June 15, 1965 J. A. SCOTT 3,189,490

METHOD AND APPARATUS FOR QUENCHING PIPE

Filed Nov. 5, 1962 2 Sheets-Sheet 1

FIG. 1

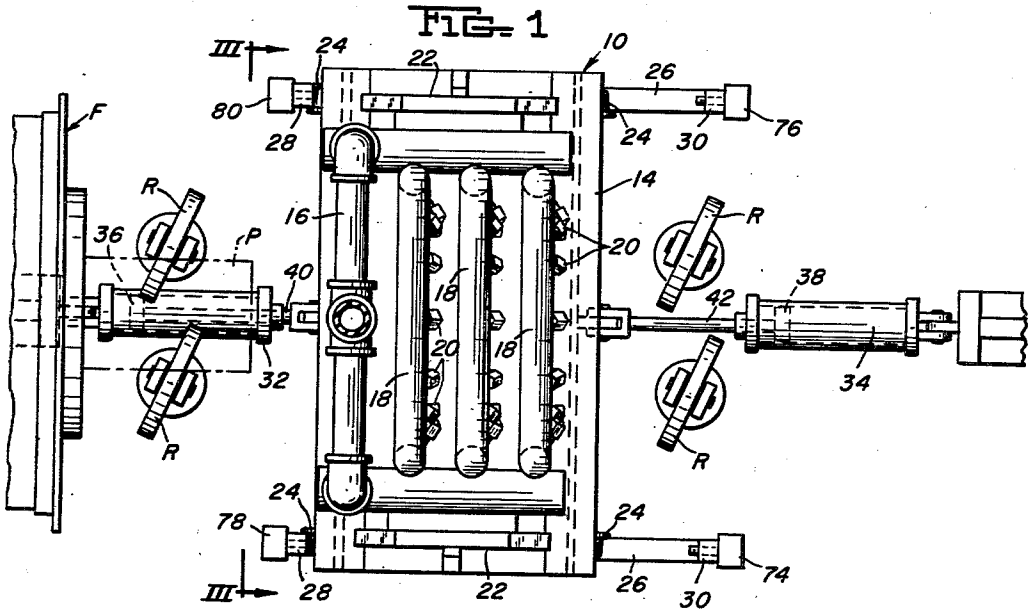
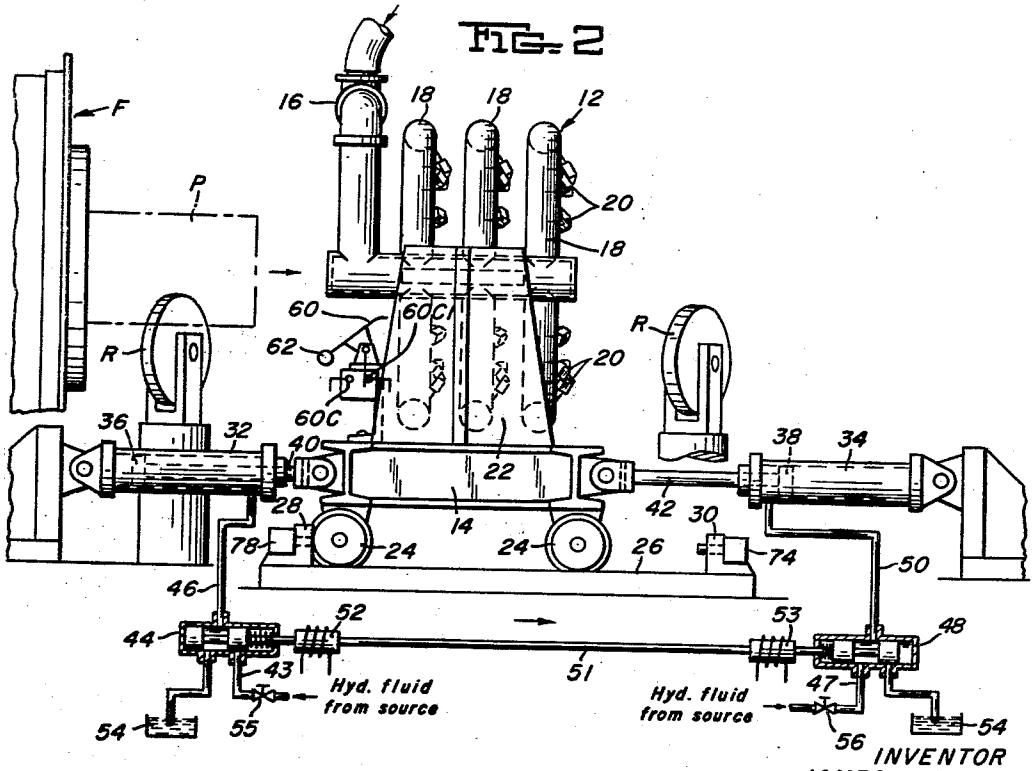


