

July 25, 1950

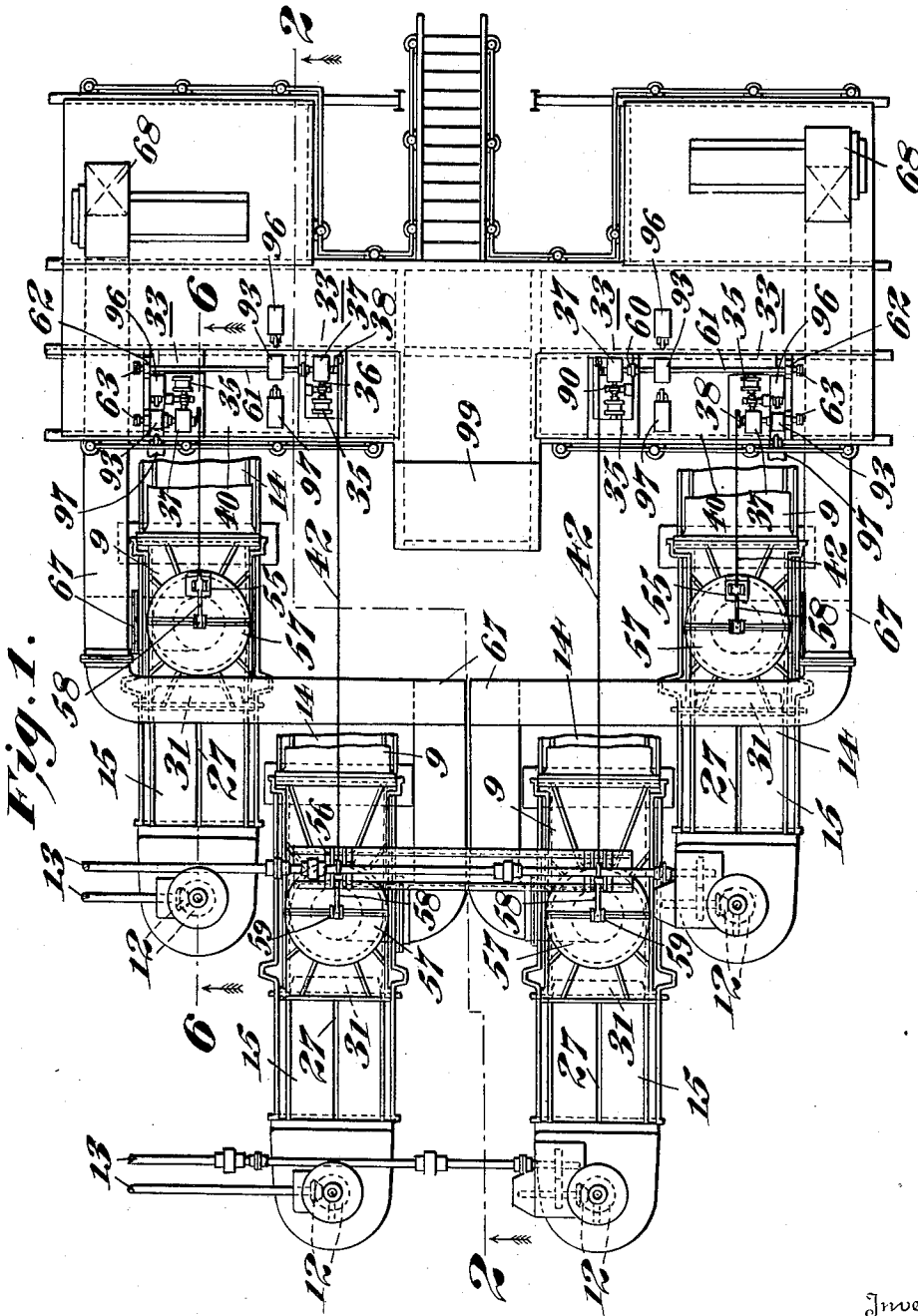
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2,516,248

METHOD AND APPARATUS FOR COOLING RODS

Filed Aug. 3, 1946

6 Sheets-Sheet 1



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METHOD AND APPARATUS FOR COOLING RODS

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6 Sheets-Sheet 2

Fig. 4.

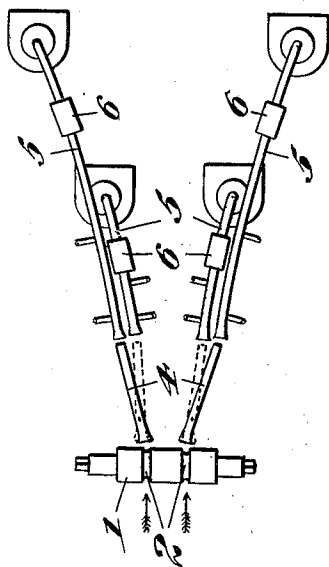


Fig. 2.

