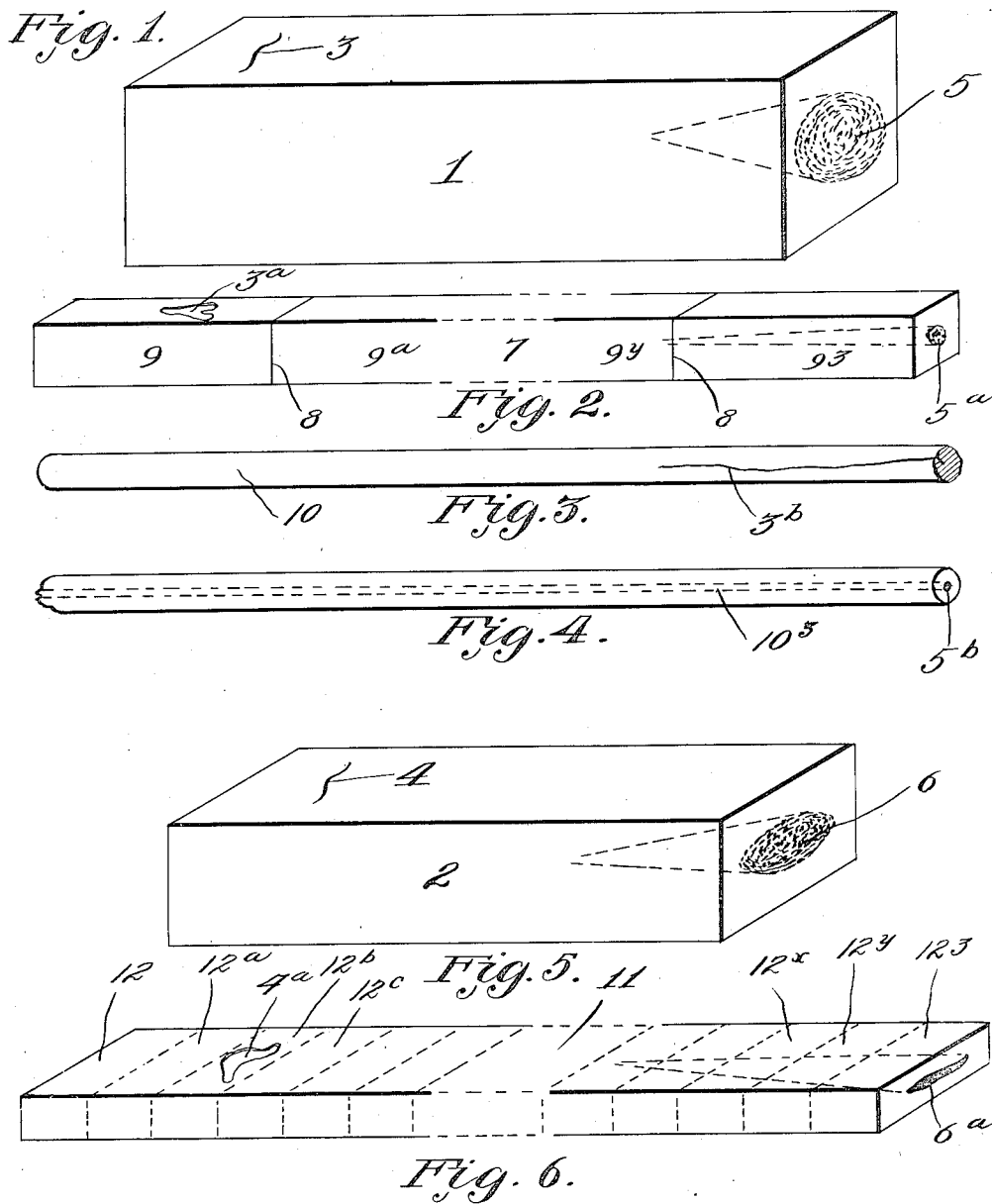


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METHOD OF MAKING STEEL BARS.
APPLICATION FILED AUG. 16, 1912.

1,060,764.

Patented May 6, 1913.

3 SHEETS—SHEET 1.



Witnesses

Philip A. Jones
Elfriede Schmidt.

