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PATENT SPECIFICATION

NO DRAWINGS. **984,951**

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COMPLETE SPECIFICATION

Sheet Steel and method of making it

We, JOHN LYSAGHT (AUSTRALIA) LIMITED, a Company incorporated under the laws of the State of New South Wales, of 50 Young Street, Sydney, in said State, Commonwealth of Australia, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:—

This invention relates to the manufacture of cold-reduced, annealed, low carbon steel sheet.

Although not restricted thereto, the invention is primarily concerned with steel sheet which is eventually galvanised, and the invention is described herein (by way of example) largely in terms of its applicability to that purpose.

In almost every use of low-carbon sheet steel it is necessary to deform it; for example, it is corrugated, ribbed or flanged to make roofing sheets or other claddings; it is used, crimped, folded, beaded, drawn, arcuately rolled and otherwise formed in the making of pipes, gutters, containers and many other articles.

Conventionally produced low-carbon, cold-reduced annealed steel sheets exhibit the undesirable characteristics of "springback," "fluting," and "stretcher strain." These disabilities are well known in the art.

Fluting and stretcher strain have hitherto been partially controlled by the process of temper rolling and or roller levelling after the annealing process. Those expedients are not completely satisfactory however, because steel sheet so treated is subject to "ageing". This results in a return, after a period of time, of the undesirable fluting or stretcher strain, accompanied by increased springback.

Springback, fluting, stretcher strain and ageing are more pronounced in cold-reduced batch-annealed low carbon steel than in the older pack rolled product, while the otherwise advantageous advent of continuous annealing processes has resulted in further increase of these undesirable characteristics.

While special steels (so-called "stabilised" or "non-ageing" steels) are being used, which are virtually free from the above-stated defects, their use is usually confined to those cases where the steel has to undergo the more severe forming operations, owing to their considerably higher price. Moreover, they possess definite disadvantages for hot-dip galvanising processes, and they are not (so far as we are aware) suitable for continuous annealing processes.

The main object of the present invention is to overcome or ameliorate the stated disabilities in a very simple manner, by the provision of a method of producing cold-reduced, annealed steel sheet from conventional low carbon steel, which has lower springiness and increased resistance to fluting and stretcher strain, which requires little temper rolling and or roller levelling by comparison with similar steels as hitherto produced, and which retains a higher resistance to return of the mentioned undesirable characteristics.

The term "sheet" as used hereinafter is intended to apply to steel layers of any required length, and of any practical width having regard to the nature of the rolling equipment available. For example, the sheet width may be as great as six feet or even more, or as small as one foot or even less; it is customary however, when producing relatively narrow sheets, to produce sheet a good deal wider than the required width, as may be best suited to the production plant, and then obtain the lesser width sheets by longitudinal slitting.

The term "sheet" as used herein is also intended to apply only to steel layers of a finished thickness within the range of 0.05" to 0.012", as to apply the method subject hereof to the production of steel layers outside that range becomes impracticable, in an economic sense, as the required final thickness

[*Price 4s. 6d.*]

recedes from the stated range either positively or negatively.

The invention may be summarised as a method of making cold-reduced, annealed, low-carbon steel sheet of a final sheet thickness within the range of 0.05" to 0.012"; which comprises the steps of cold-reducing a conventionally produced initial strip to bring it to an intermediate thickness which is from 10% to 25% greater than said final sheet thickness, annealing the strip of intermediate thickness, then further cold-reducing said strip to bring it to said final sheet thickness, and finally annealing the sheet so formed.

The initial strip is produced in any conventional manner; for example, by hot rolling to give what is commonly referred to as "hot strip." The thickness of this initial strip is not critical. It may be selected, for production of a given final thickness, on the basis of what would be commonly regarded as a suitable thickness for conventional single stage cold reduction to that final thickness, because the intermediate thickness required according to the present invention is only fractionally greater than the required final thickness.

The initial strip thickness will be governed by economic and technical factors applicable to the production plant to be employed. For ordinary four high mills a suitable initial thickness, when the final thickness is required to be (say) 0.049", would be from 0.12" to 0.10"; and for a final thickness of 0.024" or less, a suitable initial thickness would be from 0.080" to 0.070".

The initial strip is first pickled, preferably continuously, to remove oxides and the like. It is then subjected to the first cold reduction which brings it to an intermediate thickness which is from 10% to 25% greater than the required final thickness, and preferably from 12% to 18% greater than the final thickness.

After the first reduction the first anneal is effected. This may be any conventional method of annealing but for ~~preference~~ preference it is a batch anneal. The second cold reduction is then carried out. The second anneal is then effected. Like the first it may be of any conventional kind, but if it is to be followed by continuous galvanising it is preferably a continuous anneal as the final anneal and the galvanising will then both be continuous and hence effected in such close sequence as to amount to a single operation.