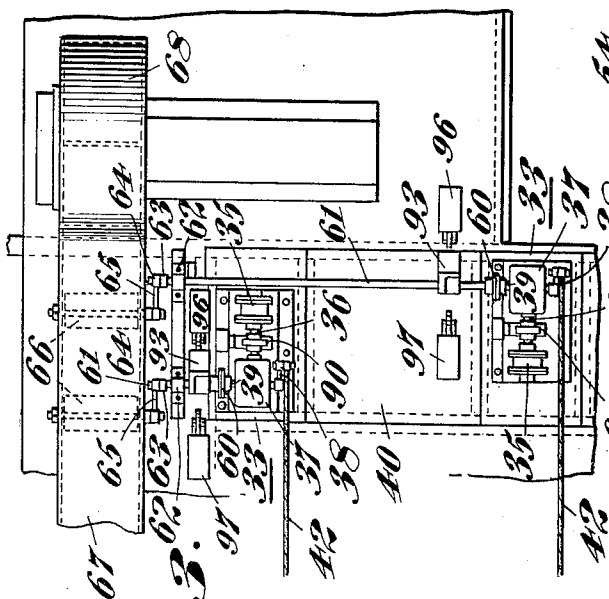
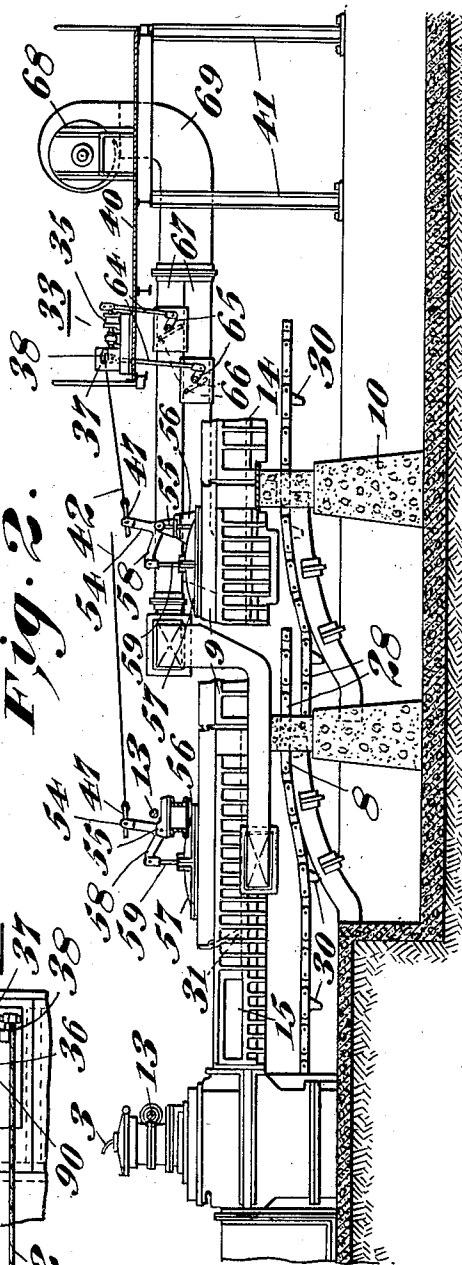


Fig. 3.

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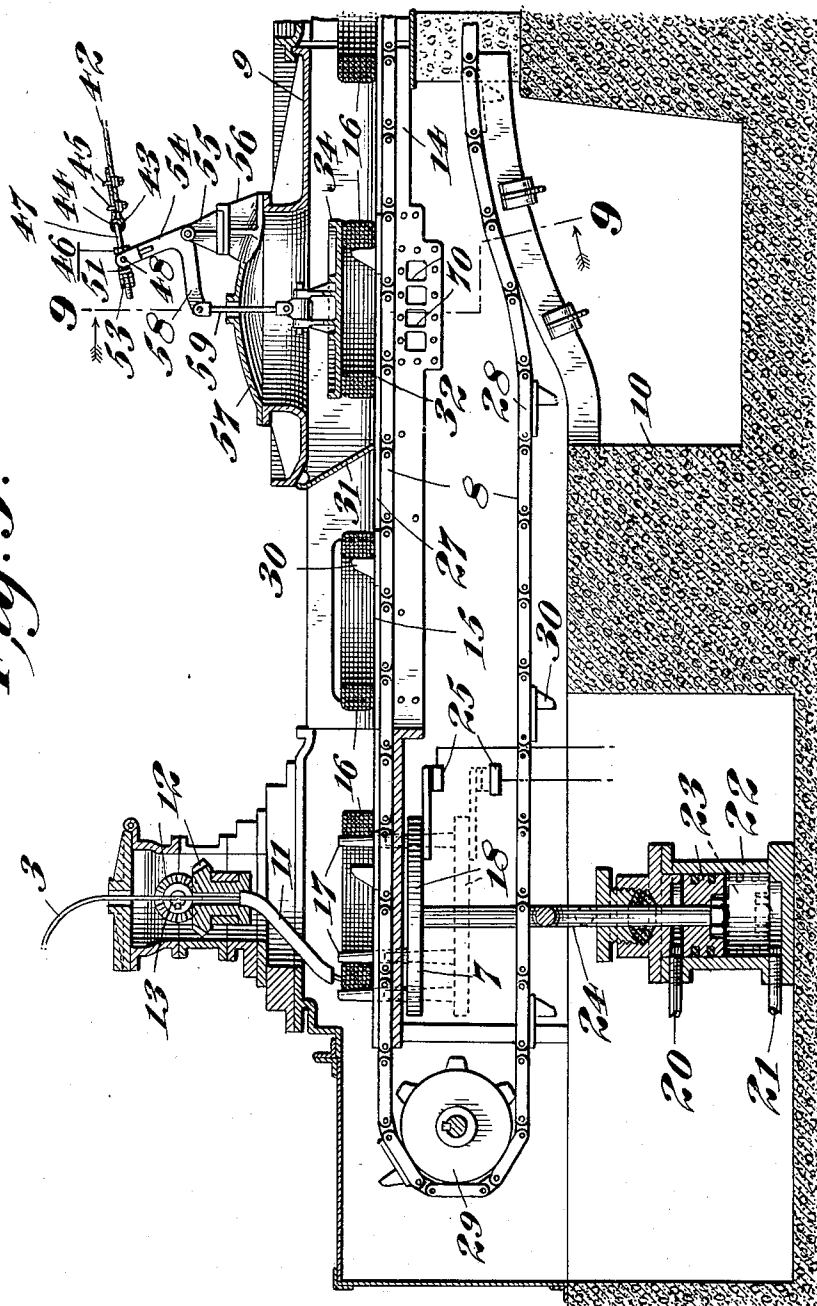
2,516,248

