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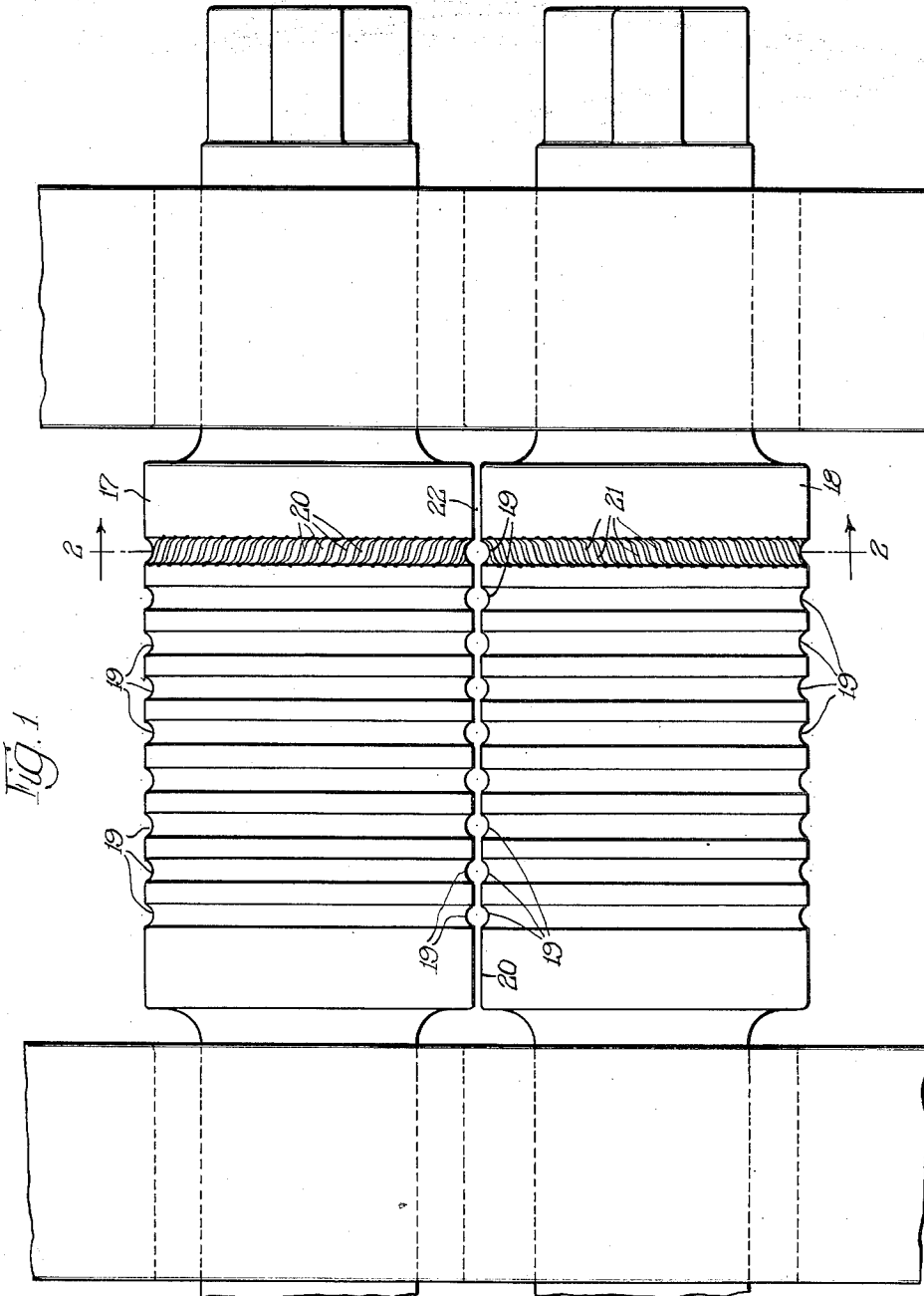
V. M. SURERUS

2,377,980

REINFORCING BAR

Filed May 24, 1944

3 Sheets-Sheet 1



INVENTOR.

INVENTOR,
Victor M. Surerus,

BY

Wilkinson, Hurley, Byrnes & Knight
attys.

