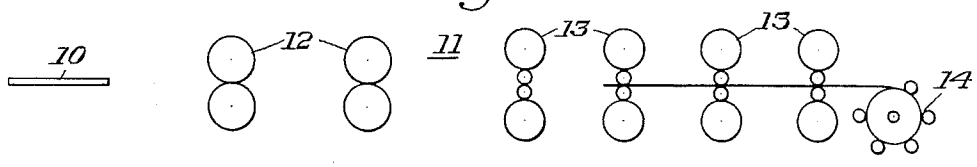
Jan. 16, 1940. R. J. WEAN 2,187,595

METHOD OF MAKING SHEET METAL

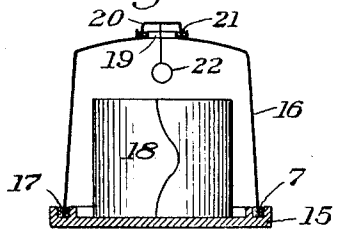
Filed Aug. 24, 1938

Fig. 1.



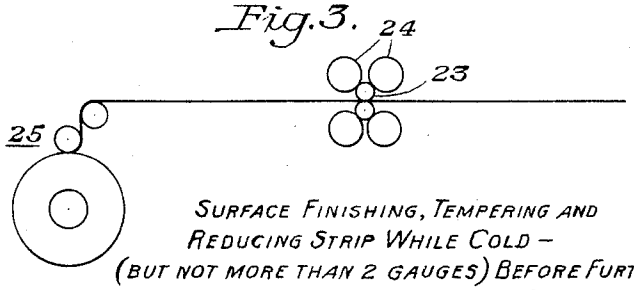
HOT ROLLING OF STRIP 18 GAUGE OR THINNER
(COILED IMMEDIATELY ON ISSUING FROM LAST STAND AT 1300° F. APPROX.)

Fig. 2.



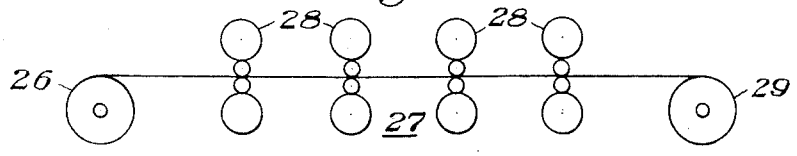
COOLING HOT ROLLED STRIP IN
NON-OXIDIZING ATMOSPHERE.

Fig. 3.



SURFACE FINISHING, TEMPERING AND
REDUCING STRIP WHILE COLD —
(BUT NOT MORE THAN 2 GAUGES) BEFORE FURTHER
PROCESSING, E.G., SHEARING, COATING, STAMPING, ETC.
(PROCESSING UNCOILER OPTIONAL)

Fig. 4.



ALTERNATIVE FINISHING: COLD ROLL TO DESIRED GAUGE

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UNITED STATES PATENT OFFICE

2,187,595

METHOD OF MAKING SHEET METAL

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Application August 24, 1938, Serial No. 226,510

6 Claims. (Cl. 148—11.5)

This invention relates to the manufacture of sheet metal and, in particular, to the making of sheet steel in strip form for various uses at a lower cost than heretofore.

A considerable tonnage of sheet steel in the form of single-pickled, cold-rolled stock is used for a wide variety of purposes and this material is made in all gauges for such uses as require a cold-rolled finish to provide the desired surface condition. Usually, such material is made in thicknesses of twenty gauge or less. The present method of making this material is to hot roll strip to a thickness of sixteen gauge, pickle it and cold roll it to twenty gauge. It is then annealed in a non-oxidizing atmosphere and subjected to a skin pass. The cost of the operations subsequent to the hot rolling varies between eight dollars and ten dollars per ton, which means that the finished product must be sold at a relatively high price.

I have invented a method of making sheet steel having characteristics comparable to those of the present day single-pickled, cold-rolled stock and usable for practically all purposes to which the latter has heretofore been devoted, without incurring the high finishing cost above mentioned. In a preferred practice of the invention, I hot roll steel strip to a thickness of about sixteen gauge, coil it while hot and place it within an enclosure furnished with a non-oxidizing atmosphere. The material thus cools in the absence of atmospheric oxygen which prevents the formation of scale on the strip. The slow cooling also exerts a desirable annealing effect on the material. When it has been sufficiently cooled, I subject it to cold rolling to reduce it to the desired finished gauge but in no case more than two gauge divisions from the thickness of the hot-rolled material. The final reduction may be effected in different ways, some of which will be explained later and may be performed at the entering end of a processing line wherein the material after reduction may be sheared, coated, stamped or the like.

The following detailed explanation of the invention has reference to the accompanying drawing illustrating diagrammatically a preferred practice with certain alternatives. In the drawing:

Fig. 1 is a diagram illustrating the hot rolling of a slab of steel of suitable composition to the form of strip;

Fig. 2 is a diagram illustrating a cooling and annealing treatment to which the coiled strip is subjected after hot rolling;

Fig. 3 is a diagram illustrating one method of effecting the reduction of the hot rolled strip to the desired final gauge; and

Fig. 4 is a diagram illustrating an alternative method of reduction.

Referring now in detail to the drawing, I subject a slab 10 of steel of the desired composition to hot rolling in a continuous mill indicated generally at 11, after heating the slab to a temperature suitable for such rolling, e. g., 1500° F. While I have shown in Fig. 1 a continuous mill comprising two 2-high stands 12 and a plurality of 4-high stands 13, it will be understood that that the reduction of the heated slab into strip form may be accomplished by any convenient method or apparatus known to the rolling art. The several stands of the mill 11 are adjusted to produce hot rolled strip which is not more than two gauge divisions thicker than the desired finished material. If eighteen gauge material is being manufactured, for example, the hot rolled strip would be reduced to a thickness not exceeding sixteen gauge. Similarly, if twenty or twenty-two gauge finished material is desired, the hot strip is reduced to eighteen or twenty gauge or less.

The strip turned out by the mill 11 is coiled tightly by a coiler indicated at 14. The coiler is preferably located as close as possible to the last stand of the mill. The temperature to which the slab is initially heated and the rolling schedule, furthermore, are so determined that the temperature of the strip issuing from the mill will be as high as practicable, e. g., 1250–1350° F., without introducing the risk of adjacent turns of the coil sticking together.

After the hot rolled strip has been coiled, it is placed within an enclosure to which a non-oxidizing atmosphere is supplied. Fig. 2 illustrates one type of such enclosure including a base 15 and a cover 16. A sealing channel 17 extending around the periphery of the base is adapted to receive the lower edge of the open-bottomed cover 16 after a coil has been disposed on the base as indicated at 18. The cover 16 has an opening 19 in the top thereof. A removable closure 20 overlies the opening. A sealing channel 21 extends around the opening to receive the bottom edge of the closure.

The construction just described makes it possible to maintain a non-oxidizing atmosphere within the cover 16, in accordance with my invention described and claimed in greater detail in copending application, Serial No. 219,936, filed July 18, 1938, for Method and apparatus for pro-

viding nonoxidizing atmosphere. According to that invention, a cartridge 22 containing nonoxidizing gas or a material which generates such gas in the presence of heat, is suspended from the closure 20 when the cover 16 is lowered over the coil 18. The contents of the cartridge are released by the melting of a fusible plug in the cartridge or by the fusion or combustion of a suspension thereof and breakage of the cartridge on falling through the coil onto the base 15. The contents of the cartridge serve either to purge the cover 16 of any air trapped thereunder as it is lowered, or to combine chemically with the oxygen content thereof to prevent oxidation of the coiled strip. It will be understood that the formation of the coil in the first place for transfer to the base 15 and enclosure within the cover 16 may be effected sufficiently quickly to preclude substantial oxidation of the strip prior to being enclosed within the cover.

As previously stated, the relatively slow cooling of the coil inside the cover 16 effects an annealing of the strip. The annealing effect produced is determined by the temperature of the strip as it emerges from the last stand of the mill, and the rate of cooling after being placed within the cover 16. The latter is preferably of conducting material such as metal plate, and may or may not have a lining of thermal insulation, depending on the rate of cooling desired. The natural rate of cooling, furthermore, may be increased by air blasts directed onto the cover. The extent of the annealing effect which it is desirable to produce in the coiled strip during cooling thereof depends on the nature of the use to which the material is to be put. Considerable softness is desirable, for example, in material which is to be subjected to severe drawing operations. A much lower softness, however, may be permissible for uses in which only simple drawing or none at all is involved.

After the strip has cooled substantially to atmospheric temperature, it is removed from the enclosure formed by the cover 16 and base 15 by merely lifting the former. The strip is then ready to be subjected to cold rolling to reduce it to its desired finished gauge but not in excess of two gauge divisions, i. e., from 18 to 20, from 20 to 22, from 22 to 24 or the like.

One form of apparatus for effecting the final cold reduction is shown in Fig. 3 and includes a pair of work rolls 23 having off-set backing rolls 24, the rolls being suitably journaled in the usual housings (not shown). The rolls 23 and 24 are preferably designed to have sufficient spring to compensate for inequalities in the thickness of the strip across the width thereof. Before being passed through the rolls 23, the strip may or may not be subjected to the action of a processing uncoiler indicated at 25. Because of the nonoxidizing atmosphere maintained within the cover 16, the scale formed on the coil during cooling is not sufficient to prevent satisfactory cold reduction without the necessity of first subjecting the strip to an acid pickling. The rolls 23 produce a high finish on the surface of the strip and also effect a tempering thereof. After passing between the rolls 23, the strip may be fed continuously through a line of equipment for further processing such as shearing, coating, stamping or the like. The simplicity of the arrangement shown in Fig. 3 is such that users of sheet metal will probably prefer to buy hot rolled strip in coils produced according to the invention and reduce it to finished gauge at their own plants just prior to further processing operations which their product requires. Alternatively, the strip may be reduced to finished gauge before it leaves the steel mill. In either case, the cost of the finished material is only slightly more than that of the hot rolled strip and is much less than the cost of equivalent single-pickled, cold-rolled stock made according to methods previously used.

Fig. 4 illustrates an alternative method of finishing the hot rolled strip. It comprises simply passing the hot rolled strip from a coil 26 through a cold reducing mill 27 conveniently including a plurality of stands of 4-high mills 28, and recoiling it on a reel 29. Other forms of mills may also be employed for effecting the cold rolled reduction. The advantage of the invention resides not so much in the specific manner of effecting the cold rolling reduction as it does in the fact that only a relatively small cold reduction is effected. This adds to the economy resulting from the avoidance of the pickling before cold rolling and annealing after cold rolling which have been necessary heretofore.

The amount of cold reduction required expressed as a percentage of the thickness of the hot rolled strip, varies from 17% to 25% for finished gauges between eighteen and twenty-four. For these gauges, the thickness of the hot rolled material varies from sixteen to twenty-two gauge. In all cases I prefer to reduce the hot rolled strip to a thickness not more than two gauge divisions greater than the gauge of the finished material.

The material produced in accordance with the invention may be used for a wide variety of purposes, in addition to those for which single-pickled, cold-rolled stock as previously made has been employed. It provides material cheaper than the latter for use as barrel stock and also provides a source of material cheaper than that which has been previously used for automobile bodies, enameling stock, and the like. The invention not only has the advantage of a reduction in the cost of the product as compared with single-pickled, cold-rolled stock, but also makes it possible to dispense entirely with pickling and associated operations which are objectionable from the operator's standpoint because of the fumes which inevitably accompany such process.

Although I have illustrated and described but a preferred practice of the invention with one modification thereof, it will be understood that changes in the procedure described may be made without departing from the spirit or sacrificing the advantages of the invention as defined in the appended claims.

I claim:

1. In a method of making sheet metal, the steps including hot rolling a slab into strip in the open air, coiling the strip, substantially immediately disposing a coil of hot-rolled strip, while at a temperature of 1000° F. or above, on a supporting base, lowering a protective cover thereover, supplying a non-oxidizing atmosphere within said cover, and, when the strip has cooled substantially to atmospheric temperature, cold rolling it to gauge in the absence of contact with acid.

2. In a method of making sheet metal, the steps including hot rolling a slab to strip form in the open air and coiling it substantially immediately at a temperature of 1000° F. or above in air, disposing the coil in an enclosure and permitting it to cool slowly while supplying a nonoxidizing atmosphere thereto, and, after the strip has cooled substantially to atmospheric tempera-

ture, maintaining it out of contact with acid and reducing its thickness by not more than 25% by cold rolling.

3. In a method of making sheet metal, the steps including hot rolling a slab in air to a thickness not more than 35% in excess of the desired finished gauge, coiling the strip in air substantially immediately, disposing it within an enclosure and supplying a non-oxidizing atmosphere thereto, and when the strip has cooled substantially to atmospheric temperature, maintaining it free from acid and reducing its thickness by not more than 25% by cold rolling.

4. In a method of making sheet metal, the steps including subjecting a heated slab to hot rolling in air to produce hot rolled strip having a thickness exceeding that of the desired finished product by not more than two gauge divisions, coiling the strip in air substantially immediately while at a temperature of about 1300° F. and substantially immediately on completion of the coiling, placing the coiled strip in an enclosure and maintaining a non-oxidizing atmosphere therein during cooling of the strip, whereby the strip may be cold-rolled to final gauge without contact with acid.

5. In a method of making sheet metal, the steps including hot rolling a slab to strip in air and coiling the strip substantially immediately in the open air while at a temperature of 1000° F. or above and, before substantial cooling of the strip has taken place, disposing it in an enclosure, supplying a non-oxidizing atmosphere within said enclosure while permitting the coiled strip to cool slowly therein, and then, when the strip has cooled sufficiently, removing it from said enclosure and cold rolling the strip to the desired gauge in the absence of contact with acid.

6. In a method of making sheet metal, the steps including hot-rolling a slab into strip in the open air, coiling the strip substantially immediately, disposing the coil of hot-rolled strip, while at a temperature of 1000° F. or above, on a supporting base, lowering a protective cover thereover, supplying a non-oxidizing atmosphere within said cover, and, when the strip has cooled substantially to atmospheric temperature, cold rolling it to gauge in the absence of contact with acid.

RAYMOND J. WEAN.

CERTIFICATE OF CORRECTION.

Patent No. 2,187,595. January 16, 1940.

RAYMOND J. WEAN.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, second column, line 57, beginning with "In a method" strike out all to and including the word and period "acid." in line 67, comprising claim 1, and insert instead the following -

> In a method of making sheet metal, the steps including hot rolling a slab to strip form in the open air and substantially immediately coiling it at a temperature of 1000° F. or above in air, disposing the coil in an enclosure and permitting it to cool slowly while supplying a non-oxidizing atmosphere thereto, and cold rolling the strip to gauge, when it has cooled substantially to atmospheric temperature, in the absence of contact with acid. ;

and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 12th day of March, A. D. 1940.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)