Inventors

Harry R. Jones
Edward L. Hang
and

John Mc Connell

By

Harry Freese
Attorney

H. R. JONES, E. L. HANG & J. McCONNELL.

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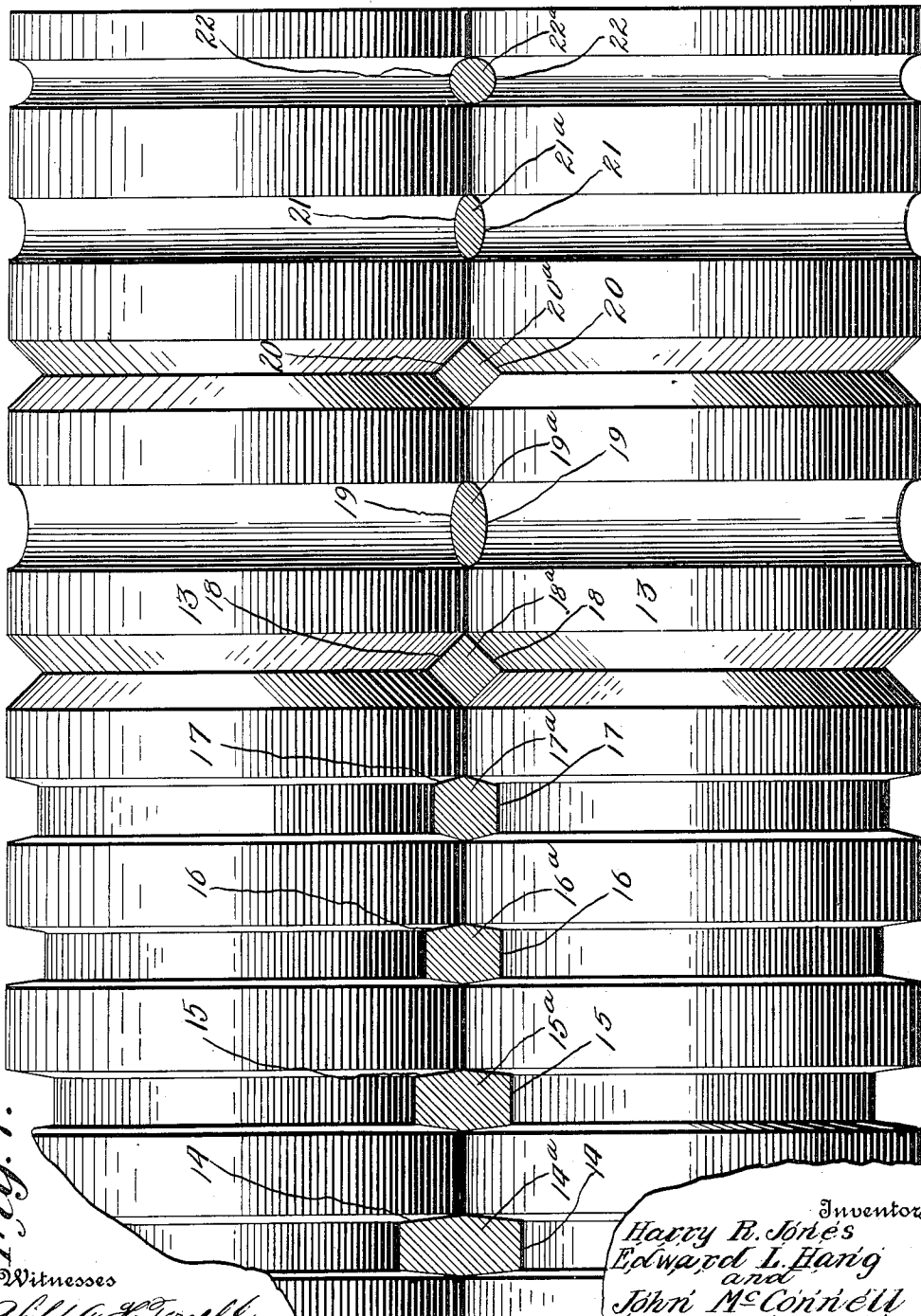


Fig. 7.

Witnesses

Philip A. Cornell
E. Friede Schmidt.