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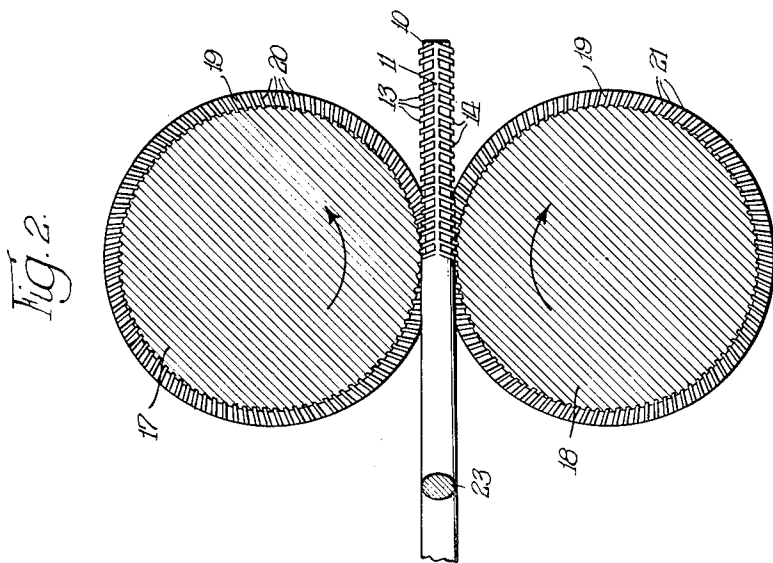
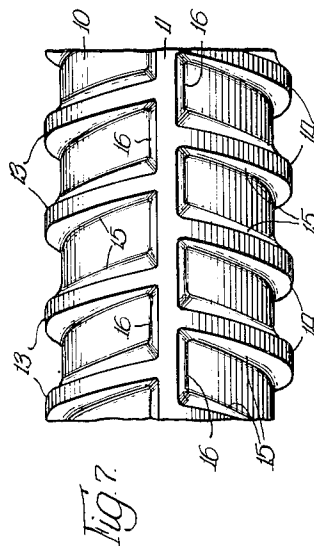
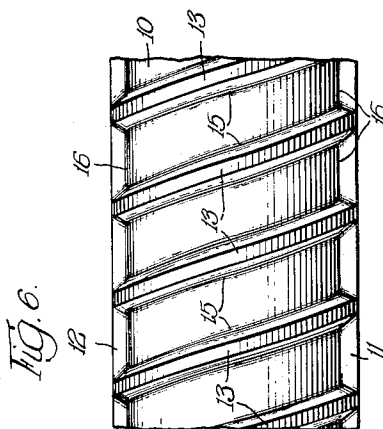
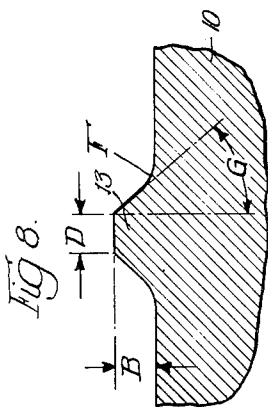
V. M. SURERUS

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3 Sheets-Sheet 2



INVENTOR.

Victor M. Surerus,

BY

Wilkinson, Hussey, Byrum, & Knight
Attys.

