

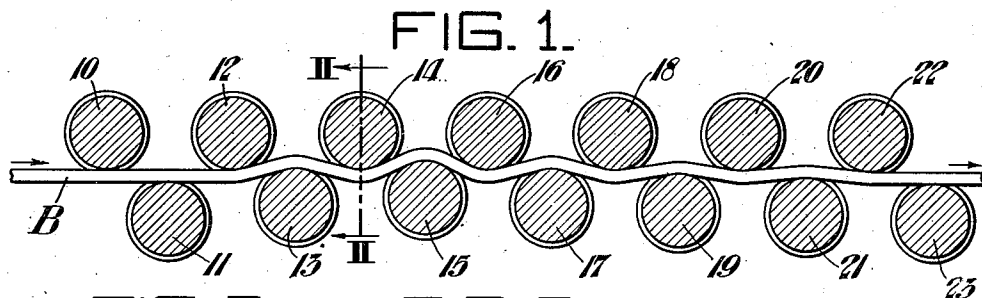
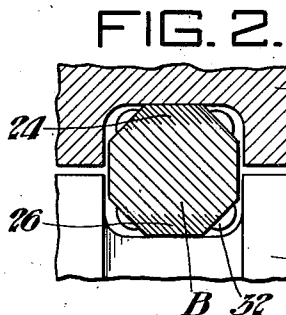
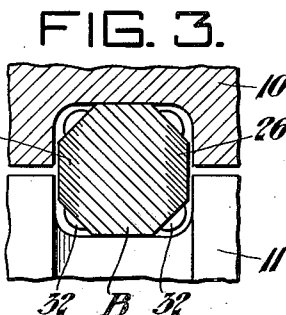
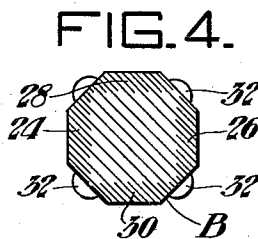
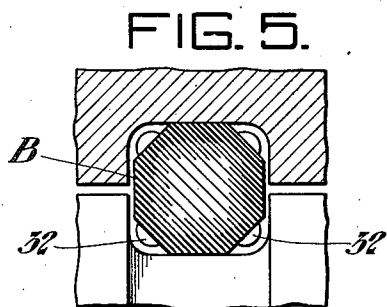
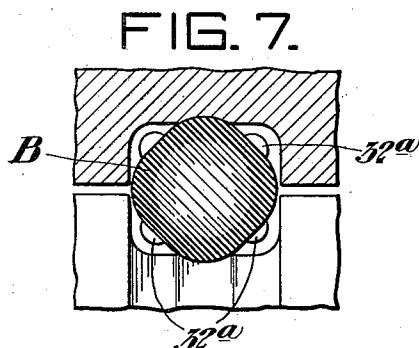
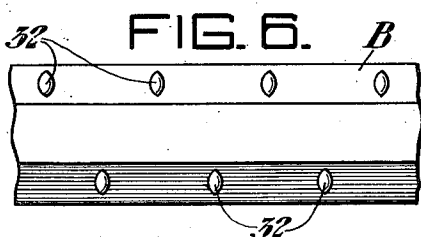
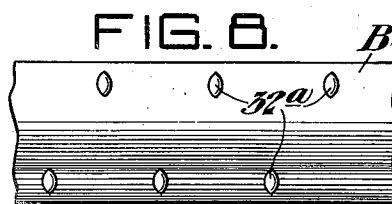
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G. G. GREULICH

2,347,904

METHOD OF COLD-WORKING METALLIC BARS

Filed July 26, 1941



Inventor:
GERALD G. GREULICH,
by *John E. Jackson*
his Attorney.

UNITED STATES PATENT OFFICE

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METHOD OF COLD-WORKING METALLIC BARS

Gerald G. Greulich, Mount Lebanon, Pa.

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4 Claims. (Cl. 153—54)

The present invention relates to improvements which, while not limited thereto, are peculiarly well suited for cold-working steel bars such as are utilized for concrete reinforcements.