METHOD AND APPARATUS FOR COOLING RODS

Filed Aug. 3, 1946

6 Sheets-Sheet 3

Fig. 5.



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2,516,248

METHOD AND APPARATUS FOR COOLING RODS

Filed Aug. 3, 1946

6 Sheets-Sheet 4

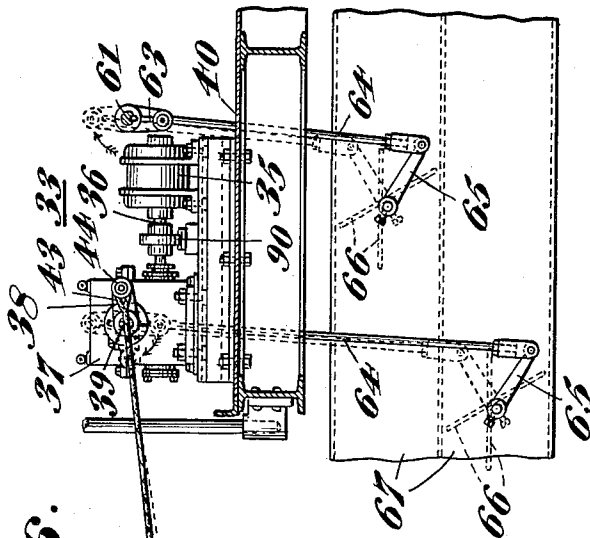


Fig. 6.

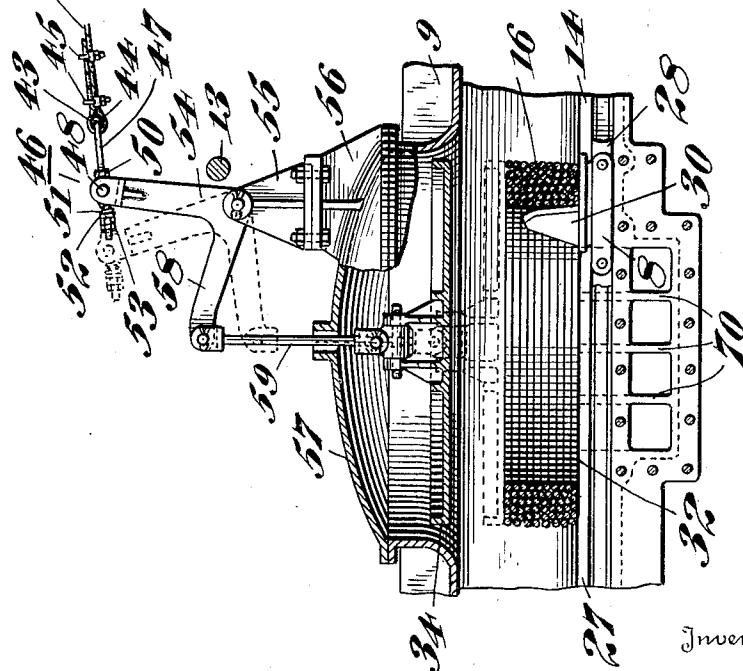


Fig. 7.

