April 22 , 1924. 1,490,944

R. W. SIMPSON

METAL ROLLING

Filed Nov. 25 1922 2 Sheets-Sheet 1

FIG. I.

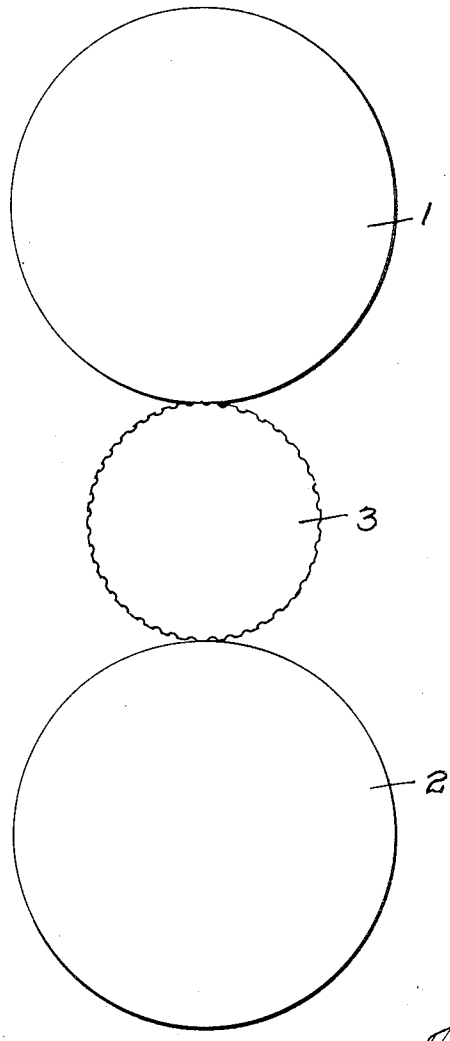


FIG. II.

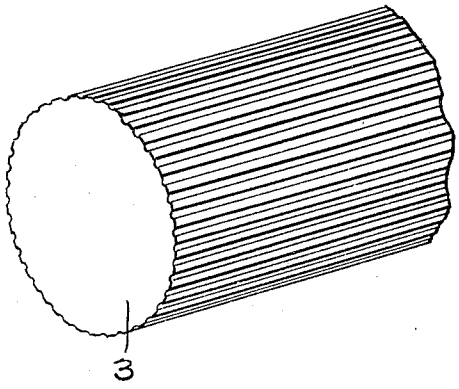
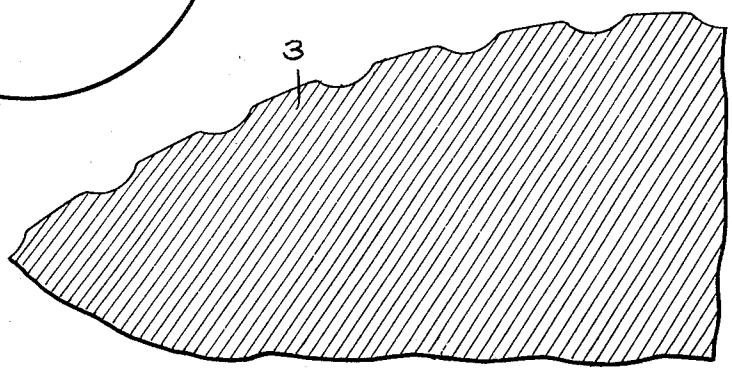


FIG. III.



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FIG. IV.

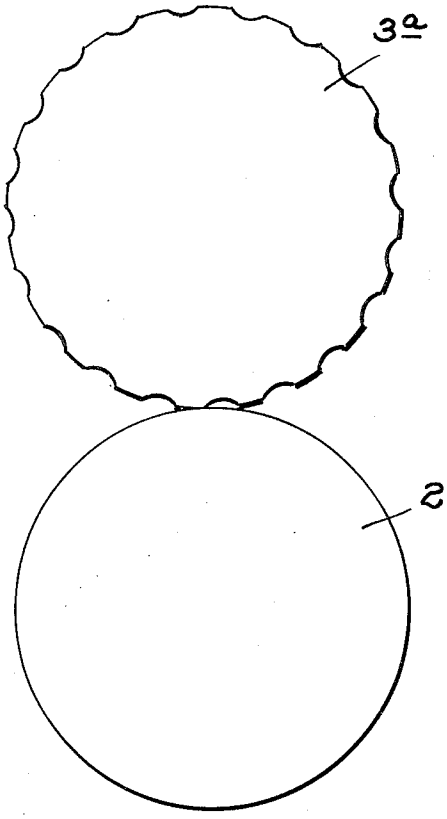


FIG. V.

