July 2014

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J. H. Hitchcock

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Oval Repeaters and Twist Guides

This memorandum is intended to put on record the observations of Myles Morgan and others regarding the behavior of oval sections in repeaters, and the reasons which underlie the observations. Experience demonstrates that there is a preferred direction of twist for an oval section which is about to enter a repeater. In a repeater which curves to the right in the direction of motion, the twist which brings the oval from horizontal to vertical position should be made in a clockwise direction when viewed in the direction of motion. Conversely, in a repeater which curves to the left in the direction of motion, the direction of twist on the entering oval should be counterclockwise when viewed in the direction of motion. This is the direction employed in both repeaters of the Nettlefolds rod mill, in the second repeater of the Templeboro rod mill, the first repeater of the Nettlefolds merchant mill, and the first repeater of the Templeboro rod mill, as shown on Eric Fors' sketch dated 23 April 1948. This sketch indicates that twist in the opposite direction is employed in the first repeater of the Jarrow merchant mill, the second repeater of the Columbia rod mill, and the second repeater of Bethlehem No. 2 rod mill at Sparrows Point.

The attached illustration and the following comments suggest the reasons for this preference, and also demonstrates that the angle of twist per unit length of section is an important factor in the successful repeating of oval sections. Here are shown three successive sections through the groove of a repeater which curves to the right in the direction of motion. In the three views of column A, successive positions are shown of an oval section which approaches the repeater with a clockwise twist, which is the preferred direction. The oval section at its first contact with the repeater should not yet have reached in the progress of twist a position in which the long axis of the oval is vertical. This permits the sloping side wall on the early break out section of the repeater curve to make contact with the flat side of the oval, where it can initiate the curve of the bar around the repeater without forcing the front end of the bar upward out of the repeater groove to any serious extent. As the front end of the bar proceeds around the repeater curve, the long axis of the oval approaches more nearly to the vertical, and in this zone the overhanging lip of the repeater restrains the bar from jumping out. The angle of twist which the twist guides have imparted to every foot of the bar must cause the bar to continue twisting until forces are developed in the repeater groove which remove the twist imparted by the twist guide. In section 3 of column A the oval section is shown with its long axis beyond the vertical position. In this position centrifugal force acting on the center of the bar, and opposed by the bottom of the oval and the lower outside corner of the repeater groove, straightens out the twist imparted by the twist guides and carries the oval around the rest of the repeater curve in a vertical position.
In column B are shown three similar views of an oval section in which the opposite direction of twist is employed. Here the bottom of the oval, rather than the side, makes first contact with the sloping wall in the break out section of the repeater groove, so that the front end of the bar can easily climb up the sloping wall rather than being persuaded around the curve of the repeater. If the front end of the bar passes the break out section safely, proceeding under the overhanging lip on the outside of the repeater groove, as shown in part 2 of column B, the front end is then confined, but there will still be a part of the bar in section 1, pressing with its bottom against the sloping wall, and endeavoring to break out against the frictional restraint to motion of the leading parts of the bar. If the front end passes safely into the later portion of the repeater curve, the long axis of the oval again tends to twist beyond the vertical position, as shown in section 3 of column B. Here the combination of centrifugal force and side wall restraint again tend to remove the twist, as in section 3 of column A, but here the conditions are somewhat less favorable because of the frictional restraint of the groove on the bottom of the bar and because contact at the top of the bar is limited to a vertical side wall instead of the lower corner fillet which acts in section 3A. Experience in several mills has demonstrated that the direction of twist shown in column B is extremely troublesome whereas the direction illustrated in column A is successful almost without exception.

An important exception to the successful performance of the twist direction shown in column A was found at Algoma, and this experience illuminates another factor of extreme importance in the successful repeating of ovals. At Algoma the articulated plugs which were used as twist guides were first installed to place the long axis of the oval in a vertical position at the point of delivery from the plugs, rather than at the entrance to the repeater groove. Although the direction of twist was as shown in column A, the front end of the bar had entry into the repeater groove at the position shown in section 1 of column B. With this arrangement, it was impossible to carry the front end of even one bar around the repeater. After readjustment of the articulated plugs to reduce the angle of twist, so that the front end of the bar was in the position shown in 1A at entrance to the repeater groove, the ovals traveled around the repeater admirably. This experience demonstrates that even when the correct direction of twist is employed, the angle of twist must be properly adjusted for satisfactory results.

J.H. Hitchcock

JHH/gj

M. Morgan
J. O'Malley
R. Kinnicutt
W. Hill
W.W. Knight
1) \[ \text{Clockwise Twist} \]
   \[ \text{R.H. Repeater} \]

2) \[ \text{Counter Clockwise Twist} \]
   \[ \text{L.H. Repeater} \]

3) \[ \text{Clockwise Twist} \]
   \[ \text{R.H. Repeater} \]

4) \[ \text{Counter Clockwise Twist} \]
   \[ \text{L.H. Repeater} \]