March 19, 1963 R. E. BALLENTINE ETAL 3,081,524

SCALE BREAKING APPARATUS FOR DRAWN WIRE

Filed May 17, 1957 3 Sheets-Sheet 1

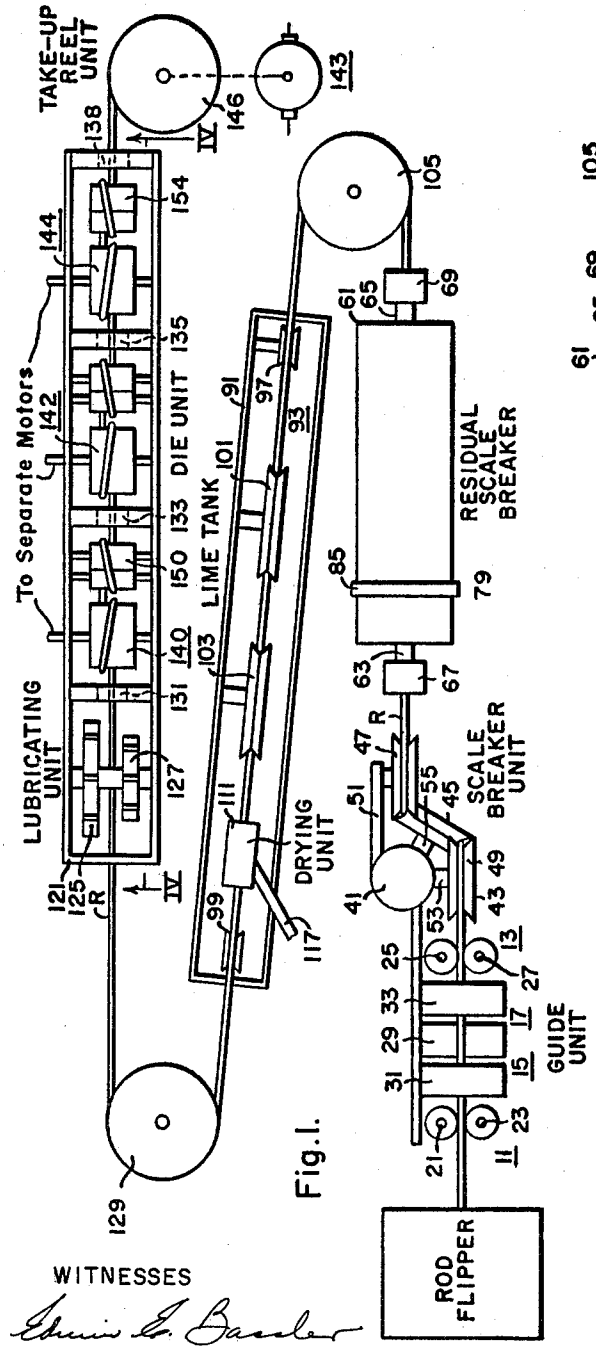

Fig. 1.