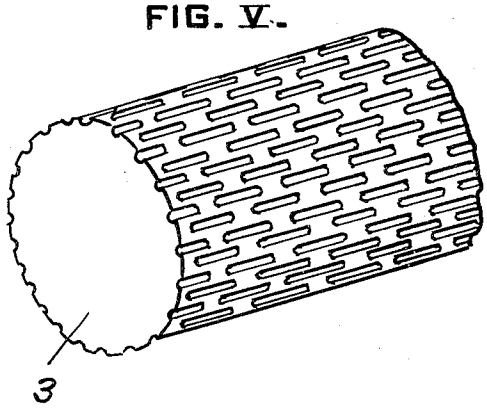


FIG. VI.

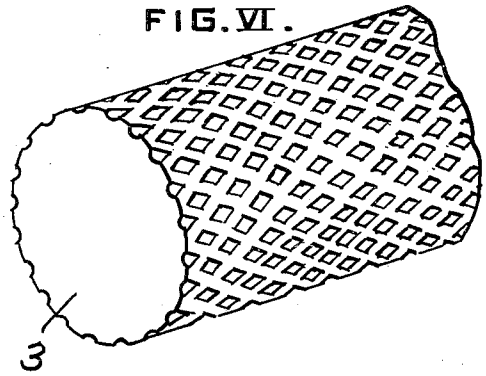
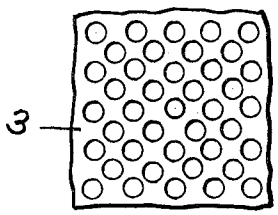


FIG. VII.



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UNITED STATES PATENT OFFICE.

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METAL ROLLING.

Application filed November 25, 1922. Serial No. 603,184.

To all whom it may concern:

Be it known that I, ROBERT W. SIMPSON, residing at Norristown, in the county of Montgomery and State of Pennsylvania, a citizen of the United States, have invented or discovered certain new and useful Improvements in Metal Rolling, of which improvements the following is a specification.

My invention relates to the rolling of steel plate, and while it is applicable to the rolling of steel generally, I have developed it in the production of chrome-nickel plate ranging in thickness from an eighth to a quarter of an inch. In this application I have found the invention to be of great value. The steel with which I am particularly concerned is of a composition which includes nickel (1.40 to 1.60%), chromium (.40 to .60%), manganese (.45 to .60%), and carbon (.18 to .26%). Plates rolled from steel of such composition are in demand, among other uses, for forming the frames of automobile trucks. In the course of fabrication into automobile frames this plate material is sand blasted, and it then appears that such chrome-nickel plate as ordinarily is produced is unsatisfactory. All steel plate is rolled from slab form. The slab as it comes from the heating furnace to the plate mill is enveloped in a coating of scale, a coating which in the rolling operation is more or less completely removed, and for the more complete removal of which the expedient is commonly resorted to of sprinkling the material while in course of rolling with coal dust. In the rolling of chrome-nickel plate the expedients usually employed for loosening and breaking the scale away are so far inadequate that as has now appeared much scale remains, adhering in blotches or patches, and is sunk by rolling into the surface of the plate. Thereafter when in the course of automobile fabrication (for example) the plate is sand blasted, the rolled-in patches of scale are eroded away, and an objectionably irregular and pock-marked surface remains.

The material is rolled hot, from the slab, and ordinarily two mills are employed in rolling. These mills are spoken of as tandem mills, and by that term the fact is indicated, that the material initially heated while in slab form to the proper rolling temperature, is carried without intermission and at a continuing elevated temperature through the two mills, and so brought to its ultimate proportions as a plate, without reheating. The two mills are spoken of as the roughing mill and the finishing mill. Through each the material is passed a number of times. These mills may be two-high mills or three-high; as a matter of fact, the mills in which I have developed and to which I have applied my invention are, both of them three-high mills.

