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Drahtherstellung

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Straightening of steel wire according to the direction of drawing

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The moving direction of steel wire in a straightening unit has an effect on straightening quality. This paper explains not only theoretical considerations (microstructural investigations) but also tests on various wires with a 7 roll straightening unit. The straightening results varied according to the wire's direction in the straightening unit. For a majority of the investigated roll adjustment settings the quality of straightening was better in drawing direction (production direction) than in the opposite direction.

1 The direction of wire during drawing and straigthening

The investigations to be described below were set out to determine what effect a wire's direction of drawing has on the quality of straightening in a straightening device.

The fundamental question is: Does straightening in the direction of drawing (production direction) bring any advantages for the quality of straightening? To answer this question, theoretical considerations were followed by tests on steel wires.

2 Theoretical considerations

2.1 Directed wire drawing

Wire is transformed to its required final diameter on drawing machines. After the last drawing pass the wire is wound onto reels or laid in coils in drawing direction (fig. **1**).

Before further processing, steel wire normally is to be straigthened. Using coiled wire it is possible, by noting the arrangement of the wire loops, to straighten the wire either in the direction of drawing or in the opposite direction to drawing. For straightening in the opposite direction to drawing the end of the wire coil is inserted in the straightening device; for straightening in the direction of drawing the beginning of the wire (fig. **1**) is inserted and processed.

Wire on a reel is processed in opposite direction to drawing, unless it is rewound.

2.2 The wire's microstructure

The microstructure of the original wire is changed by the forming process. The draw ratio is derived from the quotient of the reduction of cross section area and the initial cross section area. The higher the draw ratio, the greater the grain elongation in the direction of the wire axis. Formable microstructural components (ductile ferrite crystals) follow the forces in forming direction. Brittle components (pearlite crystals) are shattered under the action of the forming force and are then aligned in drawing direction.

The formation of a drawing texture was confirmed by microstructural examinations conducted on wire. The microphotograph (fig. **2**) shows a severely elongated ferrite grain in the longitudinal microsection. Some of these grains display splits at their ends, resembling the form of a tail-fin. The direction of the wire (beginning and end of the wire) is defined by this striking phenomenon. This *tail-fin* of the microstructural components is important when straightening the wire.

3 Straightening tests

Wires of various diameters and with different material parameters which had been wound on reels were tested. A 7 roll straightening unit from the

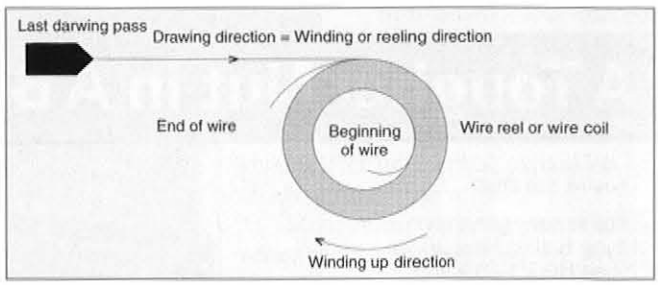
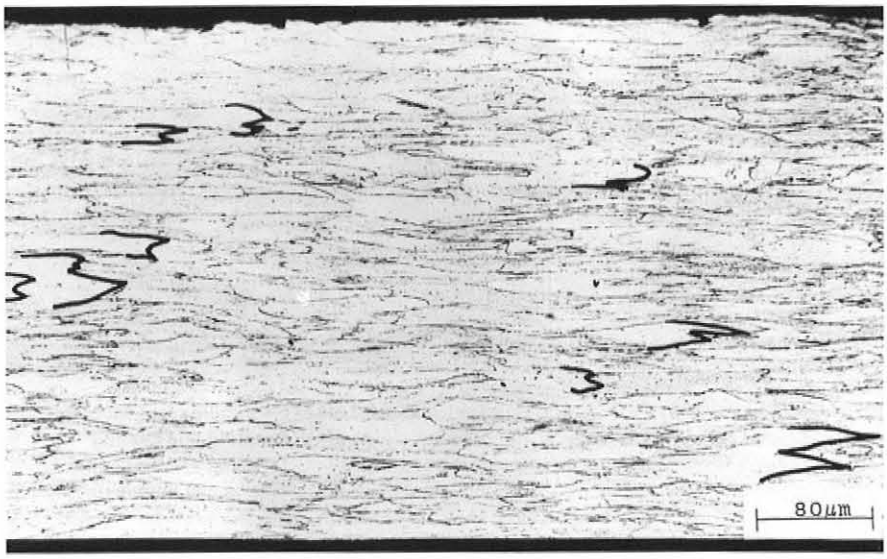


Fig. 1. Representation of drawing direction

Fig. 2. Part of the microstructure from a longitudinal section (drawing direction from right to left)



