thereby to completely seal the inside diameter opening of said pipe end, heating said length above the critical temperature range by passing the length through a heating zone with the covered end trailing, and passing it through a circumferentially spaced liquid spray directed at an acute angle to the direction of pipe travel, said hole being dimensioned to dissipate heat from the inside of said trailing end to such an extent as to effect transformation hardening therein.

References Cited in the file of this patent

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,140,964 July 14, 1964

Robert G. Middlemiss

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, line 51, for "Towever" read -- However --; column 2, line 56, for "35%" read --- .35% --; line 57, after ".906"" insert -- in --.

Signed and sealed this 10th day of November 1964.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents