

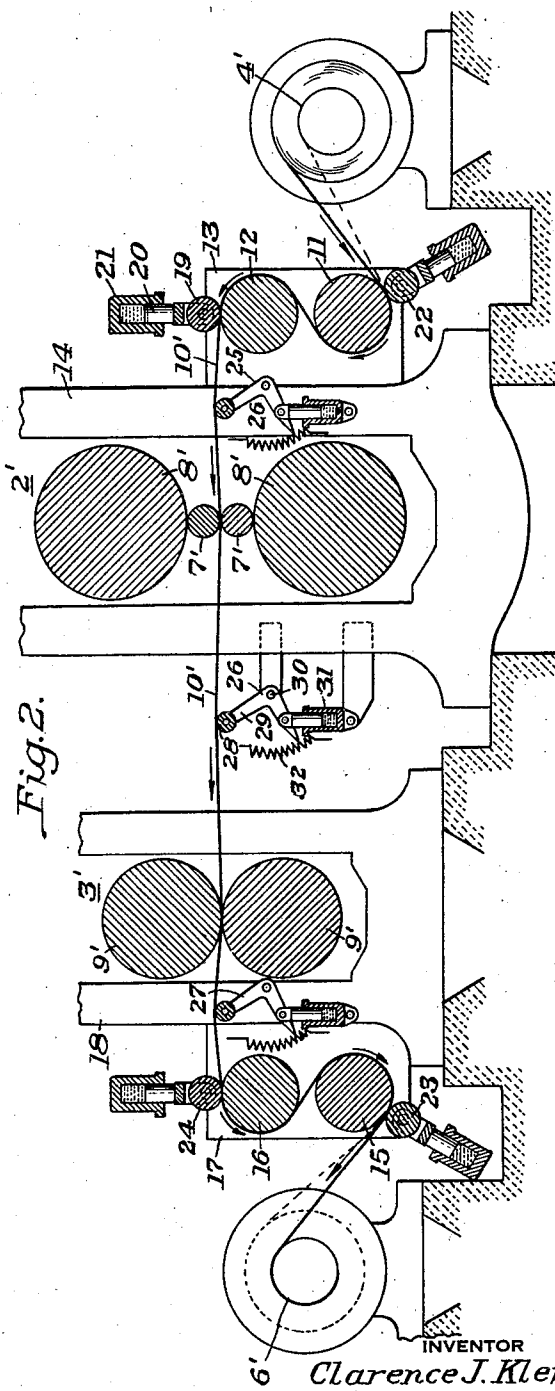
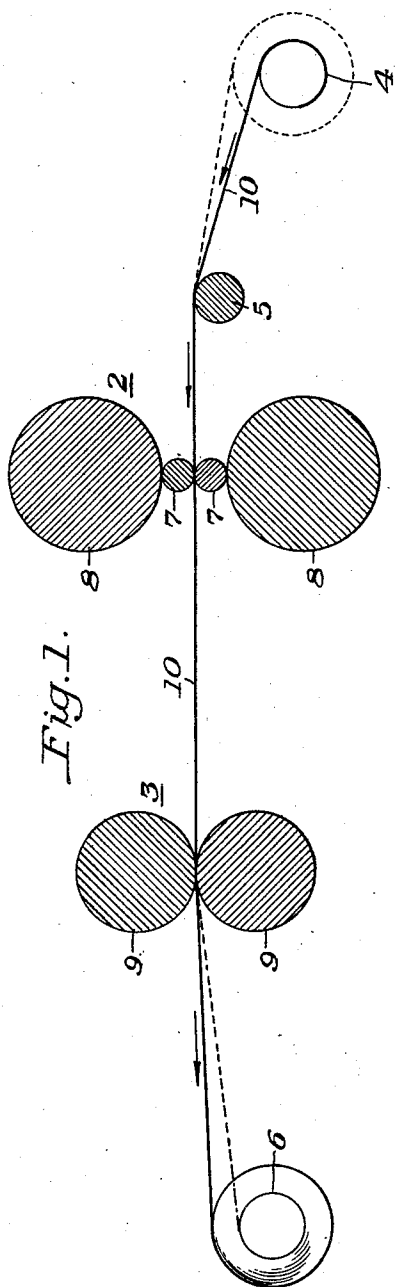
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METAL ROLLING

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METAL ROLLING

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Our invention relates broadly to the art of metal rolling, and more particularly to the treatment of wide and thin varieties of metal. The invention is of great value in the treatment of tin plate in coils and will be described in connection therewith, but is also useful in connection with sheared lengths of material. Tin plate is commonly made of mild steel in widths up to 42" and of a thickness of .006" and heavier. A typical tin plate steel has the approximate analysis: carbon 0.04 to 0.12; manganese 0.30 to 0.50; phosphorus up to about 0.04; sulphur up to about 0.05, the balance being substantially iron.