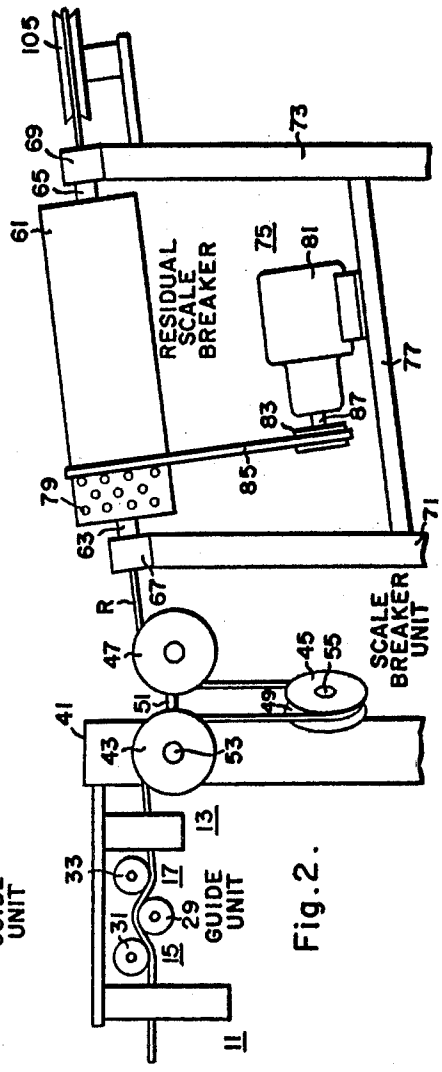

Fig. 2.

WITNESSES

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SCALE BREAKING APPARATUS FOR DRAWN WIRE

Filed May 17, 1957

3 Sheets-Sheet 2

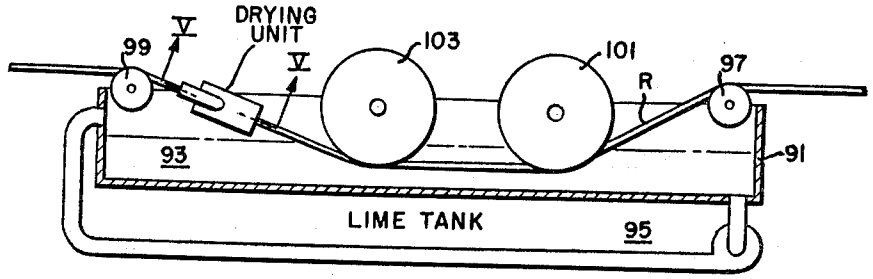

Fig.3.

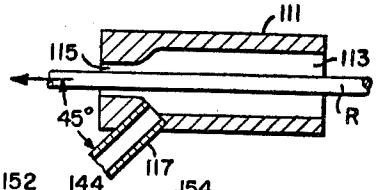

Fig.5.

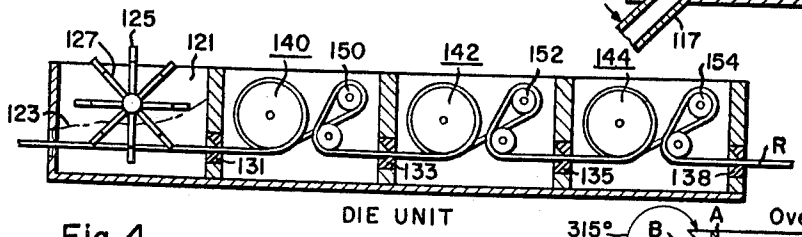

Fig.4.

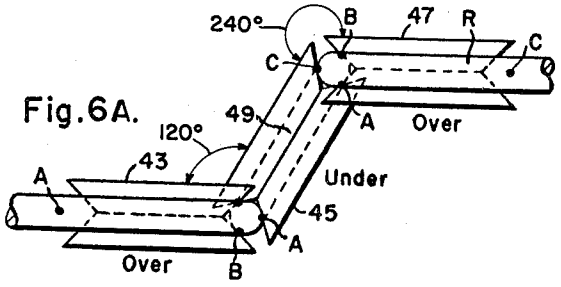

Fig.6A.

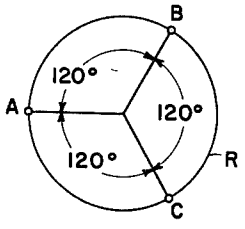

Fig.6B.