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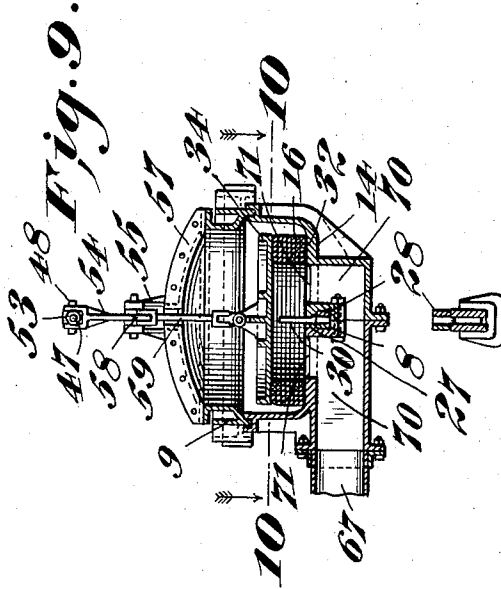
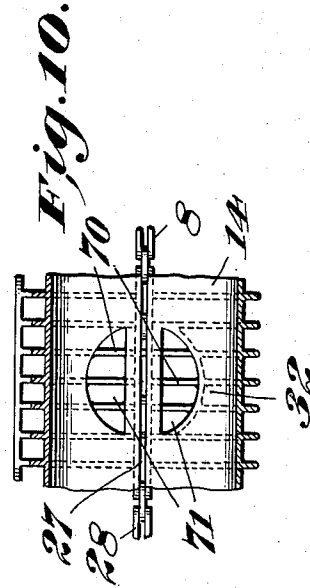
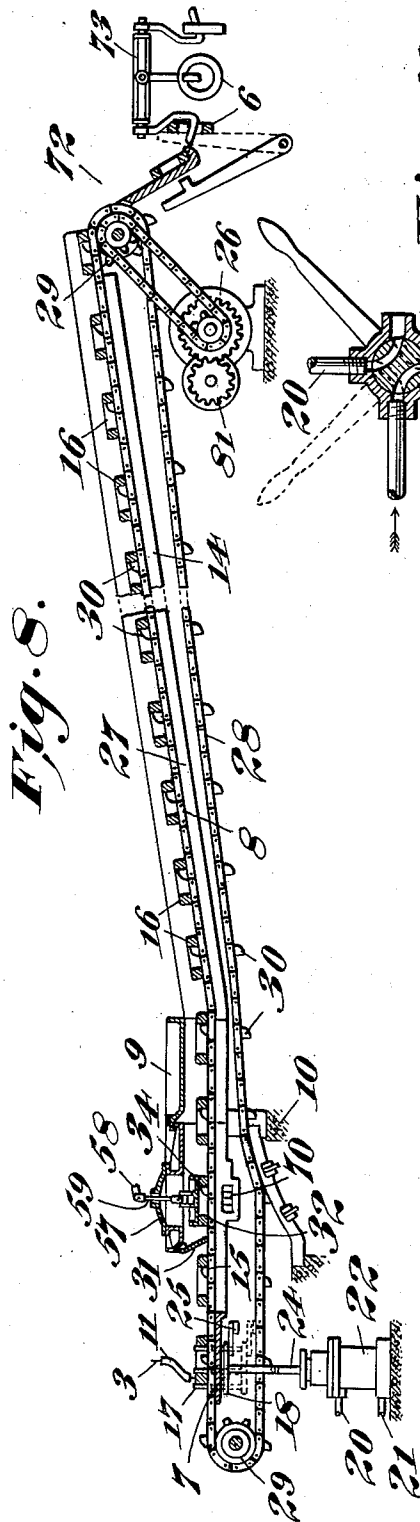
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2,516,248

