June 30, 1942. H. W. DODSON ET AL 2,288,184

METHOD OF MAKING STAINLESS-CLAD SHEET-STEEL

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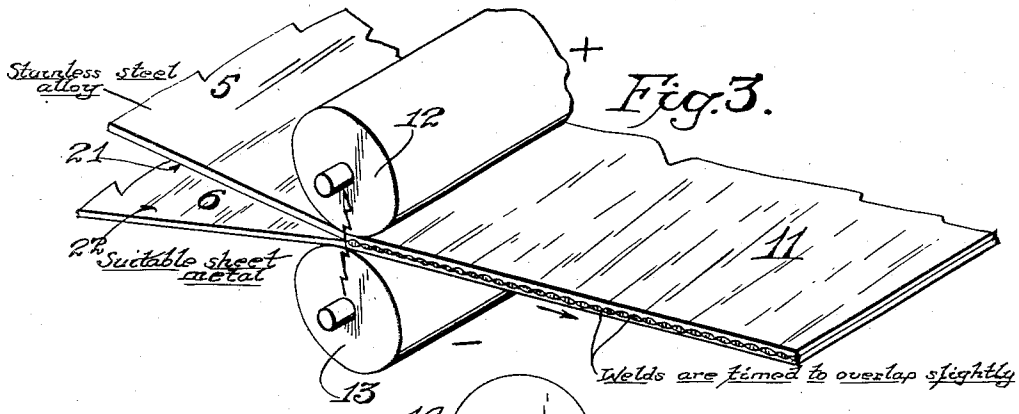

Fig. 3.

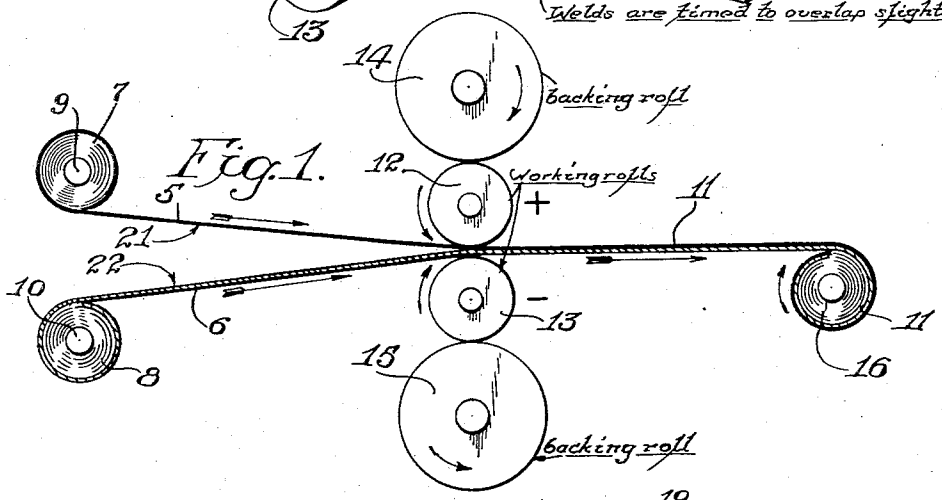

Fig. 1.

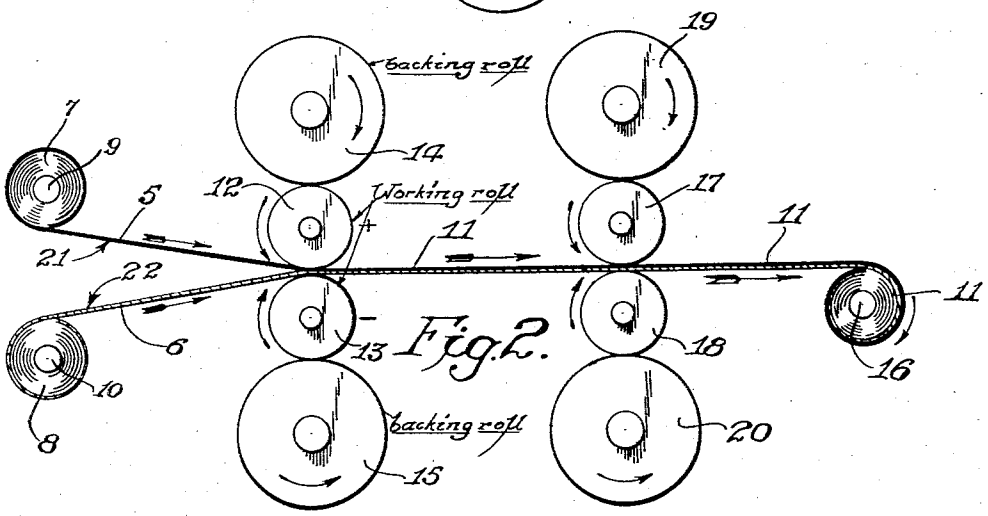

Fig. 2.