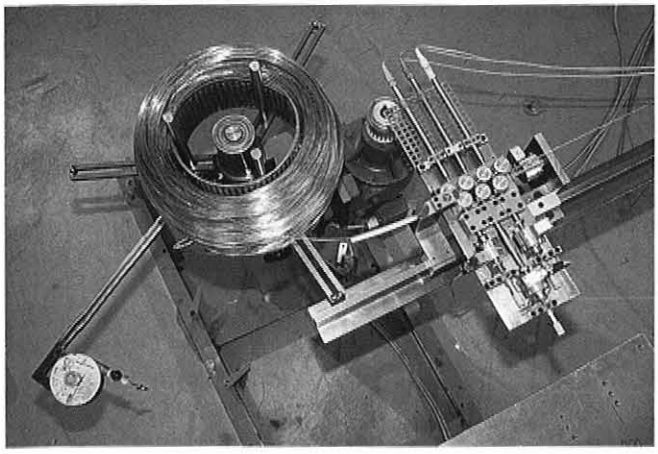


Fig. 3. Experimental constructia (Illustration reference: Witels Apparate Maschinen Albert GmbH & Co KG, D-12277 Berlin)

Witels-Albert company was used for the straightening (fig. **3** and **4**). The straightening rolls No. 2, 4, and 6 were adjusted individually. The straightened wire specimens were 1000mm long.

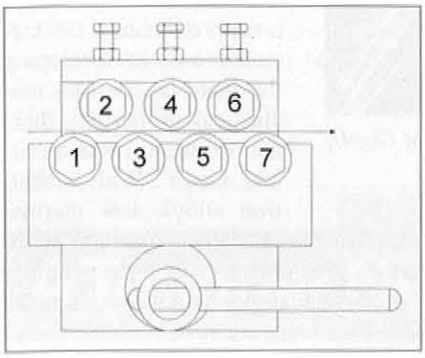


Fig. 4. Straightening unit ER 7-3 (Illustration reference: Witels Apparate-Maschinen Albert GmbH & Co. KG, D-12277 Berlin)

During the straightening tests, wire loops were wound from the reels, the beginning and the end of the wire being noted. The beginning of the wire and the end of the wire were marked. For each wire the straightening was performed with the same roll adjustment settings in drawing direction and in the opposite direction to drawing. The (residual) cambers h were measured relative to a measurement length l = 600mm (fig. **5**). A large camber means a severer residual bend and hence a poorer straightening result.

4 Better straighthening the wire in the direction of drawing

The evaluation covered those adjustment settings for which the camber of at least one of the two directions in the straightening unit was sufficiently small.

The effect of the direction in the straightening unit is evident in the varying (residual) camber. The evaluation was carried out for each wire in accordance with the following scheme:

For the same adjustment settings of the straightening unit the measured cambers in both directions were compared. This resulted in three groups:

- drawing direction is better,
- opposite direction to drawing is better, and
- no significant differences.

Fig. **6** and **7** list the test results for the wire diameters ∅ 1.07mm and ∅ 2.0mm with yield points 1000N/mm^2 and 1170N/mm^2 respectively. The figures show the advantages of straightening in drawing direction. Nearly two thirds of the adjustment settings produced better straightening results in drawing direction, where as only about one tenth of all the adjustment settings produced better straightening results in opposite direction to drawing. For the other cases there were no significant differences.

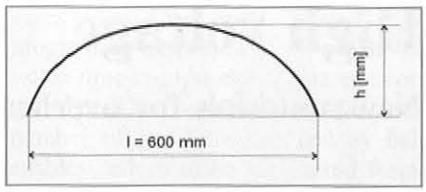


Fig. 5. Determining the camber h

5 Summary and conclusions

The straightening rests indicated that smaller cambers and hence better straightening results were achieved with a majority of the investigated adjustment settings in drawing direction. According to these findings, wires should always be further processed in drawing direction.

For wires that are difficult to straighten it is necessary to establish the direction of drawing. The wires are to be formed in this direction in the straightening unit because straightening in the direction of drawing often produces better results.

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Fig. 6. Test results of wire ∅ 1.07mm

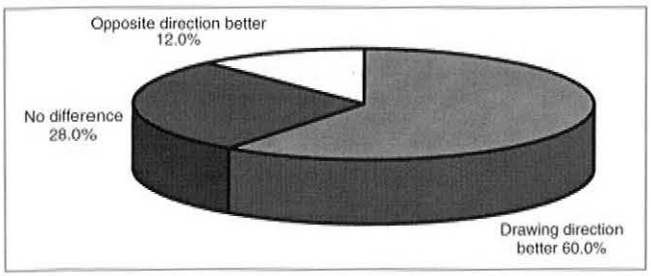

Fig. 7. Test results of wire ∅ 2.0mm