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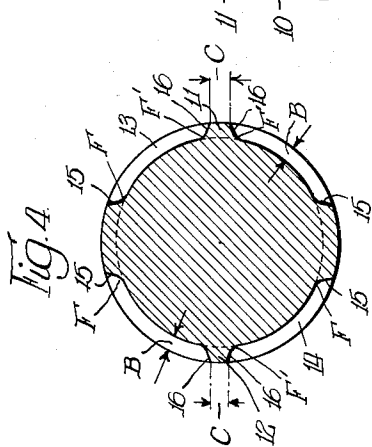
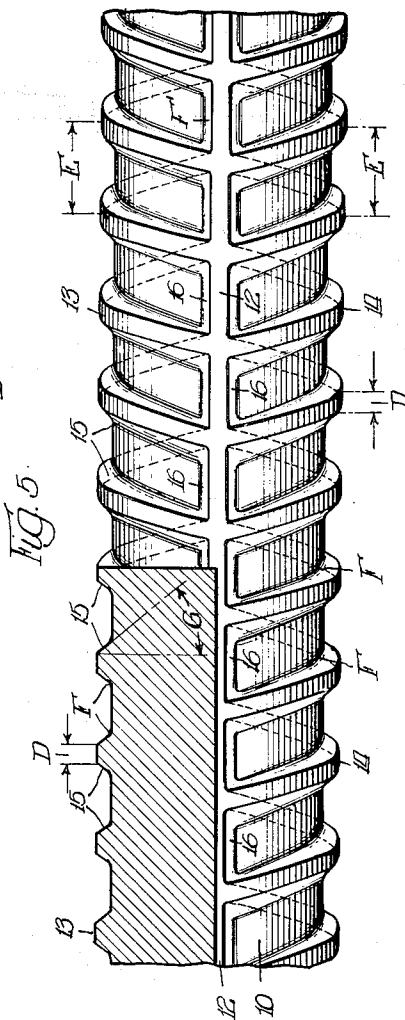
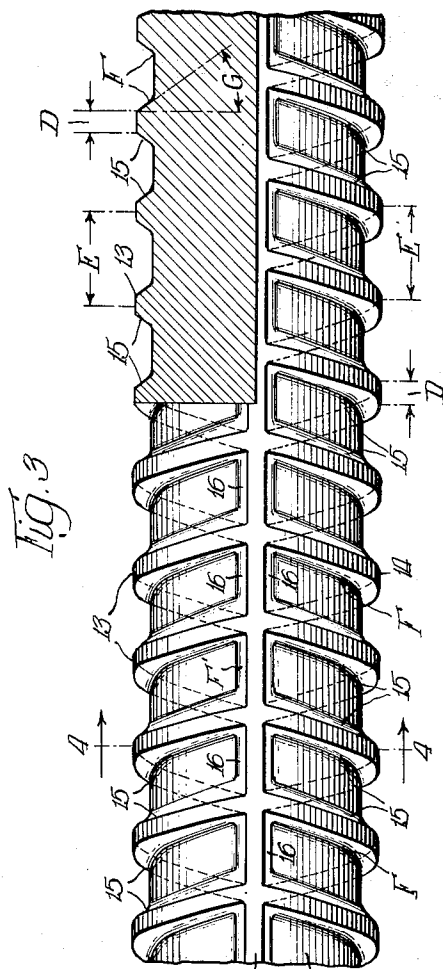
V. M. SURERUS

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REINFORCING BAR

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3 Sheets-Sheet 3



INVENTOR.
Victor M. Surerus.

BY

Wilkinson, Hurley, Byrnes & Knight
Attys.

UNITED STATES PATENT OFFICE

2,377,980

REINFORCING BAR

Victor M. Surerus, Chicago, Ill., assignor to Inland Steel Company, Chicago, Ill., a corporation of Delaware

Application May 24, 1944, Serial No. 537,125

9 Claims. (Cl. 72-111)

This invention relates to reinforcing bars of the type especially adapted to be embedded in bodies of concrete.

This application is a continuation in part of applicant's copending application Serial No. 501,553, filed September 8, 1943, entitled Reinforcing bar.

One of the objects of this invention is to provide a reinforcing bar of such form that it may be produced very economically and present very high bond value.

Another object is to provide a reinforcing bar of such form that the rolls in which it is produced shall not require in their manufacture special machines for profiling them and involving relatively great expense due to the high cost of the machines and to the relatively great length of time required for performing the profiling operation, but which may be produced economically by means of a hobbing lathe according to the process described and claimed in applicant's copending application filed of even date herewith.

Another object is to provide a reinforcing bar of such form that any tendency to rotation of the bar in either direction by the forces exerted against it under load will be counteracted.

Another object is to provide a reinforcing bar of such form that it will present substantially equal bond value, for resisting forces exerted against it in either of opposite directions lengthwise of the bar and a high degree of bond value for resisting forces otherwise directed against the bar.

Another object is to provide a reinforcing bar of such form that when embedded in concrete the load to which the structure is subjected is distributed substantially evenly, thereby increasing resistance to slippage of the bar in the concrete and affording greater protection against cracking of the concrete under various loading stresses.