METHOD AND APPARATUS FOR COOLING RODS

Filed Aug. 3, 1946

6 Sheets-Sheet 5



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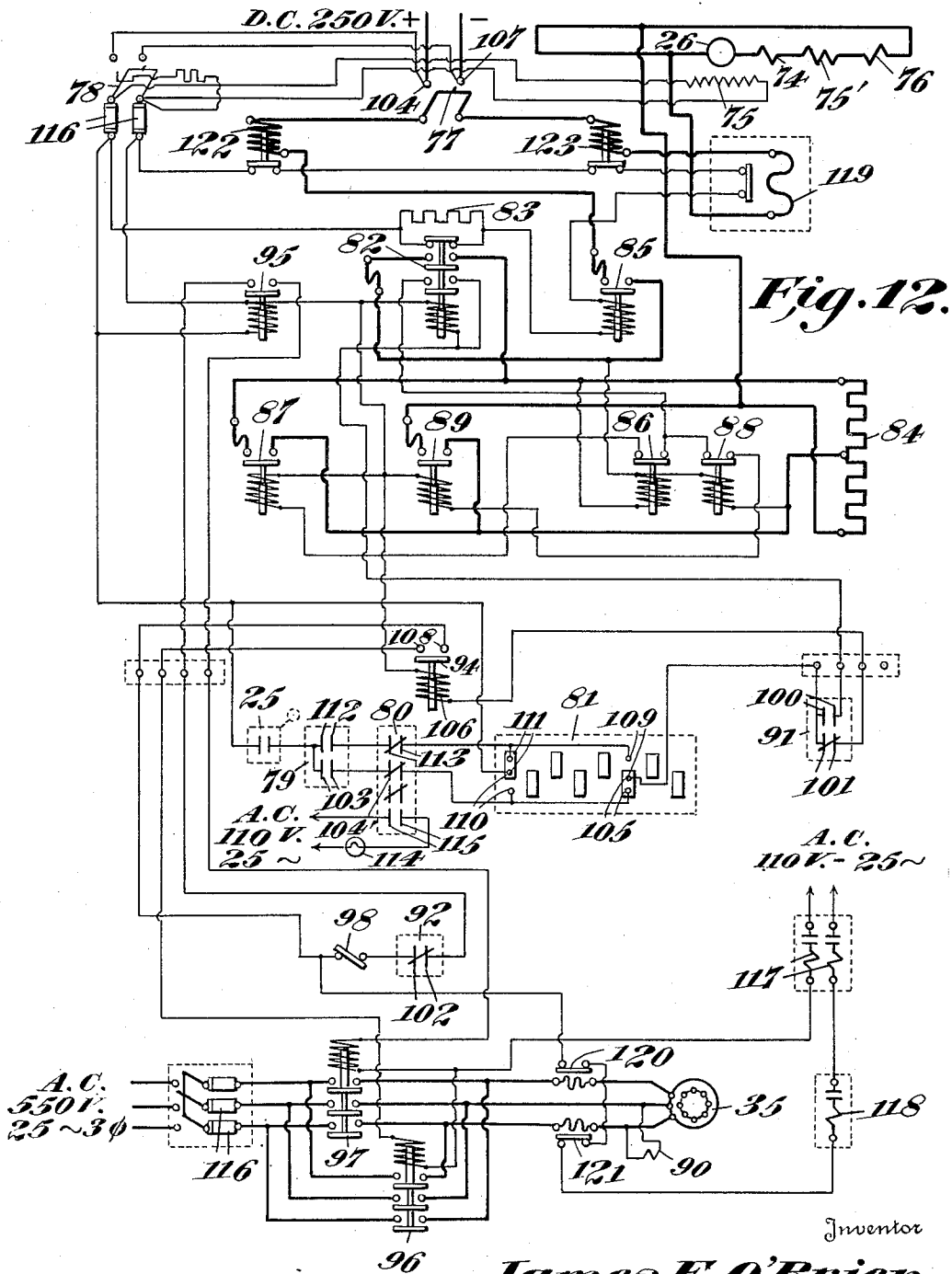
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2,516,248

METHOD AND APPARATUS FOR COOLING RODS

Filed Aug. 3, 1946

6 Sheets-Sheet 6



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UNITED STATES PATENT OFFICE

2,516,248

METHOD AND APPARATUS FOR COOLING RODS

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Application August 3, 1946, Serial No. 688,234

11 Claims. (Cl. 148—21.55)

1

My invention relates in general to the processing of metal rods, and more particularly to a method and apparatus for the controlled cooling of coils of hot rolled rods of iron and steel.

In the manufacture of ferrous rods and rod products such as wire, it has been the usual practice to conduct the hot freshly rolled rod from the finishing roll pass through a water-cooled tubular guide which initially cools the rod somewhat, then through a water-eliminating apparatus provided with jets of air to blow the water from the surface of the rod, and then to form the rod into coils on a reeling mechanism. From the reeling mechanism the coils are removed by a chain conveyor and discharged to a hook conveyor for further cooling on a bed or the like.

Having necessarily been rolled at a temperature well above the upper critical range, or at about 2000° F. to 1800° F., a hard black coating of scale, chiefly ferrous-ferric oxide (Fe_3O_4), will normally form upon the hot rod surface, particularly on the inner parts of the coil which cool very slowly. Cooling with water alone below 1500° F. is generally impracticable, because of the increased danger of embrittlement due to a too drastic quench.

But since the amount of scale formed varies in accordance with the time and temperature of exposure to the atmosphere, and scale formation stops below 1100° F., controlled rapid cooling of the rod in air to below that point effects savings, both in weights of iron and acid, and in cleaning time, which when applied to the large tonnages produced by the usual rod mill are important and worthwhile. Moreover, the quality and uniformity of grain structure, particularly of high carbon steels, are notably improved, the pearlite instead of coarse lamellar plates being in the form of small uniform grains which facilitate subsequent heat treatment and drawing the rod into wire.

Among the objects of my invention in the controlled cooling of hot rolled rods, therefore, are the following: reduction of scale loss; quicker, cheaper cleaning of rods due to less scale; more uniform physical properties from outside to center of coils; and better drawing properties in high carbon grades.

Other and further objects, purposes and advantages of my invention will appear in the following detailed description, in the attached six sheets of drawings, and in the appended claims.

In the drawings:

Figure 1 is a top plan view of the coiling end of conveyor and rod cooling apparatus;

2

Fig. 2 is a section taken along the line 2—2 of Fig. 1;

Fig. 3 is a top plan detail view of the blower and hood motor for one pair of conveyor lines;

Fig. 4 is a top plan view of the finishing rolls, guides and delivery troughs to the cooling reels;

Fig. 5 is a section through the reel and the cooling station of one of the conveyors, on the line 6—6 of Fig. 1;

Fig. 6 is a fragmentary section, also on the line 6—6 of Fig. 1, showing in detail the operating mechanism of the hood and dampers;

Fig. 7 is a top plan detail view of the take-up device attached to the hood lifting cable;

Fig. 8 is a diagrammatic view of one of the conveyor lines;

Fig. 9 is a section taken on the line 9—9 of Fig. 5;

Fig. 10 is a section on the line 10—10 of Fig. 9;

Fig. 11 is a detail view of the reel pin control valve; and

Fig. 12 is a wiring diagram of the electrical system by which the movements of the reels, the conveyors, the blowers and the dampers are automatically coordinated and controlled.