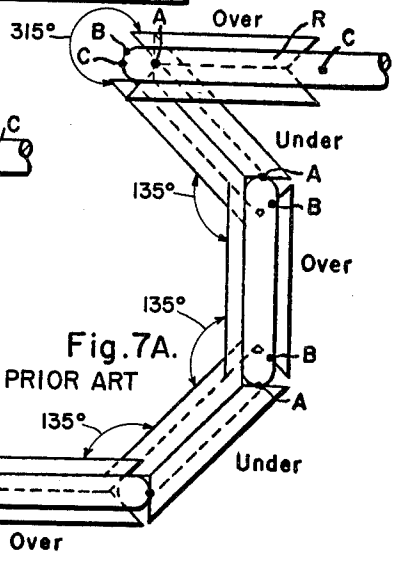

Fig.7A.
PRIOR ART

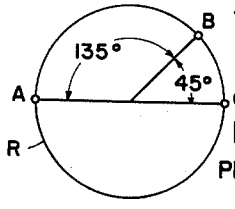

Fig.7B.
PRIOR ART

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SCALE BREAKING APPARATUS FOR DRAWN WIRE

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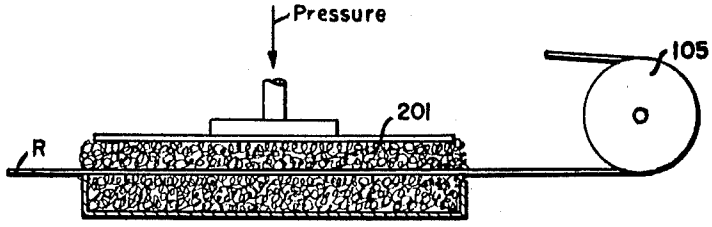

Fig.8.

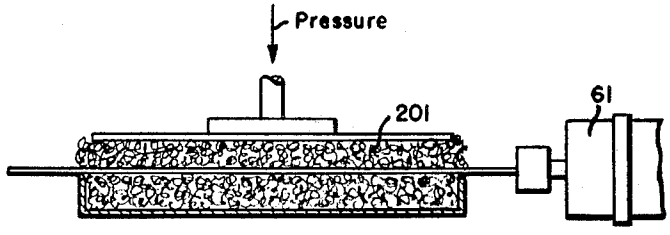

Fig.9.

United States Patent Office 3,081,524 Patented Mar. 19, 1963

3,081,524

SCALE BREAKING APPARATUS FOR DRAWN WIRE

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Filed May 17, 1957, Ser. No. 659,817
3 Claims. (Cl. 29—81)

This invention relates to the art of drawing rod into wire of desired dimensions and has particular relationship to the drawing of hot-rolled rod. Specifically, this invention concerns itself with the drawing of rod for cores for flux-coated arc-welding electrodes. In the following discussion, the raw material which is drawn will be referred to as "rod" and the final product as "wire."

An important problem which arises in the drawing of hot-rolled rod is the removal of the scale from the rod. In accordance with the teachings of the prior art, the scale is removed by pickling in an acid bath. To neutralize the acid, the pickling rod is then dipped in a hot-lime bath preparatory to the drawing operation. This prior art practice is excessively costly and there have been attempts to reduce the cost by providing mechanical descalers in place of the above-described chemical descalers. These attempts have not been successful resulting in drawn wire of mediocre or poor quality.

It is accordingly broadly an object of this invention to provide low-cost apparatus for drawing rod into wire at high speed.

It is another object of this invention to provide apparatus including mechanical descaling means for drawing rod into wire at a low unit cost and it is a further object of this invention to provide such apparatus through which the rod passes continuously and as it passes is descaled and prepared for the drawing.

In a drawing operation the rod passes from a pay-off reel or rod flipper to a take-up or storage reel. The take-up reel is power-driven and pulls the rod through the components of the drawing apparatus. The prior art drawing apparatus includes principally guiding means in the form of rollers or a die, a mechanical descaler which may break the scale by flexing the wire and at least three, and usually more than three, drawing dies. It has been found that mechanical descalers of the prior art types do not remove the scale entirely and it is necessary that the rod be passed through a lubricant, so that the drawing dies may not be scored by the residual scale. The lubricants used in the prior art drawing apparatus are of the powdered (soap) type.

In its broader aspects, this invention arises from the discovery that the poor quality of the wire produced with the prior-art drawing apparatus including mechanical descalers is to a large extent caused by the properties of this lubricant. Soap type lubricants adhere to the rod as it passes through the dies and the resulting product is highly contaminated with lubricant.