Another object is to provide a reinforcing bar of such form that the cross-sectional area at any transverse section of the bar, is the same, whereby the bar shall be of uniform strength throughout its length and in fabricating to any desired shape, tendency to twist or pull away from a common plane is eliminated.

Another object is to provide a reinforcing bar of such form as to accomplish the object last above stated and which will present a high bond value.

Another object is to provide a reinforcing bar of such form that steam or water normally pocketed in passes having projections extending at right angles to the line of rolling, will be per-

mitted to escape during the rolling of the bar, whereby breaking out of the roll passes which would produce imperfect bars is avoided and thus more tonnage per pass set up will be available.

Another object is to provide a reinforcing bar of such form that it will afford the maximum opportunity for the concrete to bind with the bar regardless of the position of the bar in the pouring of the concrete, whether in a horizontal or vertical position, or in an intermediate position.

Another object is to provide a reinforcing bar of such form that it will be free of sharp projections, thereby eliminating the need for special protective equipment for the workmen in handling the stock in the mill, fabricating plant, or on location; and other objects as will be manifest from the following description.

Referring to the accompanying drawings—

Figure 1 is a view in elevation of rolling equipment suitable for producing the improved reinforcing bar of this invention.

Figure 2 is a sectional view of the mill of Figure 1 showing the rolling therein of a bar in accordance with this invention.

Figure 3 is a view in side elevation of a section of a reinforcing bar in accordance with this invention, a portion of the section shown being shown in section, the bar being viewed from the right in Figure 4.

Figure 4 is a section taken at the line 4-4 on Figure 3 and viewed in the direction of the arrows.

Figure 5 is a view similar to Figure 3 of the bar, showing the bar after the same has been rotated 180°, a portion of the bar being shown in cross-section.

Figure 6 is a view similar to Figure 3 after the bar has been rotated 90° in the direction which causes the top to approach the viewer.

Figure 7 is a view like Figure 3 of a modification of the bar shown in Figure 3.

Figure 8 is an enlarged fragmentary view of the bar, in cross-section, showing the shape of the lugs.

Referring to the improved reinforcing bar of this invention as shown in Figures 2 to 8, inclusive, it comprises a solid, cylindrical body or core section 10 provided at diametrically opposed portions with parallel ribs 11 and 12 extending longitudinally of the bar, and longitudinally extending, diametrically opposed, sets of helical lugs located in the spaces between the ribs 11 and 12 and joining at their ends with these ribs, the helical lugs of these sets being indicated at 13 and 14, respectively.

The lugs 13 and 14 are segments of threads, the

lugs of one set being segments of a right-hand thread and those of the other set segments of a left-hand thread, whereby the adjacent ends of the lugs of the sets, shown as terminating in common transverse planes, incline in opposite directions relative to the adjacent ribs 11 and 12. Thus when the bar is viewed in the position shown in Figure 3 the helical lugs 13 and 14 converge from the left-hand end toward the right-hand end of the bar, whereas when the bar is viewed in the position shown in Figure 5, the helical lugs 13 and 14 converge from the right-hand end toward the left-hand end thereof.

The ribs 11 and 12 and lugs 13 and 14 throughout their lines of juncture with the core 10, are provided with angular side faces, those between the ribs and core being represented at 15 and those between the lugs and core at 16.

The rolling of the bar may be effected, as for example, by the rolling apparatus described in applicant's copending application referred to, the rolls of which, journaled in the uprights of a roll-stand, are indicated at 17 and 18 and driven in any suitable way (not shown).

The bars to be rolled are, in accordance with the common practice of rolling reinforcing bars, introduced into mating concave pass grooves on the rolls, to extend crosswise of the axes of rotation of the rolls; the apparatus shown being formed with nine sets of such mating pass grooves represented at 19, the surfaces of one set only of the pass grooves being shown as having lug-forming grooves 20 and 21 to correspond with the helical lugs to be produced on the bar, it being understood that in the particular apparatus shown all of the sets of pass grooves would be correspondingly grooved.