By way of example typical thickness figures according to the invention may be as set forth in the following table:

Initial Strip Thickness (Inches)	Intermediate Thickness (Inches)		Final Sheet Thickness (Inches)
	Limiting Range	Preferred Range	
0.12 to 0.10	0.0539 to 0.0613	0.0549 to 0.0578	0.049
0.085 to 0.080	0.0264 to 0.0300	0.0269 to 0.0283	0.024
0.080 to 0.070	0.0132 to 0.0150	0.0134 to 0.0142	0.012

Experiment has indicated that steel sheet when made according hereto, either as a continuous sheet or as a number of separate individual sheets, has a grain structure including a high proportion of large grains which gives low springback and a product which requires much less severe temper rolling and or roller levelling, than conventionally processed steels, to suppress fluting or stretcher strain; and which has a very substantially improved resistance to return of these undesirable properties.

WHAT WE CLAIM IS:

1. A method of making cold-reduced, annealed, low-carbon steel sheet of a final sheet thickness within the range of 0.05" to 0.012"; comprising the steps of cold-reducing a conventionally produced initial strip to bring it to an intermediate thickness which is from 10% to 25% greater than said final sheet thickness, annealing the strip of intermediate thickness, then further cold-reducing said strip to bring it to said final sheet thickness, and finally annealing the sheet so formed.

2. A method according to claim 1 wherein said intermediate thickness is from 12% to 18% greater than said final sheet thickness.

3. A method according to claim 1 or claim 2 wherein the step of annealing the strip of intermediate thickness is performed as a batch anneal.

4. A method according to any one of the preceding claims wherein said step of finally annealing the sheet is performed as a continuous anneal.

5. A method of making cold-reduced,

recedes from the stated range either positively or negatively.

The invention may be summarised as a method of making cold-reduced, annealed, low-carbon steel sheet of a final sheet thickness within the range of 0.05" to 0.012"; which comprises the steps of cold-reducing a conventionally produced initial strip to bring it to an intermediate thickness which is from 10% to 25% greater than said final sheet thickness, annealing the strip of intermediate thickness, then further cold-reducing said strip to bring it to said final sheet thickness, and finally annealing the sheet so formed.

The initial strip is produced in any conventional manner; for example, by hot rolling to give what is commonly referred to as "hot strip." The thickness of this initial strip is not critical. It may be selected, for production of a given final thickness, on the basis of what would be commonly regarded as a suitable thickness for conventional single stage cold reduction to that final thickness, because the intermediate thickness required according to the present invention is only fractionally greater than the required final thickness.

The initial strip thickness will be governed by economic and technical factors applicable to the production plant to be employed. For ordinary four high mills a suitable initial thickness, when the final thickness is required to be (say) 0.049", would be from 0.12" to 0.10"; and for a final thickness of 0.024" or less, a suitable initial thickness would be from 0.080" to 0.070".

The initial strip is first pickled, preferably continuously, to remove oxides and the like. It is then subjected to the first cold reduction which brings it to an intermediate thickness which is from 10% to 25% greater than the required final thickness, and preferably from 12% to 18% greater than the final thickness.

After the first reduction the first anneal is effected. This may be any conventional method of annealing but for ~~preferance~~ it is a batch anneal. The second cold reduction is then carried out. The second anneal is then effected. Like the first it may be of any conventional kind, but if it is to be followed by continuous galvanising it is preferably a continuous anneal as the final anneal and the galvanising will then both be continuous and hence effected in such close sequence as to amount to a single operation.

By way of example typical thickness figures according to the invention may be as set forth in the following table:

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0.080 to 0.070	0.0132 to 0.0150	0.0134 to 0.0142	0.012

Experiment has indicated that steel sheet when made according hereto, either as a continuous sheet or as a number of separate individual sheets, has a grain structure including a high proportion of large grains which gives low springback and a product which requires much less severe temper rolling and or roller levelling, than conventionally processed steels, to suppress fluting or stretcher strain; and which has a very substantially improved resistance to return of these undesirable properties.

WHAT WE CLAIM IS:

1. A method of making cold-reduced, annealed, low-carbon steel sheet of a final sheet thickness within the range of 0.05" to 0.012"; comprising the steps of cold-reducing a conventionally produced initial strip to bring it to an intermediate thickness which is from 10% to 25% greater than said final sheet thickness, annealing the strip of intermediate thickness, then further cold-reducing said strip to bring it to said final sheet thickness, and finally annealing the sheet so formed.

2. A method according to claim 1 wherein said intermediate thickness is from 12% to 18% greater than said final sheet thickness.

3. A method according to claim 1 or claim 2 wherein the step of annealing the strip of intermediate thickness is performed as a batch anneal.

4. A method according to any one of the preceding claims wherein said step of finally annealing the sheet is performed as a continuous anneal.

5. A method of making cold-reduced,

annealed, low-carbon steel sheet substantially as herein described.

6. Cold - reduced, annealed, low - carbon steel sheet when made by a method according to any one of the preceding claims.

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