The plate brought in the finishing mill to its ultimate thickness is passed through flattening rolls, and then allowed to grow cold.

As I have said, sprinkling with coal dust or equivalent abrasive during rolling is inadequate to overcome the difficulty mentioned and to give a perfectly satisfactory finished plate. The scale upon chrome-nickel steel is so tough and adherent that it does not yield to the usual treatment, but is so far resistant as to remain as a blemish or defect in the finished article.

I overcome the difficulty and produce chrome-nickel plate practically free from scale by rolling the material under a corrugated roll having the particular characteristics which I shall presently specify, and which lends and adapts itself to the conditions of rolling and attains the end in view as I shall describe.

My roughing mill is a three-high mill; the top and bottom rolls are 30-inch rolls, and the middle roll is an 18-inch roll.

The middle roll is grooved longitudinally from end to end, with grooves rounded on a $\frac{5}{16}''$ radius and sunk $\frac{3}{32}''$ deep, the grooves being spaced $\frac{13}{16}''$ apart, center to center, or $\frac{1}{2}''$ apart, rim from rim. The rims of the grooves I round on a curve of $\frac{1}{16}''$ radius. It will be remarked that by grooves so proportioned and spaced, less than half of the normal cylindrical surface of the roll is cut away in grooving.

Referring to the drawings, Fig. I shows in vertical and transverse section the three rolls of this roughing mill arranged in operative relative position; Fig. II shows in perspective the grooved middle roll; Fig. III is a fragmentary view in cross section and to larger scale showing in detail the grooving; Figure IV is a view similar to Figure I illustrating an admissible modi-

fication in a general organization of the mill. Figures V and VI are views similar to Figure II illustrating admissible variations in the configuration of roll surface. Fig. VII illustrates another surface configuration. In the three-high mill shown in Fig. I, 1 and 2 are the top and bottom rolls, which are, as they are here shown, smooth surfaced and cylindrical. The middle roll 3 also is truly cylindrical, but for the grooves, cut as and to the dimensions I have indicated, and as clearly shown in the drawings.

These things are to be observed by way of comment upon the mill in its preferred form and proportions as now described, and upon its operation upon the material passed through it. The grooves are shallower than the material is thick; the grooves are spaced apart at a distance greater than the ultimate thickness of the material and at a distance greater than groove width; the material as it advances through the roll pass, instead of being subjected to a substantially constant and continuous stress, is subjected to a stress which is discontinuous, broken up, rhythmically intensified over a succession of areas, separated by areas of diminished stress, or perhaps of no stress at all; that while so subjected to a pulsating stress, the material is on the opposite side sustained by a continuous surface. There is not then, nor can there be, any distortion of the material throughout all its thickness, but only a superficial kneading or peening of the surface metal. It will further be observed that as the material advances repeatedly to and fro through the passes of this roughing mill (being reduced in thickness and extended horizontally with each traverse) first one face and then the other is subjected to the kneading or peening action of roll 3, and it will also be observed that since the metal is elongating, and since there is no provision to such end, repeated contacts of roll 3 with either side cannot be in the same track,—that is to say, the grooves will not be brought to bear successively on identically the same areas of surface.

The metal under this treatment is formed with superficial welts, which are completely ironed out in the finishing mill, so that, so far as concerns smoothness of surface, there is in the finished product no trace nor sign of the welts formed in the roughing mill.

While this rolling operation is in progress the material itself is at or approximately at straw-colored heat, and it and the rolls are sprayed upon by copious jets or water. This water entrapped as rolling progresses within the grooves and between the body of the roll 3 and the surface of the material under treatment, and penetrating into interstices of the coating of scale and between scale and underlying metal, is there, in such confined spaces, converted by contact with the hot metal into steam. Then, when presently the surfaces separate and the confinement is relieved, the steam expands explosively.

I do not mean to limit myself unduly to any particular theory or theories of operation; my belief, based upon careful observation, is that both the kneading or peening of the surface and the explosive action of the steam which I have described, tend to separate loosen and break up the coating of scale; certainly it is true that, by virtue of the use under usual conditions of the grooved roll, this heavy tough closely adherent scale upon nickel-chrome steel is broken and loosened, so that it falls away, and I obtain a product which in this respect is more excellent than can be got by any other expedient known to me.