Cold reduced tin plate is commonly made by hot rolling steel slabs of approximately the aforesaid analysis into coiled strips of desired width, length, and thickness. The hot rolled strip of a thickness of about 0.08" is pickled, usually in sulphuric acid, to remove the scale, and then cold rolled to a thickness slightly greater than that required in the completed tin plate, which has a thickness of .006" and heavier. Cold rolling increases the hardness and tensile strength of the metal and decreases the ductility. For example, the hardness of the cold reduced strip will be of the order of 80 on the Rockwell 30-T scale and the ductility has an Erichsen value of about 2.10 m. m. on 85 pound stock. Strips, coils, or sheets in this condition are usually referred to as "full hard" and have but limited use. This hard thin steel, either in coils or in sheared lengths, is annealed at a temperature of approximately 1200° F., if box annealed, or approximately 1650° F., if open annealed in a suitable atmosphere, for a sufficient time to make the steel soft and ductile. The metal is then slowly cooled. The steel will then have a hardness of approximately 60 or even less, as measured on the 30-T Rockwell scale and is usually spoken of as "dead soft." The "dead soft" stock has various uses, but for many purposes, such as the making of tin can bodies, it is necessary to considerably increase the stiffness of the metal. The added stiffness or temper is commonly imparted to the soft metal by subjecting it to temper passes through a mill while the material is cold. This final cold rolling also renders the surfaces of the metal very smooth and flat. The amount of reduction by such a cold rolling or tempering operation may vary from about 1% to about 10% and does not seriously affect the gauge of the material. However, in very accurate rolling, allowance is made

for such reduction in the previous rolling operations.

Difficulty has been encountered in imparting high temper to annealed sheets of low carbon steel. In order to produce the desired high hardness in the finished stock, the use of steels of special analysis, such as so-called "high carbon" steel, rephosphorized steel, etc., has been resorted to. Such steels are difficult to roll and process and consequently, the costs are high when expedients of this kind are resorted to.

We have found that ordinary low carbon tin plate stock can be processed so as to impart sufficient temper or hardness thereto to suit the demand for plate which has a high temper, is smooth, and flat. By a "high temper," we mean a hardness of from 4 to 6 on a scale where "dead soft" material has a hardness of 1 and the "full hard" material has a hardness of about 7. We employ apparatus by means of which sufficient pressure and tension can be exerted on the annealed stock to accomplish the desired result in one pass. The apparatus comprises a 4-high mill having work rolls small enough in diameter to produce sufficient reduction of gauge to impart the desired stiffness to the sheet in one pass, arranged in tandem with a mill having relatively large rolls which do not noticeably reduce the thickness of the strip, and whose sole function is to flatten and smooth the strip so as to impart thereto such a surface as is now demanded by strip users. In other words, the reduction and tempering is substantially all done in the 4-high mill in one pass. The slight reduction and possible slight hardening effect which may be afterwards produced in the material by the mill having relatively large rolls (e. g., a 2-high mill) is only incidental to the main function of smoothing and imparting a high finish to the metal.

We provide means at the entering side of the 4-high mill for feeding the strip material thereto and means at the exit end of the 2-high mill for receiving the material. It is also within our contemplation to provide suitable tensioning apparatus between the material-feeding means and the first mill and between the second mill and the material-receiving means. In some instances, it may also be desirable to provide devices for producing constant tension in the strip at various points; for example, between the aforesaid tensioning apparatus and the entering side of the 4-high mill, between the 4-high mill and the second mill, and between the second mill

and the tensioning apparatus adjacent thereto, or in any combination of these locations.