Fig. 7a



Fig. 7b

Inventors
Harry R. Jones
Edward L. Hang
and
John McConnell

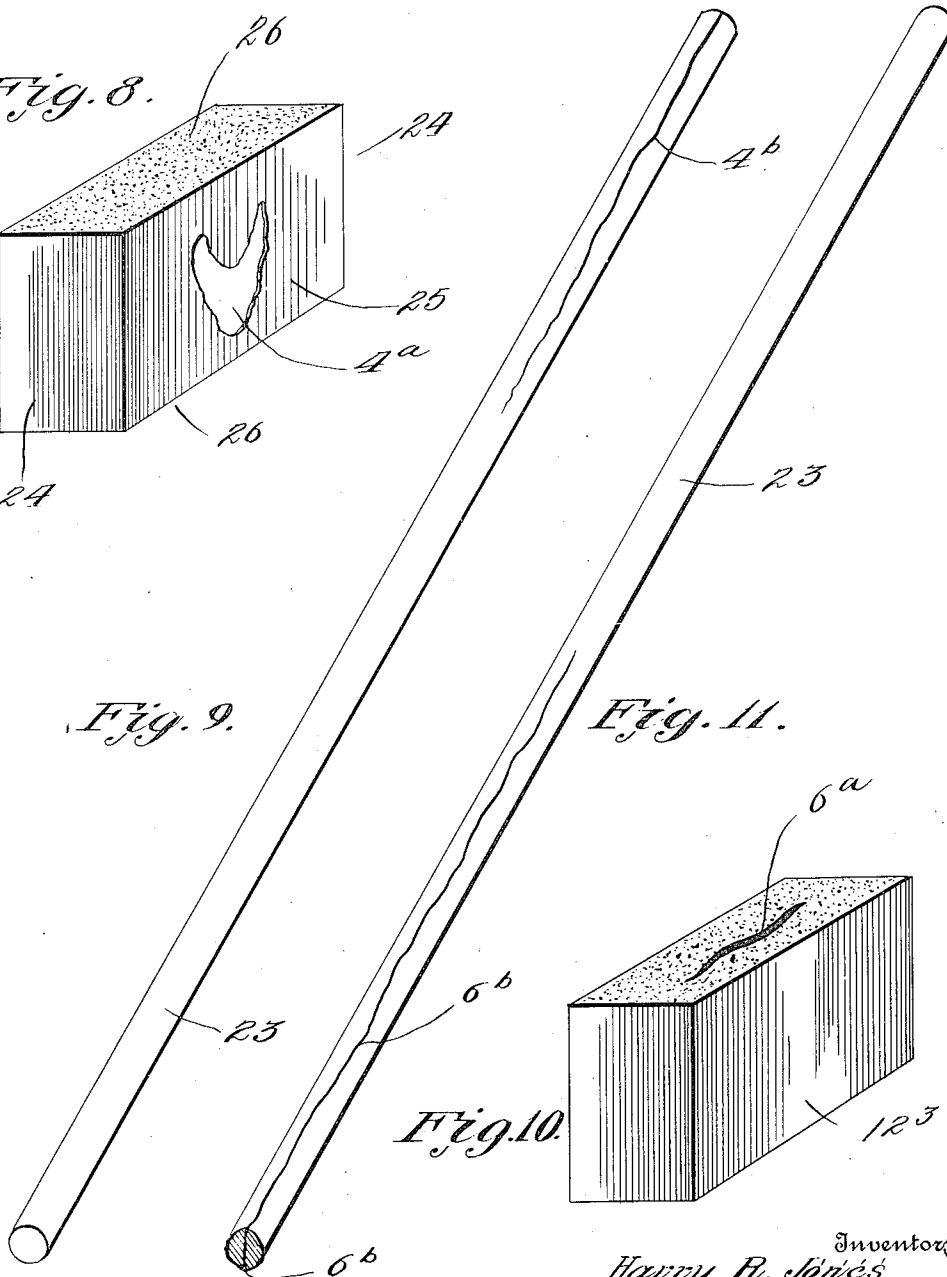
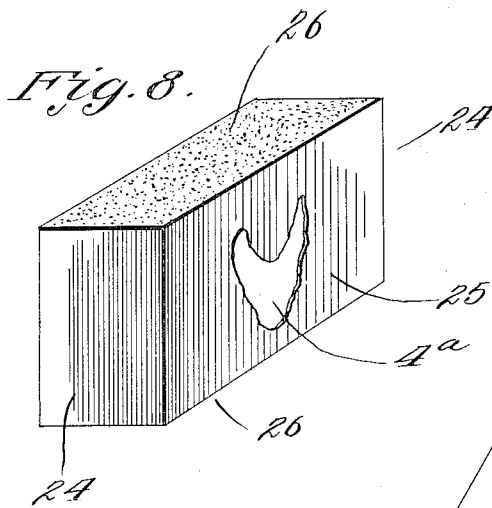
Harry Freese
Attorney

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3 SHEETS—SHEET 3.