It is then a specific object of this invention to provide drawing apparatus including mechanical descaling means which shall include facilities for so treating the rod as to permit the use of petroleum grease lubricants similar to those used in bright drawing the rod which, in accordance with the teachings of the prior art, is pickled and limed.

In accordance with a specific aspect of this invention, the rod, after being mechanically descaled, is passed through a wet lime bath at a moderately elevated temperature and then dried. It has been discovered that mechanically descaled rods so treated lends itself to the use of a bright drawing lubricant such as petroleum grease. Specifically, the mechanical descaling may include one

step in which a large part of the scale is removed by flexing the rod and a second step in which the residual scale is removed before the rod is treated with wet lime.

The motion of the rod as it leaves the supply means, particularly where it is a rod flipper, is highly irregular and it is probably in an attempt to suppress this irregularity that die-type guides are used in accordance with the teachings of the prior art. But such guides have proved unsuccessful and it is another specific object of this invention to provide guide means for effectively guiding the rod as it passes into the drawing line from supply means even where such means is a rod flipper.

The specific aspect of this invention involving the guiding of the rod arises from the realization that the tension introduced by a guide of the die type is excessive. It has been found that the cumulative action of the guiding die, the descaling flexing means and the several drawing dies is to impress such high tension on the rod as to prevent the effective drawing of the rod at the high speeds demanded by modern industry. In accordance with this invention, guides of the roller type which restrict the rod from moving laterally in at least two degrees of freedom are provided. The guiding rollers are so spaced that the tension impressed by them on the rod is inappreciable.

The mechanical descaling is effected in accordance with this invention by passing the rod over sheaves arranged in a predetermined manner. It has been found in arriving at this invention that the effective descaling takes place as the rod is bent around the sheaves. At each bend, the fibers of the rod most remote from the center of curvature of the bend are tensioned and it is the scale overlying these tensioned fibers which is broken away. In accordance with this invention, the sheaves are so relatively positioned that different circumferential portions uniformly spaced around the cross section of the rod are tensioned by each of the sheaves. Specifically, three sheaves each having a groove engaged by the wire are provided. The sheaves are at different levels and the planes of the grooves of the first and second sheaves are displaced by an angle of approximately 120° and the planes of the grooves of the second and third sheaves are displaced at an angle of approximately 240°. The effect of this displacement is to cause the scale to break away along arcs displaced by 120° around the periphery of the cross-section of the rod.

Further, the grooves have a diameter of substantial magnitude. This assures effective breaking of the scale and prevents excessive tension from being impressed on the rod.

The residual scale is removed by passing the rod after it is treated by the sheaves through a container in which limestone is rubbed against the surface of the rod. The rubbing is effected by rotating the container. The axis of the container is at a substantial angle to the horizontal with the rod exit opening above the rod entrance opening. Thus, jamming of the rod by the limestone at the exit is avoided. In addition at least the lower part of the container has openings through which loose scale may be ejected.

The novel features considered characteristic of this invention are disclosed generally above. The invention itself, both as to its organization and its method of operation together with additional objects and advantages thereof will be understood from the following description of a specific embodiment when read in connection with the accompanying drawings in which:

FIGURE 1 is a view in top elevation of drawing apparatus or a drawing line in accordance with this invention;

FIG. 2 is a view in side elevation of the portion of the drawing line of FIG. 1 showing the guide and the mechanical scale breaker;

FIG. 3 is a view in side elevation of the portion of the

drawing line of FIG. 1 showing the lime tank and the drying unit;

FIG. 4 is a view in section taken along line IV—IV of FIG. 1;

FIG. 5 is a view in section taken along line V—V of FIG. 3;

FIGS. 6A and 6B are diagrams showing the manner in which the rod passes around the scale breaker sheaves in the practice of this invention;

FIGS. 7A and 7B are diagrams showing the manner in which the rod passes around scale breaker sheaves in accordance with teachings of the prior art;

FIG. 8 is a fragmental view showing a modification of this invention; and

FIG. 9 is a fragmental view showing a further modification of this invention.