It is one of the objects of our invention to impart a desired stiffness and surface flatness to thin strip metal by treating the ordinary low-carbon, tin plate stock in one operation and at a desirable speed. Another object is to provide apparatus which accomplishes this purpose. Still another object is to provide a method and inexpensive apparatus which will accomplish these purposes at relatively low cost.

The details of our invention are more fully set forth in the following description referring to the accompanying drawing, forming part of this specification, in which we have shown for purposes of illustration only, certain preferred embodiments of our invention.

In the drawing:

Figure 1 is a diagrammatic representation of apparatus suitable for carrying out this invention; and

Figure 2 is a diagrammatic illustration of a modification of the apparatus shown in Figure 1.

In Figure 1 of the drawing we have shown diagrammatically a simple form of apparatus suitable for the practice of our invention. As there illustrated, the apparatus for treating strip metal of a width up to about 36" comprises a 4-high mill 2 and a 2-high mill 3, arranged in tandem; a pay-off reel or entry reel 4, disposed adjacent the entering side of the 4-high mill 2; a billy roll or guide roller 5 between the reel 4 and the mill 2; and a take-up reel or delivery reel 6 disposed on the exit side of the 2-high mill 3.

The 4-high mill comprises a pair of metal work rolls 7 which are held against initial deflection by a pair of cooperating backing-up rolls 8, all of which are suitably journaled in housings, not shown. The work rolls range in diameter from about 6" to about 8". The backing-up rolls are many times larger in diameter than the work rolls 7; for example, we have used backing-up rolls having diameters ranging from about 32" to about 38" when used in connection with work rolls of from about 6" to about 8" in diameter and about 42" wide. But considerably larger rolls could also be satisfactorily used if desired. The work rolls are driven by any conventional means, such as an electric motor, which may be connected by suitable means to the work rolls 7 or backing rolls 8; or one alone of the backing rolls 8 may be driven.

The 2-high mill 3 comprises a pair of rolls 9 of any suitable diameter, such as from about 24" to about 36", journaled in suitable housings (not shown). The sole purpose of these rolls is to smooth and flatten the strip so the diameter of the rolls is not important, so long as the rolls have sufficient strength and are sufficiently large in diameter to perform their function. We have found that rolls of from about 23" to about 36" in diameter are quite suitable for a 42" mill, although rolls of larger diameter can be satisfactorily employed. We prefer to use iron rolls rather than steel rolls, as we have found that iron rolls impart a smoother and more satisfactory finish to the strip metal than do steel rolls. The rolls 9 are driven in unison in any conventional manner, such as by an electric motor connected to the rolls by conventional means. Either or both rolls may be driven. The peripheral speed of the rolls 9 is slightly greater than the peripheral speed of the work rolls 7, so that a desired amount of tension is exerted on the strip 10

between the rolls 7 and the rolls 9. The strip 10 is preferably delivered to the reel 6 under very little tension.

It is to be understood that a 4-high mill having work rolls of about 16" or up in diameter may be used instead of the 2-high mill 3. Where a 4-high mill is used as the last or finishing stand, the work rolls must be relatively large in diameter, of the order of about 16" or up, to properly flatten and impart a smooth finish to the strip.

The pay-off reel 4 is of the well known "cone" type which has a suitable retarding device associated therewith, such as the conventional motor generator set, to impose a controlled drag or tension on the strip. The take-up reel 6 is preferably of the collapsible type and is driven in the conventional manner by a suitable electric motor.

In the operation of this mill, the strip 10 is fed from the pay-off reel 4 and over the billy roll 5, which is commonly made of brass to avoid scratching the strip, through the 4-high mill 2, thence between the rolls 9 of the 2-high mill 3, and thence to the take-up reel 6. The pay-off reel 4 is operated so as to exert tension on the strip 10 between the reel and the work rolls 7. The work rolls 7 are adjusted to the draft necessary to impart in one pass the degree of hardness required, such as a hardness of 6 where the dead soft material has a hardness of 1, and the full hard material has a hardness of 7. A material which is 6 hard is very stiff. The draft of the mill 2, combined with the tension imparted by the pay-off reel 4 and the rolls 9 of the 2-high mill, must be sufficient to reduce the strip in an amount sufficient to impart thereto the necessary hardness and bring it to the thickness desired in the finished strip in one pass.