Witnesses

Philip A. McConnell
Elfriede S. Schmidt.

Inventors

Harry R. Jones
Edward L. Hang
and
John M. McConnell

By

Lang Freese
Attorney

UNITED STATES PATENT OFFICE.

HARRY R. JONES, EDWARD L. HANG, AND JOHN McCONNELL, OF CANTON, OHIO, ASSIGNORS TO THE UNITED STEEL COMPANY, OF CANTON, OHIO, A CORPORATION OF OHIO.

METHOD OF MAKING STEEL BARS.

1,060,764.

Specification of Letters Patent.

Patented May 6, 1913.

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To all whom it may concern:

Be it known that we, HARRY R. JONES, EDWARD L. HANG, and JOHN McCONNELL, all citizens of the United States, and all residing at Canton, in the county of Stark and State of Ohio, have invented a new and useful Method of Making Steel Bars, of which the following is a specification.

The invention relates to the art of rolling steel from ingots into bars; and the objects of the improved method are to save some of the waste, and to expose and minimize some of the defects incident to the ordinary methods in use, and especially to produce a steel bar having a more compact and homogeneous structure throughout its body than has resulted from prior methods of rolling.

The objects of the invention thus set forth in general terms, are attained by the improved method of making the steel bars from slab ingots, illustrated in the accompanying drawings, forming part hereof, in which—

Figure 1, is a perspective view of a substantially square ingot ordinarily used for making steel bars, the same being laid upon one side and showing some of the defects frequently present therein; Fig. 2, a perspective view of a billet rolled from such an ingot by ordinary methods, showing the development of the several defects into partially formed "snake" and "pipe" flaws, and showing the ordinary division or severing of the billet into sections for rolling into bars; Fig. 3, a fragmentary perspective view of a bar longitudinally rolled by ordinary methods from such a billet-section, showing the final development of one of the defects into a fully formed "snake" seam; Fig. 4, a fragmentary view of a bar longitudinally rolled by ordinary methods from such a billet-section, showing the final development of one of the defects into a fully formed "pipe" hole; Fig. 5, a perspective view of a slab ingot of the kind commonly used for rolling into slabs and sheets, the same being laid upon its side and showing some of the defects frequently present therein; Fig. 6, a perspective view of a slab rolled from a slab-ingot,

being the first step in the improved method, showing the development of the defect into partially formed "snake" and "pipe" flaws, and showing the division or severing of the slab into short sections for carrying out the improved method of cross-edge rolling; Fig. 7, a fragmentary side elevation of a pair of rolls showing an end view of the improved form of slab-section and, in succession, the various cross-sections into which the same is reduced by the rolls to form a bar by the improved method. Fig. 7^a, an end-edge view of one of the improved slab sections. Fig. 8, a perspective view of one of the improved slab-sections, showing the partial development of a "snake" seam in the side thereof; Fig. 9, a fragmentary perspective view of a bar rolled from the same slab-section, showing the complete development of the "snake" seam in the side thereof; Fig. 10, a perspective view of one of the improved forms of severed slab-sections showing the partial development of a "pipe" hole in the end-edge thereof; and Fig. 11, a fragmentary perspective view of a bar rolled from the same slab-section, showing the complete development of a "pipe" seam in the side, instead of a "pipe" hole in the body thereof.

In molding the square ingots 1, or the slab ingots 2, of molten metal, certain irregularly shaped shrinkage cracks, as 3 or 4, commonly called "snakes," are formed in the sides of the ingots from the accumulation of unexpelled air or other gases; and a porous or spongy formation, as 5 or 6, commonly called a "pipe," is frequently formed in the upper end of the ingots, which porous formation extends longitudinally into the body of the ingot and may be caused by the escape of air and other gases while the ingot is being molded. At any event, these defects, which are illustrated in Figs. 1 and 2, are well known and recognized by manufacturers of steel, the former defect usually developing into what is commonly known as a "snake" seam; and the latter defect usually developing into what is commonly known as a "pipe" hole, in the finished bar.