The apparatus, in accordance with the invention, includes a Rod Flipper, a Guide Unit, a Scale Breaker Unit, a Residual Scale Breaker, a Lime Tank, a Drying Unit, a Lubricating Unit, a Die Unit and a Take-Up Reel Unit. The Take-Up Reel Unit is driven and the rod R is pulled by the Reel continuously from the Flipper in succession through the Guide Unit, the Scale Breaker Unit, the Residual Scale Breaker, the Tank, the Lubricating Unit and the Die Unit. While the apparatus as shown includes a Rod Flipper, apparatus in which a pay-off reel is included instead of a Rod Flipper is within the scope of this invention.

The Rod Flipper may be of any type available in the art.

The Guide Unit includes a plurality of pairs 11, 13, 15 and 17 of rollers. Two rollers of two pairs 11 and 13 are oppositely disposed with their axes 21 and 23 and 25 and 27 defining a pair of parallel planes. The other pairs 15 and 17 include a single roller 29 cooperative with rollers 31 and 33 on both sides of it. The axes of the pairs 29 and 31 and 31 and 33 define planes at an angle to each other and substantially at right angles to the planes defined by the axes 23 and 25 and 25 and 27. The rod R is passed from the Rod Flipper between the rollers of the pairs 11, 13, 15 and 17. The rollers suppress lateral movement of the rod in two directions and thus the irregularities introduced by the Flipper are suppressed. The rollers do not appreciably restrain the rod R and thus do not introduce appreciable tension.

The Scale Breaker Unit includes a post 41 from which a plurality of sheaves 43, 45, 47 are rotatably suspended at different levels. Each of the sheaves 43, 45, 47 includes a groove 49 for receiving the rod R. Two of the sheaves are suspended from pins 51 and 53 secured in the upper portion of the post; the other from a pin 55 below the first-mentioned rods. The planes defined by the grooves 49 are angularly displaced with reference to each other. The planes of the grooves 49 of the first and second sheaves 43 and 45 are at an angle of 120° to each other, and the planes of the second and third sheaves 45 and 47 are at an angle of 240° to each other. The rod R is passed in succession through the grooves of the sheaves, as viewed from FIG. 1, passing over the groove 49 of the first sheave 43, under the groove 49 of the second sheave 45 and over the groove 49 of the third sheave 47.

The Residual Scale Breaker includes a limestone box in the form of a cylindrical drum 61 filled with limestone particles (not shown). Stub shafts 63 and 65 having central longitudinal openings are secured centrally in the bases of the drum 61 in any well-known manner. The stub shafts 63 and 65 run in bearings 67 and 69 mounted on opposite frames 71 and 73 of a support 75. The support includes a platform 77 between the frames 71 and 73. The frame 73 is higher than the frame 71 and the drum 61 is thus suspended at a small angle of the order of about 10° to the horizontal. The bearings 67 and 69 are properly inclined so that they are properly engaged by the stub shafts 63 and 65. The drum 61 has openings 79 at least in the lower part of its wall. On the platform 77 a motor 81 is mounted; this motor is connected to drive the drum 61 through a pulley wheel 83 and a belt 85. The platform 77 is mounted at an angle to the horizontal so that it is parallel to the axis of the drum 61 and the motor 81 is so mounted on the platform that its shaft 87 is parallel to the axis of the drum.

The Residual Scale Breaker is disposed adjacent to the Scale Breaker Unit with the lower frame 71 nearest the Scale Breaker Unit. The rod R from the Scale Breaker Unit passes through the openings in the shafts 63 and 65 and through the limestone in the drum 61. During the drawing operation, the drum 61 is rotated and the limestone container rubs against the rod R removing residual scale. The rotation prevents the limestone from channeling. The inclination of the drum 61 prevents the limestone from jamming the exit end of the drum. The scale removed by the limestone tends to settle in the forward end of the drum 61 and falls out of the openings 79. The tendency of the container to fill up with scale (iron oxide, Fe_3O_4) is thus avoided.