The rolls 17 and 18 are spaced apart, as represented at 22, to provide spaces at opposite sides of the grooves 19 into which the metal of the bar (shown in the section 23 of the bar in Figure 2 as of general oval cross section) from which the reinforcing bar is to be produced, is extruded in the rolling operation, to form the ribs 11 and 12 on the bar.

The lugs to be formed on the bar being segments of right and left-hand threads, respectively, the lug-forming grooves 20 and 21 of the pass grooves in the rolls to produce the lugs in the rolling of the bar may be easily formed by means of a hobbing lathe according to applicant's process above referred to.

As will be understood, the hob means employed for producing the lug-forming grooves 20 and 21 should be so shaped as to produce the inclined faces on the leading side of the lugs of such angularity to the vertical that wiping and damage to the bar and rolls during the rolling operation will be avoided. Inasmuch as the angularity of the side of the lug is limited as to its steepness or its approach to the vertical in instances where wiping or unwanted damage is to be avoided, the maximum angle that can be employed is represented in the drawings as the angle G, which is the angle of the inclined surface with respect to the vertical. This angle is marked on the lug in Figure 8.

It has been found that for a bar of any given diameter it is desirable to limit the height of the lug for any given angularity of the lug in order to avoid wiping and damage during the rolling operation. The applicant has devised a formula for determining the height of the lug, which formula is as follows:

Lug height $B = (.0464 \times \text{nominal diameter of}$

bar) + .020 inch: in which the nominal diameter of the bar is the diameter of the plain round equivalent in weight of the nominal size bar.

Example for 1 1/4 inch nominal size

1 1/4 inch square nominal size = 1.410 inch diameter equivalent round, wherefore

Lug height $B = (.0464 \times 1.410) + .020$

or, .065 + .020

or, .085 inch.

In addition, the applicant has worked out a formula by which to determine angle G in any particular case, which formula is as follows:

Angle $G = \text{angle } R - \text{angle } S$

wherein

Angle $R = \text{the angle whose tangent is equal to}$

$(.675 \sqrt{10B} \times \sqrt{\text{pass dia.}})$

and

Angle $S = \text{an angle of } \frac{.10}{B} \text{ degrees}$

and in which

$B = \text{the height of the lug}$

and

Pass diameter = the outside diameter of the rolls minus twice the depth of pass (depth of the pass groove).

Example for 1 1/4 inch square nominal size

Pass dia. = $14.986 - (2 \times .641)$

or, $14.986 - 1.282$

or, 13.704 inches.

Height of lug = .085 inch (see example above)

Angle $R = \text{the angle whose tangent is equal to}$

$(.675 \sqrt{.85} \times \sqrt{13.704})$

or, $(.675 \times .922 \times 1.924)$

or, 1.1974 (tangent of angle R)

or, $50^\circ - 8'$.

Angle $S = \frac{.10}{.085} \text{ degrees}$

or, 1.176°

or, $1^\circ - 11'$.

Angle $G = \text{angle } R - \text{angle } S$

or, $(50^\circ - 8') - (1^\circ - 11')$

or, $48^\circ - 57'$.

In utilizing the above formulas, the height of the lug is the maximum permissible, whereby lugs of the height determined by the formula, as well as lugs of less height, may be employed without suffering wiping or damage.

Similarly, in utilizing the formula for angle G, it is important to know that angles less than those determined by the formula cannot be used without suffering wiping or damage, wherefore it follows that angles greater than those determined by the formula may be employed. These formulas are correct and workable for bars of different sizes and can be employed in rolling all sizes required for a full commercial range, varying from the smallest sizes around 3/8 inch up to 1 1/4 inches, and larger.

In considering the significance of angle G, it should be understood that the limitation imposed thereby is applicable only to the lead angle of the lug on the bar for the reason that during the rolling operation the advancing movement of the

bar when leaving the rolls tends to overtake the lug-forming portions of the rolls, and hence the angularity of the cooperating portions of the roll and lug must be such as to permit a free passage if wiping and damage are to be avoided. By the "lead angle" the front or advancing face of the lug is referred to. On this account, the rear or trailing faces of the lugs on the bar may be of any desired angle. In the present illustration, the trailing faces of the lugs have the same angularity as the leading faces for the purpose of uniformity in both directions, but such is not essential to this invention.