When a square ingot is rolled longitudinally in the usual manner, and is elongated to form the billet 7, shown in Fig. 2, the "snake" 3 in the side thereof is elongated and forms a partially developed "snake" seam 3^a, extending a comparatively short distance along the side of the billet; and the porous or spongy formation 5 in the end of the ingot, is concentrated and more clearly defined and somewhat extended, and forms the partially developed "pipe" hole 5^a in the body of the billet; after which the billet is severed, as at 8, into a series of sections 9, 9^a, 9^b and 9^c, which are ordinarily further reduced by a longitudinal rolling to form finished bars, as 10 and 10^a, shown in Figs. 3 and 4. In the first case, the partially developed "snake" seam 3^a is elongated longitudinally into the completely formed "snake" seam 3^b, which extends along the surface throughout a corresponding portion of the finished bar, as shown in Fig. 3; and for the various uses of steel requiring the strength of a flawless body, such portions of the bar must be cut out and wasted as scrap. And, in the second case, the partially developed "pipe" hole 5^a is quite definitely defined and longitudinally elongated within the body of the bar into the completely formed "pipe" hole 5^b, extending within and along the corresponding portion of the finished bar; but this defect, not appearing on the surface of the bar, cannot be detected, and the bar discarded as in the case of the "snake" seam, so that bars containing "pipe" holes find their way into the market, and such flaws are only detected after the steel has been manufactured and placed into use, as in automobile gearings and other parts requiring absolutely homogeneous and flawless steel, wherein the flaw ultimately results in a breakage of the part when the same is in use. These difficulties are either largely avoided or considerably minimized, and the "pipe" flaw is exposed as a seam in the side of the finished bar, by the improved method of making the bar by the present invention, wherein a slab-ingot 2 is rolled into a slab 11 by a universal mill, in which the edges as well as the sides of the ingot and the resulting slab are subjected to compressing action of the corresponding rolls; which slab 11 is then severed into the series of sections, 12, 12^a, to 12^v and 12^z, inclusive, of a length somewhat greater than the thickness of the slab; which slab-sections are then reduced by rolling cross-wise of the severed edges in rolls having grooves of gradually decreasing depth, until a substantially square cross-section is formed; which reduced section is then further reduced by the ordinary methods of rolling into a rod having a round or other desired section.

In carrying out the improved process, the slab-ingot 2 is first reduced to the slab 11, by rolling longitudinally in a universal mill, that is to say, a mill having rolls impinging and compressing the edges as well as the sides of the ingot, so that the metal in the slab will be compressed laterally as well as in its depth, thereby solidifying the same. This longitudinal rolling is believed to give the structure of the metal a longitudinal grain somewhat analogous to the grain of wood, and at any event a microscopic examination of a longitudinal face of the metal shows a much larger or coarser crystalline structure than appears in a transverse face thereof. The slabs thus rolled, are transversely severed either by shears or other means of cutting, into a series of sections, 12, 12^a to 12^v and 12^z, which sections are severed with a greater dimension along the original grain or slab than the dimension of the depth thereof, the difference in dimensions being preferably in the ratio of about two to one, although this particular ratio is not essential. Each slab-section 12, 12^a, etc., is then reduced by heating in the usual manner and then passing between a pair of rolls 13, the several passes being made successively in the series of grooves as 14 to 22, inclusive, to form the finished bar 23, which may be of any shape in cross-section, as for instance, the round form shown.

The initial passing of the slab-section between the rolls is made by presenting to the nip of the rolls one edge-end 24 of the slab-section, being the end originally forming part of the edge of the slab, which brings the sides 25 of the section originally forming part of the side of the slab, between the sides of the grooves 14; the severed edges 26 of the slab section, that is, the end formed by the cutting of the slab across the grain thereof, being impinged and compressed between the opposing bottoms of the grooves 14, so that the slab-section is elongated by a compression exerted along the line of the grain of the original slab, throughout the entire extent thereof with the result that the structure of the metal is, as it were, upset and the grain thereof is compressed endwise into a compact and substantially homogeneous condition, the fibrous structure of the grain being substantially eliminated, and the relatively coarse crystalline structure being reduced to a much finer crystalline structure. This method of rolling is repeated two or more times, as in the grooves 15, 16 and 17 of the rolls, these grooves being respectively formed with gradually decreasing depths, so that by each pass the slab-section is reduced by a displacement of the metal between the end-edges 26 which were originally formed by the transverse cut of

the slab, that is to say, by a compression of the metal endwise of the original grain thereof without any material increase of the depth of the slab-section, until the same is reduced to a substantially square cross-section 17^a by the grooves 17; after which the bar is finished by a succession of passes in the grooves 18 to 22, inclusive, to form the cross-sections 18^a to 22^a, inclusive, in the usual manner.