The Lime Tank includes a container 91 within which there is a high concentration suspension of lime 93. The proportion of lime by weight should preferably be between 10 to 25%. The lime suspension is maintained at a temperature of about 200° F. The lime suspension is maintained in continuous circulation by a pumping system 95.

The Lime Tank includes inlet and outlet sheaves 97 and 99 of small diameter and sheaves 101 and 103 of larger diameter for guiding the rod R through the lime 93. The sheaves 101 and 103 may be provided with paddles (not shown) for stirring the lime 93. The Lime Tank is disposed adjacent the Scale Breaker Unit and the Residual Scale Breaker. The rod R is passed from the shaft 65 over a sheave 105 which reverses its direction and then into the Tank.

The Drying Unit is disposed between the sheave 103 and the outlet sheave 99. This Unit includes a venturi tube 111 (FIG. 5) having a central opening 113 with a constriction 115 near the exit end. The rod passes through this central opening 113—115. The opening 113—115 is supplied with hot air through a tube 117 which is in communication with the opening 113. The tube 117 is at an angle of about 45° to the axis of the opening 113 and is inclined in the direction of the movement of the rod R. The hot air projected through tube 117 flows along the rod R oppositely to its direction of movement and not only dries the lime on the rod but also removes any excessive lime from its surface. The amount of lime to be removed may be set by setting the velocity of the hot air supplied.

The Lubricating Unit includes a container 121 within which a lubricant 123, which should preferably be a petroleum grease, is provided. The lubricant is stirred by paddle wheels 125 and 127 which are rotated from a suitable drive and maintain the lubricant in circulation and prevent the channeling of the rod R in it. The direction of motion of the rod R is reversed by a sheave 129 as it passes from sheave 99 into the Lubricating Unit.

The Die Unit includes a plurality of drawing dies 131, 133, 135 and 138. The lubricated rod R is advanced successively through each of the dies 131, 133, 135, 138 by capstans 140, 142, 144 and 146 respectively. The capstans 140 through 146 operate at progressively higher speeds which are controlled by impedances (not shown) actuated by dancers 150, 152, 154.

In the use of the apparatus the rod R is threaded through the apparatus and secured to the capstans 140 through 146. The drives for the capstans are then energized and thereafter the rod R continues to move at a high speed through the apparatus and a clean wire is wound on the storage capstan 146. In using this invention, it has been found that hot-rolled rod may be drawn into wire of the desired dimensions at a high speed.

The sheaves 43, 45, 47 of the Scale Breaker Unit cooperate to break the scale away from the surface of the rod by bending the rod. When the rod is bent by any sheave, the part of the rod most remote from the groove 49 in the sheave is tensioned and the part in contact with the groove is compressed. The stress in the rod varies continuously from compression to tension through a center plane of zero stress. It has been discovered that when the rod R is bent by the sheaves 43, 45, 47 in accordance with the invention, the scale is broken away over the portion of the surface of the rod which is in tension. In FIG. 6 the path of the rod through the sheaves 43, 45, 47 is plotted. It is seen from this view that the center of regions of the surface of the rod from which the scale is broken away as it is bent over each of the sheaves are uniformly displaced around the periphery of the cross section of the rod, the centers A, B, C, correspond to the three sheaves being displaced by 120°.

In FIG. 7 a corresponding diagram for a scale breaker unit typical of the prior art is shown. It is seen that in this case the center B of the region over which the scale is broken away by the second sheave is displaced by 45° with reference to the center A for the first sheave, the center A for the third sheave corresponds to the center for the first sheave, the center B for the fourth to the center B for the second, and the center C for the fifth sheave is displaced 135° with reference to the center B for the fourth sheave. The breaking is then not uniform. In addition the sharp reverse bend between the fourth and fifth rods in FIG. 7A would tend to trap the scale rather than remove and would introduce excessive tension in the rod.