We have found that in many instances it is advantageous to provide means auxiliary to the mills and reels for causing tension to be imparted to the strip. Apparatus with such auxiliary tensioning means and without a billy roll is shown diagrammatically in Figure 2. Inasmuch as the only difference between the apparatus illustrated in Figure 1 and that illustrated in Figure 2, outside of the omission of a billy roll in Figure 2, resides in the auxiliary tensioning means provided in Figure 2, the same numerals with a prime affixed thereto will be used to designate parts in Figure 2 similar to those already described.

Between the pay-off reel 4' and the work rolls 7' of the 4-high mill 2', there is provided a plurality of spaced apart cooperating tension rolls 11 and 12, the longitudinal axes of which are in substantially the same vertical plane and are parallel to the longitudinal axes of the work rolls 7'. The top of the roll 12 is preferably in substantially the same horizontal plane as the pass line between the work rolls 7'. The tension rolls 11 and 12 are of the same diameter and are mounted in any convenient supports such as brackets 13, secured to the housings 14 of the 4-high mill 2'. They are connected by any convenient means to apparatus for imposing a resistance to rotation of the rolls, such as a motor generator set (not shown). The rolls 11 and 12 are made of metal and are so constructed and arranged that the strip 10' may be led around them, as shown, and frictionally engage the surfaces of the rolls over arcs which are subtended by angles of not substantially less than 180°.

The rolls 11 and 12 are made of a diameter large enough to present sufficient strip-engaging areas to maintain the desired amount of tension in the strip and to prevent slippage of the strip relative to their surfaces. We have found that tension rolls having a diameter of the order of 19" are satisfactory for use with a 42" mill.

We may also provide spaced apart cooperating tension rolls 15 and 16 between the exit side of the 2-high mill 3' and the wind-up reel 6' with the top surface of the roll 16 in substantially the same horizontal plane as the pass line of the rolls 9' of the mill 3'. The longitudinal axes of the rolls 15 and 16 are in substantially the same vertical plane and are parallel to the longitudinal axes of the work rolls 9'. The rolls 15 and 16 are of the same diameter, are mounted in any convenient housings such as brackets 17, secured to the housings 18 of the 2-high mill 3' and are driven at the same speed by any convenient means, such as by an electric motor and conventional driving couplings (not shown). The peripheral speed of the rolls 15 and 16 is slightly greater than the peripheral speed of the rolls 9', so as to exert tension on the strip 10'. The rolls 15 and 16 are so constructed and arranged that the strip 10' may be led around them, as shown, and frictionally engage the surfaces of the rolls over arcs which are subtended by angles of not substantially less than 180°. These rolls are made large enough, e. g., about 19" in diameter for a 42" mill, to present sufficient strip-engaging areas to maintain the desired amount of tension in the strip and to prevent slippage of the strip relative to their surfaces. By this arrangement, tension is imparted to the strip 10' as it emerges from the rolls 9' and the strip, after it leaves roll 15, can be wound on the wind-up-reel 6' with only sufficient tension to make a snug coil.

Adjacent the top of the roll 12, there may be provided an idle roller or contact roller 19, which is moved into engagement with the surface of roll 12 adjacent the last point of contact of the strip 10' and roll 12, by a reciprocable plunger 20 of a hydraulic unit 21. Similar idle rollers 22 and 23 may be provided adjacent the bottom of rolls 11 and 15 at the point of first contact of the strip 10' and the roll 11 and at the point of last contact of the strip 10' and roll 15, respectively. Likewise, an idle roller 24 may be provided at the point of first contact of the strip 10' and roll 16. In order to prevent marking of the strip, the rollers 19, 22, 23, and 24 are preferably formed from material which is not as hard as the strip, such as hard fibre. The rollers 22, 23, and 24 are plunger-operated in the same manner as roller 19. The various idle rollers 19, 22, 23, and 24 are used to help thread the strip through the apparatus, although they may also be used as pinch rolls, if so desired.