FIG. 2



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Filed Nov. 5, 1962 2 Sheets-Sheet 2

FIG. 3

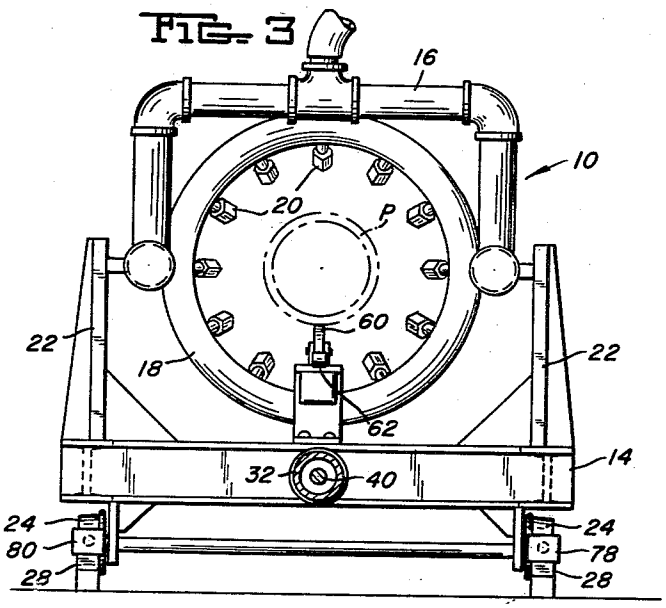


FIG. 4

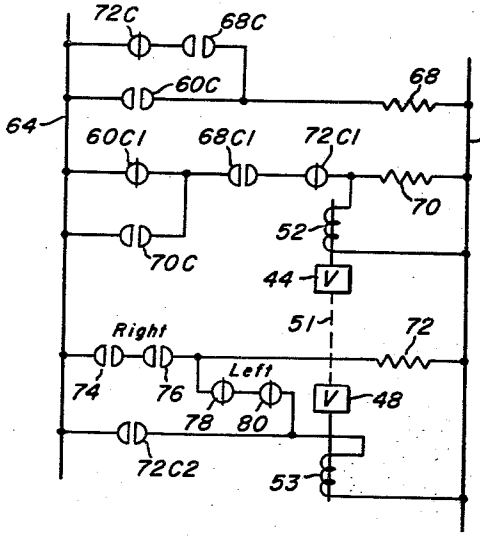
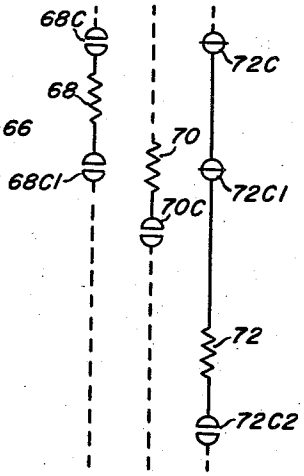


FIG. 5



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METHOD AND APPARATUS FOR QUENCHING PIPE

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This invention relates to heat treating steel pipe and, more particularly, to spray quenching sections of steel pipe as they emerge from a heat treating furnace.