In the modification shown in FIG. 8, the residual scale is removed by a mass 201 of steel wool to which pressure is applied rather than by a lime-stone box (61).

In the modification shown in FIG. 9, the steel wool 201 is used together with the box 61.

The following summary of the principal features of the invention may help in the understanding thereof.

It has been common practice for a number of years to remove the scale from hot-rolled steel rod by "pickling" in an acid bath. The rod is subsequently dipped in a hot lime bath and dried in preparation for drawing to wire sizes.

More recently, a practice called "dry descaling," involving the breaking off of scale by bending the rod around rollers, has been used by a few manufacturers for some types of wire products. A number of descaling machines have been built for this purpose but to date all have definite limitations in the quality of the drawn wire produced.

Since there is always a small amount of scale left on the rod after the dry descaling method is used, it has been necessary to use one of the powdered (soap type) lubricants to avoid scoring the drawing dies. Since these lubricants carry through the dies excessively, the resulting product is relatively dirty and contaminated with the lubricant.

In accordance with the invention the rod is descaled and limed for drawing to wire sizes with the same lubricants (petroleum lubricants) as is used to bright draw pickled and limed rod. In accordance with this invention also the rod is mechanically descaled and limed so that it may be drawn at high speeds, with a minimum of die wear, and so that wire of a quality equal to pickled and limed wire is obtained.

This invention includes an improved descaling device plus an integral hot lime bath set up directly ahead of the drawing unit so that the process is continuous.

The descaling device (FIGS. 1 and 3) includes a series of seven guide rolls 11, 13, 15 disposed so as to impart enough tension to the rod R to hold it in the main scale breaker rolls 43, 45, 47 without the use of a conventional oversize guide die which has a tendency to score the rod. The main scale breaker rolls 43, 45, 47 are in accordance with the preferred practice of this invention about 4 inches in diameter and placed at angles of 120° and 240° respectively so as to break the scale in three different arcs around the rod.

Contrary to prior art teaching, it has been found that the stretching of the rod R in the scale breaker rolls 43, 45, 47 tends to trap scale rather than loosen it. For this reason, the diameter of the rolls 43, 45, 47 must not be too small or the severity of the bends too great.

Various devices have in accordance with the teachings of the prior art been in common use for removing part of the remaining scale on the rod R after it has passed through the Scale Breaker Unit. Wire brushes, limestone boxes, boxes of steel balls, magnetic and vibration devices have all been tried with varying degrees of success. The simplest of these is the limestone box, but the prior art boxes had the disadvantage of filling up with loose scale after a period of time and some of this scale is invariably carried through the dies. The rod also had a tendency to channel through prior art boxes reducing the efficiency of the device.

In accordance with this invention, the limestone drum 61 is rotated and has holes 79 in one end to allow the scale to drop out. The rotation of the drum 61 at the same time prevents channeling and greatly improves the efficiency of loose scale removal. It was further found important to slant this rotating drum 61 to the horizontal by an angle of about 10° to 30° so that the rod R will not have a tendency to jam with the stone particles at the exit end of the drum.

Pickled wire is always dipped in a hot lime solution to neutralize the effects of the acid and to aid in the pickup of drawing lubricants.

In arriving at the invention, it has been found that although it is not necessary to neutralize unpickled wire limed descaled wire has advantages in that the lime combined with the improved descaling permits the use of bright-grease type lubricants. These have much less carry through in the draw dies and the resulting product is clean and relatively free of harmful lubricant.

To take advantage of the dry descaling economy the whole process is continuous, and includes a hot lime bath (Lime Tank) and an air drying device (Drying Unit) immediately after the rotating limestone drum 61. A sheave 105 is used to change the direction of the rod R; this sheave is large enough (approx. 12 inches dia.) not to introduce excessive tension in the rod. The solution is relatively high in lime (10 to 25%) and is kept at a moderately elevated temperature of about 200° F. The rod R is passed through the lime suspension for sufficient time to reach a temperature at which the lime will dry before the rod R reaches the first die 131 of the Die Unit. This drying is aided through the use of a heated air jet which not only helps dry the rod but also, by varying the air volume, controls the thickness of lime coating on the rod.