Referring now to Fig. 4, the numeral 1 designates the last or finishing pair of rolls in a continuous rod mill, said rolls being provided for example with the pair of grooved passes 2, from which passes the hot rolled rod 3 is directed by pivoted guides 4 through curved water-cooled pipes or troughs 5 and water eliminators 6 to one of the four reels 7. As shown in Fig. 1, each of said reels 7 is at the head of a separate conveyor 8 and is enclosed therewith in a muffle casing 9. The reels and conveyors are arranged in parallel lines on a suitable concrete foundation 10, and are of substantially identical construction, so that the description of one such line will make plain the operation of all.

While other types of reels or coilers may be used if desired, the reel 7 which I have shown in Fig. 5 is of the conventional laying type, in which a rotating delivery pipe 11, driven by gearing 12 and shafting 13 from an external power source, coils the rod 3 on the stationary bottom trough plates 14 of the conveyor 8. The rod coil 16 is formed horizontally in the usual manner, between concentric rows of vertical pins 17 mounted on a circular plate 18, which pins are raised before coiling and lowered when the coil has been completed through apertures in the bottom trough plates 14 by the operator admitting steam or other fluid through the distributor valve 19 and the pipes 20 or 21 to the desired end of the two-

3

way fluid pressure cylinder 22, thereby actuating the piston 23 connected by bifurcated piston rod 24 to said plate 18. Reel switch 25 controls the movement of the conveyor motor 26 as will hereinafter be described.

The bottom trough plates 14 of said conveyor are slotted centrally at 27 to receive an endless conveyor chain 28 carried on sprocket wheels 29, chain-driven by motor 26, and provided with regularly spaced spurs 30 adapted to engage the coil 16 and advance it to initial stop position 15, where the operator may inspect it, and thence through a pivoted flap door 31 to the second stop position 32.

When the coil 16 has reached the second position, the conveyor motor 26 is stopped and the lid-actuating mechanism 33 shown in Fig. 6 lowers a heavy deflector lid 34 onto the top of said coil. The lid-actuating mechanism 33 comprises an induction motor 35 connected by a shaft 36 to gear-reducer 37 having a crank arm 38 on one end of its shaft 39, said motor and gear reducer being mounted on the platform 40 supported by I-beam columns 41. Said crank arm 38 is connected by wire rope or cable 42, having terminal loops 43 formed around thimbles 44 and held by clips 45, to a spring take-up device 46. As shown in Fig. 7, said take-up device comprises an eyebolt 47, on which a perforated pin 48 is slidably mounted and yieldably held against the washer 49 and nuts 50 by the coil spring 51, washers 52, and nuts 53. Said pin 48 is pivoted in the clevised upper arm of bell crank 54, which is centrally pivoted in support 55 mounted on bracket 56 on conveyor cover 57. The lower arm 58 of said bell crank 54 is pivoted to clevised connecting rod 59 which in turn is pivoted to the deflector lid 34.

The other end of reducer shaft 39 is connected by means of a coupling 60 to shaft 61 journaled in bearings 62 and terminating in crank arm 63 connected by link 64 and lever 65 to damper 66 in branch air duct 67, said damper being adapted to leave the duct 67 open while deflector lid 34 is down. Air from one of the motor-driven fans or blowers 68 mounted on the platform 40 is blown through main duct 69, branch duct 67, grating 70 and floor plate opening 71 into the center of the coil 16 and outward through its convolutions. The deflector lid 34 prevents the escape of air over the top of the coil and forces the air to flow through all the strands of the coil instead, thereby cooling the rod uniformly and also blowing off some loose scale. The exhaust air leaves at the rear of the casing 9.

When the coil 16 is sufficiently cooled and ready for further travel, the induction motor 35 is reversed, the lid 34 is raised, the damper 66 shuts off the air, and the process is repeated with the next coil. The step-by-step progress of the coil on the chain conveyor terminates at the raised kick-off end 72, where it is transferred to a hook conveyor 73 for subsequent processing.

Each of the two blowers 68 is normally kept running continuously, and furnishes the air used to cool the rod coils 16 on two of the four conveyors 8. When one conveyor is in motion, however, its damper 66 diverts the air from that particular conveyor, so that the full air from its blower is directed to the other conveyor served by the same blower. As soon as the motion of the conveyor line stops, and the deflector lid 34 is lowered, the damper 66 is opened so that the normal situation of one blower furnishing air to two coils 16 simultaneously is resumed.