For certain applications, such as oil well casing, it is necessary to heat treat the formed pipe to provide the required high strength levels. One present commercially acceptable way of performing this heat treatment is by passing the formed pipe sections through barrel-type furnaces and spray quenching them as they emerge. However, pipe formed from some types of steel has exhibited a high percentage of cracked trailing ends after spray quenching. Some of these ends are cropped in subsequent operation and this cropping will often remove the entire cracked portion of the pipe. It sometimes happens, however, that the end of the pipe cracks to such an extent that an excessive amount of cropping is necessary. It has further been noted that often the cracking originates only in the last few feet of the pipe but unless the internal stresses in the pipe are relieved without delay the cracks may propagate throughout the length of the pipe and necessitate the scrapping of the entire pipe.

Although the reason for the cracking at the end of the pipe is not completely understood it is believed that as the trailing end passes the quenching fixture the quenching media is sprayed inside of the pipe, and this occurs while the inner surface is hotter than the outer surface. The impingement of the quenching media on the inner surface when it is substantially hotter than the external surface produces cooling which induces detrimental internal stresses that often produce cracks in the steel. These cracks may then propagate rapidly along the entire length of the pipe.

Several methods for preventing the entrance of the quenching media into the trailing ends of the pipe have been proposed. Caps of various designs have been attached to the trailing end, but these caps are expensive, require time and effort to attach and remove and also fail to give uniformly satisfactory results. It has also been suggested that the pipe be stopped as the trailing end approaches the spray head to allow a substantially complete cooling of the trailing end before the quenching media is impinged upon the inner surface. This requires stopping the line with attendant loss of production and possible over-heating of the succeeding pipe section which is passing through the furnace. Other proposals have proved to be equally unsatisfactory.

It is therefore a principal object of this invention to provide a method of spray quenching pipe sections which will reduce the propensity for end cracking.

A related principal object of this invention is to provide a device which will spray quench pipe sections in a way which will reduce end cracking.

Still a further object of this invention is the provision of an apparatus which will increase the length of time that the external surface of the trailing end of a pipe is quenched before the quenching media is sprayed into the pipe yet permit continuous movement of the pipe.

A more particular object of this invention is the provision of a method of quenching pipe sections emerging from a heat treating furnace wherein the trailing end of the pipe is completely cooled before the quenching media is sprayed inside the pipe.

A more specific object of this invention is the provision of a pipe quenching device which is movable in the direction of the travel of the pipe as the trailing end of the pipe approaches.

Yet another more specific object of this invention is the provision of a spray head for quenching pipe and means to actuate the head for travel in the direction of the pipe travel as the trailing end of the pipe approaches the head.

Other objects and advantages of the invention will become apparent from the following description and accompanying drawings, in which:

FIGURE 1 is a plan view of the quenching device of this invention;

FIGURE 2 is a side elevational view of the device of FIGURE 1;

FIGURE 3 is a view taken along line III—III of FIGURE 1; and

FIGURES 4 and 5 are circuit diagrams of the electric controls for the quenching device.

Referring now to the drawings, the quenching device of this invention is shown in a typical environment in conjunction with a roller conveyor having a plurality of angled rollers R adapted to move sections of pipe P therealong. The pipe P is moved along the rollers R through a conventional barrel-type heat treating furnace F. As the pipe emerges from the furnace F, which has heated it to the required heat treating temperature, it must be quenched to impart the necessary strength and hardness to the pipe. The quenching is performed by the device of this invention designated generally as 10. The device 10 includes quench head 12 mounted on a carriage 14. The quench head 12 is of conventional design and preferably is similar to that shown in my Patent No. 2,776,230, and includes a main header 16 connected to a plurality of axially spaced annular ring headers 18 each of which is equipped with a plurality of circumferentially spaced spray nozzles 20. Quenching media, usually water, is delivered from the main header 16 to the ring headers 18 and then to the spray nozzles 20, which are arranged to spray the water on the pipe P as it passes through the ring headers 18. The spray nozzles 20 are angled to spray in the direction of the pipe travel as designated by an arrow in FIGURE 2. The quench head 12 is mounted on the carriage 14 by brackets 22. Wheels 24 of the carriage 14 are mounted on tracks 26 which extend parallel to the path of movement of the pipe sections P so that the carriage 14 and quench head 12 are movable toward and away from the furnace F.