Whereas the sides of the lugs have been referred to as "angular" as determined by the angle G, it is apparent that the fillets may be enlarged to give a general concave configuration to the sides of the lugs, provided, however, that the effective angularity thereof does not exceed the angle determined by angle G.

As previously pointed out, angle G as determined by the formula, marks the limit of approach to the vertical that may be utilized without wiping, and in consequence greater angles or concavities for fillets which come within the effective rule of the formula may also be employed without suffering the damage of wiping during the bar-forming process.

By virtue of the fact that the lug-forming grooves on the rolls are inclined in relation to the axis of the bar, all trapping of steam or water between the rolls during the bar-forming operations is avoided, with the manifest advantage of avoiding spalling or similar damage to the rolls and lugs.

It will usually be desirable to provide a bar having the highest permissible lugs and the steepest possible angle on the leading face of the lug. Bars so constructed have the maximum bonding effect when embedded in concrete. Consequently, the first formula given above may be employed for determining the maximum height of the lugs of a bar of a particular size, and thereafter the second formula may be employed to determine the steepest permissible angle for the leading faces of such lug. In this manner undesirable wiping or damage to the bar and rolls may be avoided. Of course, if lug heights less than the maximum are desired, the second formula may still be employed for providing a leading side face on the lugs of the greatest possible steepness.

The form of reinforcing bar shown in Figure 7, which may be produced in the manner described in connection with the bar illustrated in Figures 3 to 6, is the same as that shown in the last-referred-to figures, except that the ends of the helical lugs of the opposite sets of lugs are in staggered relation to each other instead of being in the same transverse plane. While the lugs of one set thereof are shown as staggered with relation to the lugs of the other set a distance equal to the distance between the lugs of each set, it will be understood that the extent of such staggered spacing may be varied as desired.

As will be manifest, it is desirable that the reinforcing bars to be produced present the maximum bond value for any given amount of metal, commensurate with the tensile strength desired. While the invention is not limited to any specific dimensions of the core, lugs, and ribs of the bar, nor as to certain features thereof, to the provision of fillets (though the provision of fillets as disclosed is highly desirable) the following specifications of these portions as to certain sizes of

bars are herein noted as examples desirable to be followed in the production of reinforcing bars of light, medium, and heavy weight, respectively, one having the same weight per foot, namely, .376 pound, as a plain round $\frac{3}{8}$ " diameter bar; another having the same weight per foot, namely, 2.044 pounds, as a plain round $\frac{7}{8}$ " diameter bar; and another having the same weight per foot, namely, 5.313 pounds, as a plain $1\frac{1}{4}$ " square bar.

In accordance with the above example of the lighter weight bar, the core 10 is .354 of an inch diameter; the depth, indicated at B, of the depressions framed by the ribs and lugs, .038 of an inch; the width, indicated at C, of the ribs at their circumferential surfaces .040 of an inch; the width, indicated at D, of the lugs at their circumferential surfaces .031 of an inch; the pitch, indicated at E, .203 of an inch; the radius, indicated at F, of the lug fillets, $\frac{1}{4}$ of an inch; and the radius indicated at F' of the rib fillets, $\frac{1}{4}$ of an inch.

In the case of the above example of a medium weight bar, the core 10 is .825 of an inch diameter; the depth B, .061 of an inch; the width C, .080 of an inch; the width D, .060 of an inch; the pitch E, .375 of an inch; the radius F of the lug fillets, $\frac{1}{4}$ of an inch; and the radius F' of the rib fillets, $\frac{1}{4}$ of an inch.

In the case of the above example of a heavy bar, the core 10 is 1.360 of an inch diameter; the depth B, .085 of an inch; the width C, .100 of an inch; the width D, .080 of an inch; the pitch E, .603 of an inch; the radius F of the lug fillets, $\frac{3}{4}$ of an inch; and the radius F' of the rib fillets $\frac{1}{4}$ of an inch.

The junctures of the ribs and lugs with the core are formed with fillets as described primarily to the end of permitting the ribs and lugs to be rolled without producing a wiping action of the rolls on these portions, resulting in the opposite side walls of each rib and fillet, being the same desirable uniform contour.