4

Referring now to the wiring diagram in Fig. 12, each of the conveyors 8 has as aforesaid a direct-current driving motor 26, conventionally provided with a commutator field 74, and with compound-wound shunt field 75 and series field 75' to prevent excessive speed, and also with series brakes 76. Electrical control of conveyor motor 26 is provided by the line switch 77 and field switch 78, and by reel pin switch 25, lever-actuated master switch 79, emergency shut-off switch 80 in the kick-off pulpit (not shown), limit switch 81 geared to driving motor 26, relay 82, relay series resistance 83, and starting resistance 84, and relay series contactors 85, 86, 87, 88 and 89.

The deflector lid motor 35, preferably of the reversible alternating-current squirrel-cage induction type with shunt brake 90, is controlled by two hatchway type upper and lower limit switches 91 and 92 operated by a cam 93 on reducer shaft 39, relays 94 and 95, reversing starter relays 96 and 97, and cut-out switch 98 in reel operator's pulpit 99.

Assume that the deflector lid 34 is down, the reel pins 17 are up, and rod is being coiled on the reels 7. The line switch 77 and field switch 78 are closed. The reel pin switch 25 is open, the shut-off switch 80 is closed, and the limit switch 81 is in the position shown in the diagram. The hood motor upper limit switch 91 has its contacts 103 open and contacts 101 closed as shown. The hood motor lower limit switch 92 has its contacts 102 open.

When the coiling is complete, the reel pulpit operator lowers the reel pins 17 as previously described, and reel pin switch 25 then closes. The master switch 79 is then manually placed in position to close contacts 103. The direct current then passes from the positive terminal 104 through the reel switch 25 through contacts 103 of master switch 79 through contacts 104 of shut-off switch 80 through contacts 105 of limit switch 81 through contacts 101 of upper limit switch 91 through coil 106 of relay 94 to negative terminal 107. The relay contacts 108 then close, energizing the raise contactor 96 and completing the alternating current control circuit to the induction motor 35. As soon as the deflector lid 34 is raised a short distance the contacts 102 of the lower limit switch 92 close; and when the hood is fully raised the opening of contacts 101 of the upper limit switch 91 opens relay 94 which stops the lid motor 35.

The closing of contacts 100 of said upper limit switch 91 completes the positive control circuit to contactor 82, which then starts the conveyor motor 26 in understood manner, the series contactors 85, 86, 87 and 88 closing in desired sequence when the currents in their operating circuits drop below certain definite values as the resistance 83 is thrown into the circuit and the coils of the contactors are shorted out, thereby shorting out in turn the sections of the starting resistance 84. The field switch 78 is provided as shown with an auxiliary blade for connecting a discharge resistance across the shunt field when breaking that circuit.

After the conveyor 8 has traveled a fixed distance, the limit switch 81 trips and stops the motion by opening contacts 105. At the same time this occurs, the contacts 109 and 110 close, and contacts 111 open. The closing of contacts 110 completes the master switch circuit to the relay 95 which closes and energizes the lower contactor 97 of the motor 35. When the deflector lid 34 reaches its bottom position and the damper 66

5

is open, the lower limit switch 92 opens contacts 102 to stop the motion, and air from the blower 68 passes through the coil 16. After the deflector lid 34 has started to lower, the upper limit switch 91 returns its contacts to their original position. The unit is now ready for reeling another coil.

When the reel operator wishes to move the second coil, he lowers the reel pins and moves the master switch 79 the opposite way, closing the contacts 112. The circuit to relay 94 now passes through the reel limit switch 25, and through the contacts 112 of master switch 79, 113 of shut-off switch 80, 109 of limit switch 81, and 101 of upper limit switch 91. After the deflector lid 34 is raised, the conveyor moves and stops, and the circuit to relay 95 is set up through contacts 111 of limit switch 81.

If the operator at the kick-off pulpit requires an emergency stop, he operates the shut-off switch 80, the stop being indicated on a signal light 114 controlled by an auxiliary contact 115. If it is desired to operate the conveyor without the deflector lid 34, the latter is raised and cut-out switch 98 in reel pulpit 99 is opened. The conveyor can operate at any time when the deflector lid 34 is in the raised position.

Conventional electrical safety devices, such as the fuses 116, circuit breakers 117 and 118, thermal overload switches 119, 120 and 121, and overload relays 122 and 123, are also provided, as shown in Fig. 12, and function in their usual and well understood manner.

Rod which has been cooled by this air blast system has only a minimum amount of very light scale, which scale breaks off evenly in cleaning. The resultant smoother surface has special advantages for rod that is intended to be drawn into wire.

Although I have hereinabove shown and described my invention in considerable detail, I do not wish to be limited to the exact and specific construction so shown and described, but I may also use such substitutions, modifications, or equivalents thereof as are embraced within the scope and spirit of the invention, or as are pointed out in the appended claims.

Having thus described my invention, what I claim as new and desire to protect by Letters Patent is:

1. The method of reducing scale formation on hot ferrous rod which comprises the steps of forming the hot rod at temperature over 1500° F. into a coil, advancing the hot rod coil to a predetermined stopping position, lowering a lid onto the coil, blowing air into the center of the coil and outwardly through its convolutions until the coil is cooled below approximately 1100° F., lifting the lid from the cooled coil, and removing and further processing the coil.