The track 26 has its end limits defined by spaced pairs of stop blocks 28 and 30 which limit the direction of travel of the carriage 14. A pair of hydraulic cylinders 32 and 34 are mounted at opposite ends of the track 26 and have respectively pistons 36 and 38. Piston rods 40 and 42 extend from the pistons 36 and 38 respectively and are connected to the opposite ends of the carriage 14. A source of hydraulic fluid (not shown) is connected by conduit 43 to the hydraulic cylinder 32 through a two-way valve 44 and conduit 46 and by conduit 47 to the hydraulic cylinder 34 through a two-way valve 48 and conduit 50. The valves 44 and 48 are operable by a linkage which includes a rod 51 interconnecting the valves and a pair of solenoid coils 52 and 53. Each of the valves 44 and 48 has a first position wherein the high pressure portion of the hydraulic source is connected to the respective hydraulic cylinder and a second position where the sump or low pressure zone 54 of the hydraulic source is connected to its respective hydraulic cylinder. The valves 44 and 48 are so arranged and connected to the linkage that when coil 52 is energized the valve 44 is

shifted to the left connect the sump 54 to the hydraulic cylinder 32 and the valve 48 is shifted to connect the conduit 47 to the hydraulic cylinder 34, and when coil 53 is energized the valve 44 is shifted to the right to connect the conduit 43 to the cylinder 32 and the valve 48 is shifted to connect the sump 54 to the cylinder 34. The valves 44 and 48 are so constructed that when set in a given position they will remain in that position even though the coil that shifted them thereto is de-energized. The carriage 14 will be driven to the left as seen in FIGURE 2 when cylinder 32 is connected to the high pressure source through conduit 43 and to the right when cylinder 34 is connected to the high pressure source through conduit 47. The valves 44 and 48 are operably movable between these positions by the linkage in a manner which will be described. As can be seen in FIGURE 2, needle vlaves 55 and 56 are provided in conduits 43 and 47 between the hydraulic source and the two-way valves 44 and 48 and are adapted to regulate the fluid flow to the cylinders and thereby control the speed of travel of the carriage 14.

The control system, which will be described presently, is adapted to actuate the valves 44 and 48 to move the carriage to the right (as seen in FIGURE 2) just before the trailng end of the pipe enters the spray head. The valve 56 is regulated so that the carriage will move the spray head at the speed that the pipe section is traveling which will give an additional quench to the trailing end of the pipe section to sufficiently cool the pipe before the water is sprayed into the pipe section against the interior surface. As was described above, this additional quenching minimizes formation of cracks which if not quickly treated can lead to substantial scrap loss.

A flag switch 60, located just on the entry side of quench head 12 as shown in FIGURE 2, controls the movement of the carriage 14. The flag switch 60 is provided with a counter-weight 62 which normally biases the switch into the path of travel of the pipe. The flag switch is provided with a pair of contacts 60C and 60C1. When the flag switch 60 is projecting into the path of travel of the pipe and no pipe is traveling along this path, contact 60C is open and contact 60C1 is closed. When a section of pipe emerges from the furnace and enters the quench head it strikes and depresses the flag switch 60 which will open contact 60C1 and close contact 60C. The contacts 60C and 60C1 control the electrical circuit shown in FIGURES 4 and 5 which circuit operates the solenoid valves 44 and 48.