Broadly stated, the invention comprises the steps of reversely bending a bar throughout its full length while advancing it longitudinally through a series of alternately staggered pairs of rolls so as to cold-work and stretch or compress the outermost fibers and subsequently partially rotating the bar substantially or approximately about its longitudinal axis and repeating said continuous reverse bending operations.

The above and more detailed features of the invention will be fully apparent from the following detailed disclosure when read in connection with the accompanying drawing and the features of patentable novelty will be defined with particularity in accordance with the requirements of the patent statutes in the appended claims.

In the drawing:

Figure 1 diagrammatically illustrates a series of roll stands arranged to reversely bend the bar at spaced points while the same is advanced longitudinally through the undulating active pass defined by the rolls of the stands;

Figure 2 represents a transverse section on line II—II of Figure 1 through the work in the process of reverse bending operation;

Figure 3 is a view similar to Figure 2 but illustrating the condition of the bar in a second series of roll stands before it has been cold-worked by the rolls illustrated;

Figure 4 is a detail section diagrammatically illustrating by means of contrasted cross hatching the result of the cold-working operation to which the bar is subjected as shown in Figures 2 and 3;

Figure 5 is a view similar to Figures 2 and 3 but illustrating by the contrasting cross hatching the condition of the fibers of the bar after the same has been subjected to more than one pass;

Figure 6 is a plan view of the bar shown in Figure 5;

Figure 7 is a view similar to Figure 5 illustrating by the contrasting cross hatching the effect of subjecting a substantially square bar to a multiplicity of reverse bending operations; and

Figure 8 is a plan view of the bar shown in section in Figure 7.

Referring in detail to the drawing, Figure 1 represents in cross section a plurality of roll stands in which the upper rolls 10, 12, 14, 16, 18, 20 and 22 cooperate with a plurality of lower rolls 11, 13, 15, 17, 19, 21 and 23 to define an undulat-

ing active pass, the effect of which is to reversely bend the bar B fed therethrough throughout its full length as the work progresses through the pass. The relationship of the rolls 11 with respect to the rolls 10 and 12 is such that as the work enters it will first be subjected to a comparatively small bending operation. As it progresses to the zone of the pass defined by the rolls 12, 13 and 14, a greater bend will be made. Thereupon as the work proceeds through that part of the pass defined by the rolls 13, 14 and 15, the work will be bent in the opposite direction. Thereafter as the rolls 14, 15 and 16 come into play a bend of greater magnitude will be made. The work then passes to the rolls 16, 17 and 18 where it is reversely bent, but to a lesser degree. Likewise the rolls 17, 18 and 19 will bend the work in a direction opposite to the bend effected by the immediately preceding rolls. In this manner the work will progress through the rolls 18, 19 and 20 and thence will be acted upon by the rolls 20, 21, 22 and 23.

The effect of such progressive reverse bending operation on the longitudinally advancing work is to subject the outermost fibers of the bar stock to a cold-working operation which strains and stretches or compresses them nearly to the point approaching the ultimate strength of the material. As a result of such working, the outermost fibers become hardened, yet the inner fibers in the central zone near the neutral axis remain substantially unworked. Thus the central fibers are kept in an unhardened and ductile state.

In Figure 2 the result of the work hardening of the outer fibers has been diagrammatically indicated by the more dense cross hatching indicated at 24 and 26. The bar illustrated in Figure 2 is of approximately octagonal contour in cross section. The condition illustrated is that of a bar which has been passed through an undulating active pass formed by a series of offset rolls such as illustrated in Figure 1. After the operation shown in Figure 2 the bar will be turned approximately 90° on its longitudinal axis to the position of Figure 3. Thus the densely hatched parts 24 and 26 of Figure 3 correspond with the same parts similarly hatched in Figure 2. The work rolls shown in Figure 3 may be regarded as the rolls 10 and 11. Thus the condition of the bar in Figure 3 at the start of the operation is such that the effectively cold-worked portions are the heavily hatched portions. After this bar of Figure 3 has passed through the active pass defined by the remaining rolls 12 to 23, inclusive, the upper and lower portions 28 and 30 of Figure 4 will be cold-

worked as indicated by the more dense cross hatching. Thus it is apparent that after the bar has been subjected to the passes suggested by Figures 2 and 3, substantially all of the outer zone thereof will have been subjected to cold-working, and the outer fibers represented by the heavier hatching of Figures 5 and 7 will all have been strained nearly to the ultimate strength of the material, with a consequent increase in hardness and strength.