By this method of cross-edge rolling the slab sections, the body of the finished bar is reduced to an exceedingly compact and substantially homogeneous structure not having any appreciable grain, and having a more uniform and finer crystalline structure than is produced by the ordinary methods of rolling; and it has been found that manufactured products made from steel bars thus rolled have a much greater strength and endurance against the shocks, and strains of compression, torsion and tension, than is found in steel rolled in the ordinary manner. Furthermore, referring to Fig. 6, it is evident that the partially developed "snake" seam 4^a is limited to a certain section, as 12^b, into which the slab is severed, so that a flawless finished bar can be rolled from the other sections, as 12 and 12^a, at this end of the slab, by the improved cross-edge method of rolling; and by referring to Fig. 6, showing the section 12^b containing the partially developed "snake" seam 4^a, it is evident that if the same does not extend too deep in the side 25 of the slab-section, this side can be planed down to the bottom of the defect, in the usual manner well known in the art, for rolling a flawless bar without waste. If, however, such treatment of the slab-section is overlooked or neglected, it is evident that the improved cross-edge rolling herein described, will serve to some extent to eliminate the incipient seam by the compression of the slab-section along the length of the extended "snake" and the lateral pressure thereof against the sides of the roll grooves; but at any event, the extension of the slab-section cross-wise of the partly formed "snake" seam 4^a, does not extend the defect throughout the whole length of the finished bar 23, but only produces the completely formed "snake" seam 4^b in a relatively small portion of the bar, as shown in Fig. 9, so that it is only necessary to cut out and waste this comparatively small portion of the bar, leaving the remainder thereof in perfect form without any flaw therein. And finally it will be noted that the cross-cutting of the slab transversely severs and exposes the partly formed "pipe" hole 6^a as shown in Fig. 10, and when the same is discovered, permits the slab-section containing this obvious defect to be thrown out and re-smelted without any further expense.

But if such defect is not detected or is neglected, it is evident that the improved cross-edge rolling of the slab-section will serve to some extent to eliminate the defect, and at any event the improved method of rolling the slab-section always brings this defect to the surface of the finished bar, as the completely formed "pipe" seam 6^b; which however, extends only throughout an intermediate portion of the whole extent of the finished bar formed by the slab-section, as shown in Fig. 11, and by cutting out and discarding this portion, the remaining end portions are left in perfect condition for use. By this improved method of cross-edge rolling the slab-sections, it is evident that there is no possible chance of producing a "pipe" hole in the body of the finished bar, but that the defect is always brought to the surface thereof in the form of a "pipe" seam. Furthermore, by the improved method of cross-edge rolling set forth herein, it has been found that the transverse strength of the bar or metal is substantially the same as the longitudinal strength thereof, thus showing a very uniform condition of the bar or metal in all directions; whereas, by the ordinary methods of rolling, it is well known that the longitudinal strength of the bar or metal is greater than the transverse strength thereof.

We claim:

1. The method of making steel bars which consists in reducing slab-ingots to slabs by pressure on both sides and edges thereof, then transversely severing the slabs into sections of greater length than depth, then cross-edge rolling the slab sections to compress them endwise of the original length of the slab, and then reducing to bars of the desired cross-section.

2. The method of making steel bars which consists in transversely severing longitudinally rolled slabs into sections of greater length than depth, then cross-edge rolling the slab-sections by compressing them endwise of the original length and retaining them flatwise of the original depth of the slab to a substantially square cross-section, and then reducing to bars of the desired cross-section.

3. The method of making steel bars which consists in transversely severing longitudinally rolled slabs into sections of greater length than depth, then cross-edge rolling the slab-sections to compress them endwise of the original length of the slab to a substantially square cross-section, and then reducing to bars of the desired cross-section.

4. The method of making steel bars which consists in transversely severing longitudinally rolled slabs into sections, then cross-edge rolling the slab-sections to compress them endwise of the original length of the

slab throughout the extent of its severed faces, and then reducing to the desired cross-section.

5 5. The method of making steel bars which consists in cross-rolling a slab-section having a grain to compress it endwise of the grain throughout the extent of the section, and then reducing to the desired cross-section.

10 6. The method of making steel bars which

includes the step of cross-rolling a slab-section having a grain to compress it endwise of the grain throughout the extent of the section.

HARRY R. JONES.
EDWARD L. HANG.
JOHN McCONNELL.

Witnesses:

HARRY FREASE,
CHAS. M. BALL.