Referring now to FIGURES 4 and 5 the electrical circuit includes a pair of line wires 64 and 66 which provide the power to the circuit. The circuit includes a relay coil 68 which operates normally open contacts 68C and 68C1, relay coil 70 which operates normally open contact 70C, and relay coil 72 which operates normally closed contacts 72C and 72C1 and normally open contact 72C2. Relay coil 68 is connected across line wires 64, 66 in series with contact 60C which is connected in parallel with contacts 68C and 72C. Relay coil 70 is connected across line wires 64, 66 in series with contacts 60C1, 68C1 and 721C1 and in parallel with solenoid 52. Contact 70C is connected in parallel with contact 60C1. Relay coil 72 is connected across line wires 64, 66 in series with normally open limit switches 74 and 76. Solenoid 53 is connected across line wires 64, 66 in series with contact 72C2. Normally closed limit switches 78 and 80 are connected in series between solenoid 53 and limit switch 76. The switches 74 and 76 are mounted on the right hand stop blocks 30 and are closed by the wheels of the carriage when they abut the blocks 30, and the switches 78 and 80 are mounted on stop blocks 28 are are closed by the wheels of the carriage when the wheels strike the blocks 28.

Operation

Assume that all of the contacts and switches are in the position shown in FIGURE 4 and that the carriage and controls are as shown in FIGURE 2 with no pipe depressing flag switch 60. When a pipe section emerges from the furnace and just before it enters the quench head 12 it will depress flag switch 60. This will first open contact 60C1 and then close contact 60C. Closing of contact 60C will energize relay coil 68 and close its contacts 68C and 68C1. However, since contact 60C1 was opened before contact 60C closed, solenoid coil 52 will not be energized and contact 72C2 will remain de-energized and the carriage 14 will remain stationary against the left-hand stops 28. Thus, the pipe section will move through the quench head 12 with the water spray being directed from the spray nozzles 20 against the outer surface of the pipe. When the trailing end of the pipe passes beyond the flag switch 60 the switch will raise opening contact 60C and closing contact 60C1. Closing of contact 60C1 energizes solenoid coil 52 and relay coil 70 through contacts 60C1, 68C1 and 72C1. Energization of solenoid coil 52 shifts the valves 44 and 48 to connect the cylinder 34 to conduit 47 and cylinder 32 to the sump 54. This causes the carriage 14 to be driven to the right at a speed determined by the setting of needle valve 56. This setting is adjusted so that the carriage will move at the same speed as the pipe section is moving.

When the carriage 14 starts to move to the right it moves away from the left-hand stops 28 thereby opening contacts 78 and 80. The carriage will continue to move to the right until it abuts the right-hand stops 30 which will stop movement of the carriage and close contacts 74 and 76. Closing of contacts 74 and 76 energizes relay coil 72 which will close its contact 72C2 and open its contacts 72C and 72C1. Opening of contact 72C will de-energize relay coil 68, and opening of contact 72C1 will de-energize relay coil 70 and solenoid coil 52. Closing of contact 72C2 will energize solenoid coil 53 which will shift the valves 44 and 48 to connect the hydraulic cylinder 32 to conduit 43 and the hydraulic cylinder 34 to the sump 54. This causes the carriage to reverse direction and move to the left at a speed which is regulated by the setting of needle valve 55. By using two contacts 74 and 76 if the carriage became twisted during its travel, it would not reverse direction until it has straightened out and closed both contacts 74 and 76. Contacts 78 and 80 function in a like manner to prevent twisting of the carriage when it is moving in the opposite direction.