Since lime has a tendency to settle out of suspension a pump unit 95 to recirculate the lime suspension continuously taking the thick suspension from the bottom of the container 91 and pumping it up to the top is provided. This object can also be accomplished by paddle wheels, or other devices could be used, the important requirement being that the lime is not allowed to settle out.

After liming the wire is then passed around a sheave 129 preferably about 30 feet from the Die Unit and Lime Tank back to the first die 131. Since the rod R is under tension going into the Lubricating Unit and the first die 131, it will channel through the grease type lubricant unless some device is used to prevent this. In accordance with the invention a set of paddle wheels 125 and 127 are provided in the lubricant container 121 to keep the lubricant in continuous motion and effectively prevent channeling. These are preferably rotated at about 20 to 30 r.p.m. and in a direction so as to push the lubricant toward the die 131 and over the rod R.

It should be noted that at no place in the apparatus is the descaled rod heated directly. Heat is gained by working the rod R in the breaker rolls 43, 45, 47 by dipping in the hot lime bath 93 and by the heated air jet 117, sufficiently to allow fast drying of the lime on the rod.

It is important that the rod R be kept as cool as practicable to prevent excessive die wear from overheating. A proper balance of heat and drawing speed is essential if the line is to dry and the rod still be comparatively cool on entering the first die. In accordance with this invention this balance is effectively and readily controlled through adjustment of the lime ratio in the bath and the heated air jet.

In general, this invention includes an improved Scale Breaker Unit with guide rolls 11, 13, 15 to replace guide dies. Preferably three main 4 inch breaker rolls 43, 45, 47 placed at 120° and 240° angles are used, a tilted rotating limestone drum 61 is used for removal of residual scale. This invention also includes integrated with the just described apparatus a hot lime bath and heated air jet for drying the rod R without excessive heating of the rod and there is provided also means for stirring the drawing lubricant 123 to insure even lubrication of the rod for drawing with the bright greases.

While a preferred embodiment of this invention has been disclosed herein, many modifications thereof are feasible. This invention then is not to be restricted except insofar as is necessitated in the spirit of the prior art.

We claim as our invention:

1. Apparatus for removing scale from rod comprising in combination a plurality of sheaves, each sheave having a groove for receiving said rod and means mounting said sheaves so that said rod is capable of passing through the grooves of said sheaves in succession, the plane of said groove of a second of said sheaves in said succession being at an angle of about 120° to the plane of said groove of a first of said sheaves in said succession and the plane of said groove of a third of said sheaves in said succession being at an angle of 240° to the plane of said groove of the second of said sheaves in said succession.

2. Apparatus for removing scale from rod comprising in combination at least three sheaves, each sheave having a groove for receiving said rod and means mounting said sheaves so that said rod is capable of passing through the grooves of said sheaves in succession, the planes of said grooves of said sheaves being so related to each other that said rod is engaged by the center circles of said grooves of different sheaves at different points on the periphery of the cross section of said rod, said points being uniformly distributed around the whole periphery of said cross section, whereby regions at different points uniformly spaced around the whole periphery of said rod are subjected to tensional scale breaking stress.

3. Apparatus for removing scale from rod comprising in combination at least three sheaves, each sheave having a groove for receiving said rod and means mounting said sheaves so that said rod is capable of passing through the grooves of said sheaves in succession, the diameter of said grooves being of substantial magnitude and the planes of said grooves of said sheaves being so related to each other that said rod is engaged by the center circles of said grooves of different sheaves at different points on the periphery of the cross section of said rod, said points being uniformly distributed around the whole periphery of said cross section, whereby regions at different points substantially uniformly spaced around the whole periphery of said rod are subjected to tensional scale breaking stress.

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