And more than this. Not only is the scale removed, and more surely and effectively removed than can otherwise be achieved, this concentration of the stress which effects elongation, this localization of the stress and this intermittent character imparted to it,—this operation so made analogous to hammering, repeated in successive passes over new areas, has the effect upon the metal of the plate, condensing the metal on the surface, elongating the fibre, and increasing the tensile strength of the article, over that of plates rolled between perfectly smooth rolls in usual manner.

When compared with best results under the old method of sprinkling the plates with crushed coal, not only have I gained by getting away from the objectionable features attendant on the use of coal, mentioned below, but I have greatly improved the product. I have practically eliminated rejections of material because of the presence of scale, and that hitherto has been a serious matter in meeting the specifications and requirements of purchasers.

It is, as I have reason to believe, the localization of stress, normal rolling stress over at least half the surface of the article under treatment, but an interrupted stress,—it is the recurrence of stress over successive areas, interrupted by areas of preferably smaller extent where stress is diminished, which is the informing principle of the invention. Accordingly, the surface configuration of roll 3 admits of variation. The succession of longitudinal grooves which I have described is good,—the best configuration, I believe, which may be evolved. The essential thing is an essentially cylindrical roll with interruptions, in the form of recesses, in the continuity of the cylindrical surface. For example the grooves shown need not be continuous from end to end of the roll, but in place of each continuous groove there may be a line of short groove-shaped recesses, and these recesses may be

arranged in staggered succession, line after line. This is illustrated in Fig. V. Again, the recesses may be lozenge shaped, or round, as indicated diagrammatically in Figs. VI and VII; but whatever the particular shape of the grooves or recesses, they should, in order to achieve best results, be so shaped and proportioned that in normal operation they will form with the material under treatment pockets within which segregated bodies of water may be converted to steam which when the pockets open will expand explosively.

I have described one roll of a pair to be provided with superficial recesses, causing it to depart from true cylindrical form. Both rolls of the pair may be so recessed, and to the same end. The intended operation is, as I have explained, an operation of superficial kneading or peening, and, accordingly, if both rolls of the pair be recessed, the recesses will be such and so placed that each will, so far as concerns the superficial kneading or peening action of the other, afford proper support for the material under treatment.

I have described the invention as applied to a three-high mill. Manifestly it may be applied to a two-high mill, and if in a two-high mill one only of the rolls be recessed, the effect may be had upon both surfaces of the article by turning it over between successive transits through the mill. The structure here alluded to is sufficiently illustrated in Fig. IV where the smooth roll 2 and the recessed roll 3^a form the roll elements of a two-high mill.

The invention lends itself, as I have repeatedly indicated, to the rolling of a peculiarly difficult material, chrome-nickel steel; of course I do not mean that the invention is not widely applicable to steel rolling generally. Even in comparison with the usual practice of sprinkling the material in the course of rolling with coal dust, the operation in which my invention resides is manifestly advantageous. The use of coal dust is on other account most objectionable, and the inconveniences of its use are endured only because no other equally satisfactory way of gaining the same end has been found. It is at best a palliative, not a complete remedy. The powdered coal, collecting through continued use, fouls the mill floor and clogs and damages the machinery; and at best the crushed coal is applicable only to the upper surface of the material under treatment. And of course there is the necessity of preparing the coal and having a supply of it at hand, and there is the work of applying it; and there are other disadvantages, but these are the major ones. In the practice of my invention the offense of accumulations of coal dust is overcome, and the ends in view are attained in more perfect manner.

I claim as my invention:

1. The method herein described of rolling scale-bearing metal and at the same time freeing the surface of scale, which consists in hot rolling it, while washed with water, beneath a pocket-forming recess-surfaced roll.

2. The method herein described of rolling from a hot slab of chrome-nickel steel a plate free of surface scale which consists in rough-rolling while washed with water beneath a pocket-forming grooved roll, and finishing beneath a smooth roll.

3. In the art of hot-rolling metal the method of conducting rough-rolling which consists in causing the maximum extensive stress to be exerted upon the article under treatment at successive points separated by intervals where stress is diminished, and in such intervals generating steam within confined spaces, and in sequence thereafter venting such confined spaces.

In testimony whereof I have hereunto set my hand.

ROBERT W. SIMPSON.

Witnesses:
BAYARD H. CHRISTY,
PERCY A. ENGLISH.