From the foregoing, it can be seen that just before the trailing end of the pipe enters the quench head the carriage is actuated to move the head to maintain the spray against the exterior of the pipe and prevent any spray from being sprayed into the pipe until the carriage has moved a substantial distance with the pipe, thereby reducing the temperature of the pipe to a point below which water or other quenching media may be safely sprayed into the pipe without increasing the danger of cracking. Once the carriage has reached the extreme right position it is then reversed and returned to the left and this return will take place irrespective of whether a second pipe section is closely following the first pipe or not. If no pipe is following the previously quenched pipe section the carriage will move to the left as explained above and as it moves away from the right-hand stops 30, contacts 74 and 76 will be opened which will de-energize relay coil 72. This will open contact 72C2 de-energizing solenoid coil 53. Also, when relay coil 72 is de-energized contacts 72C and 72C1 will be closed. However, since contact 68C1 is open solenoid coil 52 will remain de-energized and valves 44 and 48 will not change position. When the carriage completes its movement to the left it will abut the left-hand stops closing contacts 78 and 80 which thereby returns the circuit to the position shown in FIGURE 4 ready to receive the next pipe.

However, if during the return movement of the carriage from the right-hand stop 30 to the left-hand stop 28, a

second pipe section is closely following the previously quenched section the head end of this second section will depress flag switch 69 as the carriage is returning thus opening contact 69C1 and closing contact 69C. However, this will not affect the movement of the carriage since solenoid 52 remains de-energized. Movement of the carriage 14 to the left will continue until the trailing end of the pipe passes over flag switch 69 which will first open contact 69C and then close contact 69C1. This, as described above, will cause solenoid coil 52 to be energized which will shift the valves 44 and 48 to provide high pressure fluid to the hydraulic cylinder 34 which will move the carriage to the right.

As was described above, the setting of the needle valve 56 should be adjusted so that the carriage will travel to the right at a speed corresponding to the speed of the pipe sections emerging from the furnace. The needle valve 55 should be adjusted so that the return speed of the carriage to the left will be sufficiently slow that the pipe sections will be adequately quenched even though the head is moving in a direction opposite from that of the pipe but sufficiently rapid so that the carriage will reach the left-hand stops 28 before the trailing end of the pipe passes over the flag switch 69. This will insure an even quench of the entire length of the pipe and a full length of travel of the quench head with the trailing end of the pipe to sufficiently cool the trailing end before the water is sprayed inside.

From the foregoing description it can be seen that no specific or constant distance between succeeding sections of pipe need be maintained; the sections can follow each other rather closely or they can be widely spaced. The only requirement is that there be enough space between the pipe sections so that the flag switch 69 will move to open contact 69C1 and close contact 69C2 before the next section of pipe depresses this flag switch.

While one embodiment of my invention has been shown and described it will be apparent that other adaptations and modifications may be made without departing from the scope of the following claims.

I claim:

1. Apparatus for spray quenching pipe sections emerging successively from a furnace comprising, nozzle means circumferentially disposed about the pipe sections as they emerge from the furnace, said nozzle means being positioned to direct a fluid spray against the external surface of a pipe section, means operable by the trailing end of each pipe section to move said nozzle means in the direction of travel of the pipe sections when the trailing end of the section reaches a preselected position prior to entry into the fluid spray, and means to return the nozzle means to their original position after a preselected movement, whereby when the trailing end of a pipe section approaches the fluid spray the nozzle means will move with the trailing end to prevent spraying of the fluid internally of the pipe until the trailing end of the pipe has had extended quenching.

2. Apparatus for spray quenching pipe sections emerging successively from a furnace comprising, a plurality of nozzles circumferentially disposed about the pipe sections as they emerge from the furnace, said nozzles being positioned to direct a fluid spray against the external surface of a pipe section at an angle inclined in the direction of travel of the pipe section, drive means adapted to move said nozzles reciprocally along the path of travel of said pipe sections, control means arranged to actuate said drive means to move said nozzles in the direction of travel of said pipe sections when the trailing end reaches a preselected position and to return the carriage to its original position after a predetermined distance of travel, whereby when the trailing end of a pipe approaches the fluid spray the nozzles will move with the pipe section to prevent spraying of the fluid internally of the pipe until the trailing end of the pipe has had extended quenching.