2. The method of cooling ferrous rods which comprises taking a hot rolled rod after it leaves the finishing roll pass at a temperature in the neighborhood of 1800° F., briefly water-cooling the rod to a temperature above 1500° F., eliminating residual water from the rod surface, forming the rod into a coil, conveying the coil in a step-by-step movement to a first position for inspection, advancing the coil to a second position, covering the top of the coil, blowing air laterally through the convolutions of the coil until the temperature of the coil is reduced at least to 1100° F., removing the covering from the coil, and then conveying the coil for further cooling.

3. The method of cooling ferrous rods which

6

comprises taking a hot rolled rod after it leaves the finishing roll pass at a temperature at least as high as the critical range, initially water-cooling the rod to substantially 1500° F., forming the rod into coils, conveying each coil in a step-by-step movement, covering the top of the coil, and then while the coil is in a stationary position blowing air from the inside of the coil laterally through the convolutions of the coil until the temperature of the coil is reduced to approximately 1100° F.

4. An apparatus for cooling hot ferrous rod comprising a reel whereby the rod is formed into a coil, a conveyor whereon the coil is moved, means responsive to arrival of said coil at an intermediate position for automatically stopping the conveyor, means operable by the stopping of the conveyor to apply a cooling medium to the coil, and means operable by resumed movement of the conveyor to divert the cooling medium from the coil.

5. An apparatus for cooling hot ferrous rod comprising means for forming the hot rod into a coil, associated means for advancing the hot rod coil, means for stopping the coil at an intermediate position, means for placing a lid on the coil, means for blowing air upwardly and outwardly through the coil, means for removing the lid from the coil, and means for resuming the advance of the coil to discharge position.

6. An apparatus for cooling hot ferrous rod comprising pairs of conveyors extending parallel with the line of delivery of the rod, an independent coiling device associated with each conveyor, a blower for each pair of conveyors, a pair of ducts connected to said blower, each duct having an outlet beneath a conveyor of said pair, a vertically reciprocable lid above each outlet, a damper in each duct, and coacting means actuated when a rod coil is positioned above the outlet to lower the lid thereon and open the damper to blow air through the coil.

7. An apparatus for cooling hot ferrous rod comprising a plurality of pairs of conveyors extending parallel with the line of delivery of the rod, an independent device associated with each conveyor for forming the rod into a coil, a casing enclosing said conveyor and coiling device, a flap door closing each conveyor from its coiling device, a grating beneath each conveyor, a movable lid above each grating, a blower for each pair of conveyors, ducts connecting said blower to the gratings of said pair of conveyors, a damper in each duct, and automatic means to lower the lid and open the damper when a coil is positioned on the conveyor directly above the grating.

8. An apparatus for cooling hot ferrous rods comprising means for rolling the rod, means for initially cooling the rod with water immediately after the rolling operation, reeling means for coiling the rod, a conveyor electrically controlled for imparting a step-by-step movement to the coil, a lid adapted to be lowered to cover the coil while the coil is held stationary on the conveyor, means for blowing air into the center of the coil to force the air under pressure laterally through the convolutions of the coil, and automatic means electrically controlled for raising and lowering the lid.

9. An apparatus for cooling a hot rolled ferrous rod comprising means for initially cooling the rod with water immediately after the rolling operation, a reeling device for coiling the rod, means for lowering and raising the reeling device after the coiling operation, a conveyor electrically con-

7

trolled for imparting a step-by-step movement to the coil, a lid adapted to be lowered to cover the coil while the coil is held stationary on the conveyor, means for blowing a blast of air into the center of the coil to force air under pressure laterally through the convolutions of the coil, means electrically controlled for automatically raising and lowering the lid, means for holding the conveyor stationary when the lid is lowered, and means for discharging the coil from the conveyor.

10. An apparatus for cooling hot ferrous rod comprising pairs of conveyors extending parallel with the line of delivery of the rod, an independent coiling device associated with each conveyor for coiling the rod, electrically controlled means for imparting a step-by-step movement for each conveyor, a trough for each conveyor having a bottom wall, a blower for each pair of conveyors, a pair of ducts connected to said blower, each duct having an outlet in the bottom wall of the trough beneath a conveyor of said pair, a vertically reciprocable lid above each outlet, a damper in each duct, and coacting means electrically actuated when a rod coil is positioned above the outlet to lower the lid thereon and open the damper to blow air into the center of the coil and forcing the air under pressure laterally through the convolutions of the coil.

11. An apparatus for cooling hot ferrous rod,

8

comprising a plurality of pairs of conveyors extending parallel with the line of delivery of the rod, an independent coiling device associated with each conveyor for forming the rod into a coil, a casing having a bottom wall enclosing each conveyor and coiling device, electrically controlled means for imparting a step-by-step movement to each conveyor, a grating in the bottom wall of the casing of each conveyor, a movable lid above each grating, a blower for each pair of conveyors, ducts connecting said blower to the gratings of said pair of conveyors, a damper in each duct, and automatic means electrically actuated to lower the lid and open the damper when a coil is positioned on the conveyor above the grating.

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