To insure a desired uniformity of tension in the portion of the strip adjacent the mills 2' and 3', we may provide constant tension devices 25, 26, and 27, located between the tension roll 12 and the rolls 7', between the rolls 7' and 9', and between the rolls 9' and 16, respectively. These devices are the known electric tensiometers and since the devices 25, 26, and 27 are all similar, only 26 will be described. The tensiometer 26 comprises a roller 28, rotatably mounted in one end of a bell crank lever 29, which is pivoted at 30. To the other end of the lever, a plunger reciprocably mounted in a hydraulic unit 31 is secured, and the end of the arm is in operative

relationship to a rheostat 32, by means of which the current to the motors driving the rolls 9' may be adjusted. The tensiometer is located so that the roller 28 will be in contact with the bottom of the strip 10' and by means of the fluid admitted to the hydraulic unit, the pressure of the roller 28 against the strip may be controlled and consequently, the tension on the strip. The tensiometer 25 in like manner controls the current through the motor driving the mill 2' and thus the tension of the strip between the roll 12 and the rolls 7'. The tensiometer 27 controls the current to the motor driving the tension rollers 15 and 16 and the tension of the strip between the rolls 9' and the roll 16.

The current control feature is not necessary to the successful operation of the tensiometers as visual scales may be provided to indicate to the operator the tension in various parts of the strip, and he may then adjust the current to the various motors to keep the strip at the desired tension.

It is to be understood that the apparatus will operate satisfactorily without the contact rolls or idle rollers 19, 22, 23, and 24 or without the tensiometers 25, 26, and 27, and without both the rollers and the tensiometers or with various rollers or tensiometers omitted, and that various arrangements of tensiometers and idle rollers may be satisfactory. It is also to be understood that our invention is not limited to the herein described preferred embodiments and that various changes in the size, shape, and arrangement of parts may be resorted to and the invention otherwise embodied and practiced within the scope of the following claims.

We claim:

1. A two-stand, skin-pass mill for imparting stiffness to strip metal while slightly reducing the thickness comprising a 4-high mill having work rolls having a diameter not greater than about one-fourth of the diameter of the backing-up rolls, a second mill in tandem with the first mill, the diameter of the working rolls of the second mill being at least twice the diameter of the working rolls in the first mill, means for introducing the strip into the first mill under back tension, and means beyond the exit side of the second mill for exerting forward tension on the strip as it leaves the rolls of the second mill.

2. A two-stand skin-pass mill for finishing strip metal comprising a first mill having small work rolls and backing rolls with a diameter several times that of the work rolls adapted to effect an appreciable reduction in the thickness of the strip to temper it, a second mill in tandem with the first mill, the second mill having large work rolls relative to the work rolls of the first mill adapted to flatten the strip without reducing its thickness materially, and means for tensioning the strip leaving the second mill.

3. A two-stand skin-pass mill for finishing strip metal comprising a first mill having small work rolls and backing rolls with a diameter several times that of the work rolls adapted to effect an appreciable reduction in the thickness of the strip to temper it, a second mill in tandem with the first mill, the second mill having large work rolls relative to the work rolls of the first mill adapted to flatten the strip without reducing its thickness materially, means for tensioning the strip between the mills, and means for tensioning the strip leaving the second mill.

4. A two-stand skin-pass mill for finishing strip metal comprising a first mill having small work

rolls and backing rolls with a diameter several times that of the work rolls adapted to effect an appreciable reduction in the thickness of the strip to temper it, means for tensioning the strip entering the first mill, a second mill in tandem with the first mill, the second mill having large work rolls relative to the work rolls of the first mill adapted to flatten the strip without reducing its thickness materially, and means for tensioning the strip leaving the second mill.

5. A two-stand skin-pass mill for finishing strip metal comprising a first mill having small work rolls and backing rolls with a diameter several times that of the work rolls adapted to effect an appreciable reduction in the thickness of the strip to temper it, means for tensioning the strip entering the first mill, a second mill in tandem with the first mill, the second mill having large work rolls relative to the work rolls of the first mill adapted to flatten the strip without reducing

its thickness materially, means for tensioning the strip between the mills, and means for tensioning the strip leaving the second mill.

6. A two-stand skin-pass mill for finishing strip metal comprising a first mill having small work rolls and backing rolls with a diameter several times that of the work rolls adapted to effect an appreciable reduction in the thickness of the strip to temper it, a second mill in tandem with the first mill, the second mill having large work rolls relative to the work rolls of the first mill adapted to flatten the strip without reducing the thickness materially, means for tensioning the strip leaving the second mill, a coiling device for the tempered strip, and operating means for the coiling device to coil the strip under just sufficient tension to make a snug coil.

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