3. Apparatus for spray quenching pipe sections emerging successively from a furnace comprising, a plurality of nozzles circumferentially disposed about the pipe sections as they emerge from the furnace, said nozzles being positioned to direct a fluid spray aginst the external surface of the pipe sections at an angle inclined in the direction of travel of the pipe section, fluid pressure drive means adapted to move said spray nozzles reciprocally along the path of travel of said pipe sections, and control means arranged to actuate said drive means to move said nozzles in the direction of travel of said pipe sections when the trailing end reaches a preselected position and to return the carriage to its original position after a predetermined distance of travel, whereby when the trailing end of the pipe section approaches the fluid spray the nozzles will move with the pipe section to prevent spraying of the fluid internally of the pipe until the trailing end of the pipe has had extended quenching.

4. Apparatus for spray quenching pipe sections emerging successively from a furnace comprising, a track extending in the direction of the path of travel of the pipe sections adjacent the exit end of the furnace, a carriage mounted on said track and movable therealong, a plurality of spray nozzles mounted on said carriage and circumferentially disposed about the pipe section as it emerges from the furnace, said nozzles being positioned to direct a fluid spray against the external surface of the pipe sections at an angle inclined in the direction of travel of the sections, drive means adapted to move said carriage on said track reciprocally along the path of travel of said pipe sections, control means arranged to actuate said drive means to move said carriage in the direction of travel of the pipe sections when the trailing end reaches a preselected position with respect to the spray nozzles and to return the carriage to its original position after a predetermined distance of travel, whereby when the trailing end of a pipe approaches the fluid spray the nozzles will move with the pipe section to prevent spraying of the fluid internally of the pipe until the trailing end of the pipe has had extended quenching.

5. The combination of claim 4 characterized by said drive means including at least one hydraulic cylinder, and means adapted to regulate the flow of fluid to said cylinder, whereby to adjust the speed of travel of said carriage.

6. Apparatus for spray quenching pipe sections emerging successively from a furnace comprising, a track extending in the direction of the path of travel of the pipe sections adjacent the exit end of the furnace, a carriage mounted on said track and movable therealong, a plurality of spray nozzles mounted on said carriage and circumferentially disposed about the pipe section as it emerges from the furnace, said nozzles being positioned to direct a fluid spray against the external surface of the pipe sections at an angle inclined in the direction of travel of the pipe sections, a first hydraulic cylinder connected to said carriage and adapted to drive the carriage in the direction of travel of the pipe sections, a second hydraulic cylinder adapted to drive the carriage in direction opposite the direction of travel of the pipe sections, control means adapted to control the movement of said carriage, said control means including first switch means arranged to actuate said first cylinder when the trailing end of the pipe passes a preselected point with respect to the spray heads to thereby drive the carriage in the direction of the path of the pipe section, said control means including second switch means positioned to actuate said second cylinder when the carriage has traveled a preselected distance in the direction of travel of the pipe section to thereby drive the carriage back to its original position, and stop means limiting the distance of travel of said carriage, whereby when the trailing end of a pipe approaches the fluid spray the nozzles will move with the trailing end to prevent spraying of the fluid internally of the pipe until the trailing end of the pipe has had extended quenching.

7. The process of spray quenching pipe sections emerg-

ing successively from a furnace, said process being adapted to reduce the propensity for trailing end cracking of the pipe due to spray entering internally of the pipe before the trailing end of the pipe has had extended quenching, said process comprising moving a pipe section with respect to a quenching spray, then moving the quenching spray a substantial distance in the direction of pipe travel as the trailing end of the pipe approaches the quenching spray, and thereafter returning the quenching spray to its original position.

References Cited by the Examiner

UNITED STATES PATENTS

2,622,606	12/52	Skivesen	134—122
2,696,823	12/54	Scott	266—6 X
2,776,230	1/57	Scott	266—6 X
2,851,042	9/58	Spence	266—6 X

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