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METHOD OF MAKING STAINLESS-CLAD SHEET STEEL

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1 Claim. (Cl. 219—10)

The present invention relates to a certain new and useful method of making stainless clad steel, although the method of the present invention may be applied to any other composite sheet metal formed of two pre-formed sheets of metal.

Stainless steel is now well recognized in the art, and for the various compositions or analyses and for the various methods of making stainless steel reference may be had to the known and published art.

Stainless steel is an expensive metal compared to the more common ferrous metals, such as structural steel, or ordinary sheet steel of various grades and analyses, and for this reason stainless steel is more or less limited in its uses by economic considerations. For this reason, various attempts have been made to make what is sometimes referred to as armored stainless steel sheets wherein some part of the total thickness of the sheet would be ordinary steel of suitable grade and some other part of the thickness would be stainless steel, so that the sheet will present a stainless steel surface on one side and an ordinary steel-surface of the other side. Such armored stainless steel sheets were intended wherever stainless steel surface was desired, but where the tensile strength of stainless steel was not necessary, that is, where a stainless steel was not used for structural strength but largely for corrosion resistance, and where an ordinary steel would amply serve for structural strength.

One of the practices in the past has been to make an ingot of a suitable stainless steel alloy and another ingot of an ordinary steel of suitable grade, as for instance soft steel, both ingots being the same size. These two ingots were then placed one on top of the other while hot and plastic, and the two ingots were then rolled together through rapid rolling operations until the united ingots were thinned down and spread out into a single two-ply sheet in much the same way as that in which ordinary sheet metal is rolled. As the two ingots are flattened out in successive rolling operations they are also firmly united with each other. One of the difficulties encountered by this process has been a comparative lack of uniformity because of the difference in plasticity of the two nigots and therefore the difference in yield under the rolling operation. This process has been unable to produce comparatively thin two-ply armored stainless steel sheets.

One of the objects of the present invention is to make a two-ply armored stainless steel sheet which can be produced much more cheaply and which will be much thinner and hence suitable for many purposes for which a thick sheet is not suitable, and which will be more uniform in the thicknesses of the two different metal layers.

In the accompanying drawing in which like reference characters indicate like parts,

Figure 1 represents a diagrammatic view of apparatus for carrying out the present invention;

Figure 2 represents a similar diagrammatic view of a modified form of apparatus.

Figure 3 represents a diagrammatic perspective view of the welding rolls.

According to the present invention, a preformed sheet 5 of stainless steel alloy and a preformed sheet 6 of any suitable carbon steel are provided, preferably supplied from corresponding coiled-up supplies 7 and 8 coiled up on suitable supply rolls 9 and 10. The sheets 5 and 6 may be of any suitable thickness and may indeed be quite thin, running down to small fractions of an inch. Thus, the stainless steel sheet 5 may be five or ten thousandths of an inch, while the backing steel sheet 6 may be of any desired thickness depending on the structural strength desired in the resultant two-ply sheet 11.

The sheets 5 and 6 may be of any suitable width depending on the current available and the capacity of the machine.

The sheets 5 and 6 are fed from the rolls 9 and 10 in superposed positions as indicated in the general manner shown in Figure 1, to between a pair of juxtaposed welding rolls 12 and 13 mounted in electrically insulated housings and suitably journalled and having connected to them the opposite terminals of an electrical circuit as indicated in the drawing. Suitable backing rolls 14 and 15 serve to press against the respective welding rolls 12 and 13 and to maintain the pressure therebetween. The welding rolls 12 and 13 are electrically insulated with respect to each other so that current must pass through the sheets 5 and 6.

By passing either a continuous but preferably a series of intermittent electrical charges of suitable voltage and amperage and for suitable periods through the rolls 12 and 13, and hence the sheets 5 and 6, these sheets are welded to each other as indicated in Figure 3, the resistance of the sheets 5 and 6 serving to produce heat therein. When using intermittent or individual electrical charges, the successive electrical charges are so timed in relation to the rotation of the rolls 12 and 13 and in relation to the linear speed of the sheets 5 and 6 that the weld produced by

one electrical charge passing through the sheets will be slightly overlapped by the next weld produced by the next electrical charge passing through the sheets, and so on, so that the net effect will be a generally continuous weld between the sheets.

The sheets may either be wound directly upon a take-up roll 16 after they leave the welding rolls 12 and 13, or they may be first passed through one or more sets of rolls like 17 and 18 backed by suitable backing rolls 19 and 20, which serve as a strip mill to reduce the over-all thickness of the composite two ply sheet 11 to any desired extent. This reduction may be only slight or it may be substantial depending on the desired result.

The sheets 5 and 6 are cleaned preliminary to the process hereinabove indicated, by any suitable pickling or cleaning methods, so that the juncture surfaces 21 and 22 thereof are clean and conducive to production of a good weld juncture or union.