The provision of the lugs (shown as helical) in inclined relation to the longitudinal axis of the bar, from rib to rib, results in the avoidance of trapping of steam or water between the rolls and the bar being rolled, with the manifest advantage

The provision of the sets of lugs in the converging relation as above referred to and the provision of the fillets as described, whether the lugs meet at the ribs as in Figures 3 to 7, inclusive, or the lugs of the respective sets are staggered relative to each other as in Figure 8, results in the bar being of the same cross-sectional area at every transverse section of the bar provided the pitch of the lugs be sufficiently great and therefore the bar is of uniform strength throughout its length.

In the case of bars of the particular sizes above given as examples, the pitches of the lugs of the several bars as set forth, are the minimum permissible if the bar is to have the same cross-sectional area throughout its length. The pitches, however, may be made greater than specified in the above examples and still result in the bar being of the same cross-sectional area throughout its length.

As will be understood, the opposing helical lugs as provided serve to strengthen the bar and cause it to resist the various bending and pulling stresses to which the bar is subjected in use.

While I have illustrated and described certain particular embodiments of my invention, I do not wish to be understood as intending to limit it thereto as the constructions shown may be

variously modified and altered and the invention embodied in other forms of structure without departing from the spirit of my invention.

I claim:

1. A reinforcing bar provided with diametrically opposed sets of lugs disposed along the length of the bar, said sets of lugs being inclined relative to the longitudinal axis of the bar, the lugs of each set being of such length as to extend about the bar throughout the major portion of 180°, each of the lugs of each of said sets of lugs having at least one side face thereof disposed on an angle to the radius of the bar which is not less than angle R minus angle S, wherein angle R=the angle whose tangent is equal to

$$(.675\sqrt{10B} \times \sqrt{\text{pass diameter}})$$

and angle S=an angle of

$$\frac{.10}{B} \text{ degrees}$$

and in which B=the height of the lug and the pass diameter=the outside diameter of the rolls minus twice the depth of the pass groove.

2. A bar of the construction defined in claim 1, further characterized in that each of the lugs of each of said sets of lugs is of a height not greater than $(.0464 \times \text{the nominal diameter of the bar}) + .020$ inch, in which the nominal diameter of the bar is the diameter of the plain round equivalent in weight of the nominal size of the bar.

3. A reinforcing bar of the construction defined in claim 1, further characterized in that the lugs of one of said sets of lugs is inclined in one direction, and the lugs of the other of said sets of lugs is inclined in the opposite direction.

4. A reinforcing bar of the construction defined in claim 1, further characterized in that the lugs of each of said sets of lugs are helically disposed with respect to said bar.

5. A reinforcing bar of the construction defined in claim 1, further characterized in that the lugs of one of said sets of lugs are disposed on a helical path of one hand, and the lugs of said other set of lugs are disposed on a helical path of the opposite hand.

6. A reinforcing bar of the construction defined in claim 1, further characterized in that said bar is provided with diametrically opposed, longitudinally extending ribs, with said sets of lugs disposed in the spaces, respectively, between said ribs.

7. A reinforcing bar of the construction defined in claim 1, further characterized in that said bar is provided with diametrically opposed, longitudinally extending ribs, with said sets of lugs disposed in the spaces, respectively, between said ribs, and fillets are provided at the junctures of said ribs and lugs with the core of the bar.

8. A reinforcing bar of the construction defined in claim 1, further characterized in that the bar is provided with diametrically opposed, longitudinally extending ribs, and the lugs of one set of lugs are disposed on a helical path of one hand in one of the spaces between said ribs, and the lugs of said other sets of lugs are disposed on a helical path of the opposite hand in the other space between said ribs.

9. A reinforcing bar of the construction defined in claim 1, further characterized in that the bar is provided with diametrically opposed, longitudinally extending ribs, and the lugs of one set of lugs are disposed on a helical path of one hand in one of the spaces between said ribs, and the lugs of said other set of lugs are disposed on a helical path of the opposite hand in the other space between said ribs, and said bar further having fillets at the junctures of the ribs and lugs with the core of the bar.

VICTOR M. SURERUS.