While the invention is not limited thereto, the described method is peculiarly well suited for the treatment of concrete reinforcing bars. Such bars are conventionally provided with ribs or protrusions such as indicated at 32. Figures 1 through 6 illustrate the invention as applied to the working of a so-called octagonal bar. The same method may be applied to the cold-working of a bar which is substantially square in cross section but having its corners rounded. Figure 7 diagrammatically illustrates such a corner-rounded square bar in the process of production. Figure 8 is a plan view of the rounded bar, Figure 7, showing the conventional ribs or protrusions 32^a formed thereon. Bars subjected to the improved method described will have their outer fibers all cold-worked and hardened a maximum amount while the central portion thereof in the zone of the neutral axis will be relatively soft and ductile. The result of the treatment is that the bar will be characterized by a high elastic limit due to the cold-working of the outer fibers while at the same time it will have high ductility because of the relative softness of the center or neutral axis zone.

The advantage of the disclosed process is that a bar typical of many reinforcing rods in demand today can be processed on conventional types of mills. This is important because it permits of feeding loose bars continuously end to end into the reverse bending rolls which results in extremely high speed processing. No handling of individual bars and fastening their ends to twisting or stretching machines or a combination of both is required as heretofore.

The method provides for effectively endowing bars with the desirable characteristics of cold-worked high tensile or high yield point bars at a very low cost of production, and accompanying the high tensile characteristics the bar will be characterized by such a degree of ductility that it can be readily bent to suit installation requirements.

It is believed that the cold-working effect or the raising of the elastic limit and ultimate strength of the bar is effected by the speed of operation as well as by the magnitude of the reverse bends imparted while the bar is passing through the undulating pass defined by the rolls 10 to 23, inclusive. That is, with a relatively high speed, the same degree of cold-working can be obtained as that which could be obtained by

a greater relative offsetting of the rolls with respect to one another at a lower speed.

While the invention has been described with particular reference to the cold-working of concrete reinforcing bars, it will be understood that it may have other applications. Accordingly, the drawings and descriptive matter are to be interpreted in an illustrative rather than a limiting sense since various modifications may be made by those skilled in the art without departure from the scope of the invention as set forth in the appended claims.

I claim:

1. The method which comprises advancing a bar longitudinally while subjecting successive portions thereof to transverse bendings which gradually increase and then gradually decrease in magnitude, whereby the outer fibers of the bar are stressed to a point approaching the ultimate strength of the material while the intermediate fibers in the region of the neutral axis are maintained relatively ductile, rotating the bar a fraction of a revolution, and repeating the above steps on different parts of the bar until all peripheral portions of the outer skin region thereof are effectively hardened sequentially in separate stages.

2. The method which comprises advancing a bar longitudinally while cold-bending successive portions slightly, then cold-bending such portions heavily, then cold-bending such portions slightly whereby the outer fibers thereof are work-hardened while the intermediate fibers in the region of the neutral axis are maintained relatively ductile, rotating the bar less than a half revolution, and repeating the above steps until all peripheral portions of the outer skin region of the bar are effectively hardened sequentially in separate stages by said cold working.

3. The method of cold-working a steel bar which comprises advancing the bar longitudinally along an undulating path while sequentially cold-bending the same transversely in varying increments which first gradually increase and then gradually decrease in magnitude, rotating the bar a fraction of a revolution, and repeating the above steps on different parts of the bar until all peripheral portions of the outer skin region thereof are effectively work-hardened sequentially in separate stages.

4. The method of cold-working a steel bar of polygonal cross-section, which comprises advancing the bar longitudinally while subjecting successive portions thereof to transverse cold-bending operations which first gradually increase and then gradually decrease in magnitude, rotating the bar approximately 90°, and repeating the said steps until all peripheral skin portions of the bar are hardened sequentially by cold work while the region in the zone of the neutral axis is maintained relatively ductile.

GERALD G. GREULICH.