Thus, the surfaces 21 and 22 must be entirely free of scale or other surface formations.

All the rolls, including the supply rolls 9 and 10 and take-up roll, etc., as well as the welding rolls and strip mill rolls, are suitably journalled in bearings supported by housings in the manner similar to that employed in rolling mills, and these parts are not here shown because they may be of any desired construction indicated by good engineering practice applicable to rolling mills.

The working rolls or welding rolls 12 and 13 are made of metal having high electrical conductivity and maximum hardness. Such materials are now known and used as electrodes in resistance welding methods known in the art. These rolls 12 and 13 may be suitably cooled by water or other means so as to reduce or minimize the heat effect thereon by reason of the welding operation.

The present method permits fine reduction in the thickness of the composite or two-ply stainless clad sheet steel, without creating work hardness. It also eliminates or minimizes work hardness already created. The welding heat being accurately controllable acts as an annealing agent. For this reason the method of the present invention permits rolling lighter gauges than heretofore commercially practicable. The present invention also permits a stainless clad steel product at lower cost thereby allowing such composite two-ply sheet metal to enter fields not now using stainless steel because of cost, such as for instance acid and chemical tanks; liquid storage and transportation tanks in general; barrels; water piping; building construction; structural work and the like.

The pressure used between the welding rolls 12 and 13 may be increased so as to assist in the reduction of the thickness, thereby relieving some of the work to be done by the rolls 17 and 18 or other successive pairs of rolls of the same kind.

The process or method of the present invention is readily adaptable to continuous mill operations or continuous mill line-up, entailing little or no substantial changes to other machinery or processes.

By the present method also any strips which have been rejected as imperfect or otherwise deficient for commercial use may be built up and re-processed.

The amount of current and therefore the heat may be controlled and also the time interval during which each passage of current is permitted to flow through the metal.

By the present process or method, sheets of various gauges and analyses may be readily assembled on short notice and without detailed scheduling. Thus, the relative thickness of the stainless steel alloy sheet and the ordinary sheet steel may be varied, and the analysis or quality of the stainless steel and regular steel may also be varied. Thus, by merely carrying in stock stainless steel sheets of relatively few thicknesses or gauges and of relatively few compositions or analyses, and by carrying in stock an assortment of ordinary steel sheet metal of various gauges and analyses, any two sheets may readily be combined to produce a composite two-ply stainless steel clad sheet having any desired over-all thickness and having any desired thickness of stainless steel alloy and regular steel and having any desired analyses in either of the two plies.

As hereinabove pointed out, the time interval during which each charge of current is passed through is correlated to the speed at which the rolls rotate or the linear speeds of the sheets. If desired, however, the rotation of the rolls 12 and 13 and the movement of the sheets at the welding point may be made intermittent with the motion timed in relation to the passage of current so that with each passage of current the sheets may be stationary for the duration of the current-passage after which the sheets are moved a slight amount for the passage of the next charge of current and so forth. This may not be necessary, however, because the rotation of the rolls 12 and 13 and the linear motion of the sheets 5 and 6 at the welding points may be continuous. If, however, an intermittent motion is used at that point, the operation of the one or more sets of strip mill rolls may nevertheless be continuous, due allowance being made for allowing a slight slack between the rolls 17 and 18 and the rolls 12 and 13; this slack being made up by any suitable variable or yieldable tensioning device which will maintain the more or less uniform tension notwithstanding the intermittent motion of the rolls 12 and 13 and the continuous motion of the rolls 17 and 18.

The term "ordinary steel" where used in the following claim has reference to steel other than the stainless steel used in making up the two-ply sheet.

The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof, and it is therefore desired that the present embodiments be considered in all respects as illustrative and not restrictive, reference being had to the appended claim rather than to the foregoing description to indicate the scope of the invention.

Having thus described the invention, what is hereby claimed as new and desired to be secured by Letters Patent, is:

A generally continuous method of making two-ply stainless-clad sheet-steel, which comprises bringing together a preformed relatively thin and relatively wide sheet of stainless steel-alloy and a pre-formed sheet of ordinary steel of generally like width, along a line across the sheets, exerting pressure upon said sheets simultaneously to press said sheets together on said line while the widths of said sheets are in substantial registration with each other along said line of pressed-contact, continuously moving successive portions of said sheets into said pressed-line contact in a direction transversely of said line, and inter-

mittently passing a welding electrical current through said two sheets through substantially the entire line of pressed-contact as successive portions of said sheets are moved into said pressed-line contact, of an intensity and volume and for a sufficient length of time in relation to the speed of the motion of said sheets to weld said two sheets together substantially continuously throughout their contiguous major surfaces by closely-spaced generally parallel line-welds, each formed simultaneously across the width of said sheets.

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