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METHOD FOR THE PRODUCTION OF METAL SHEETS
OF COMPLEX CROSS-SECTIONAL FORM
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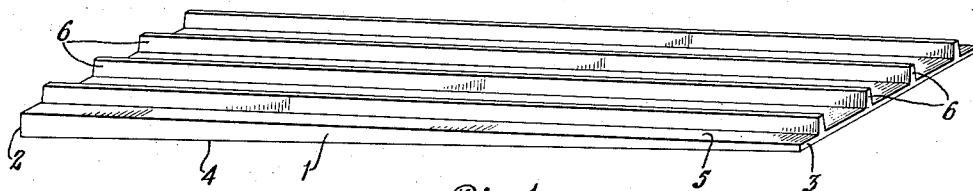


Fig. 1.

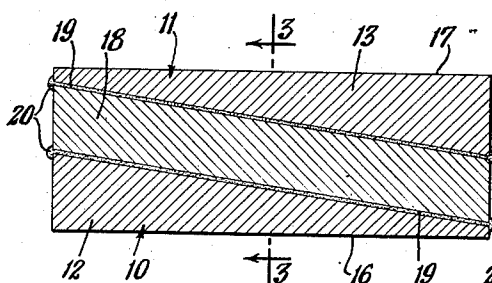


Fig. 2.

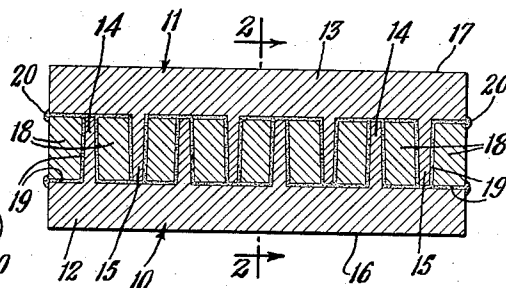


Fig. 3.

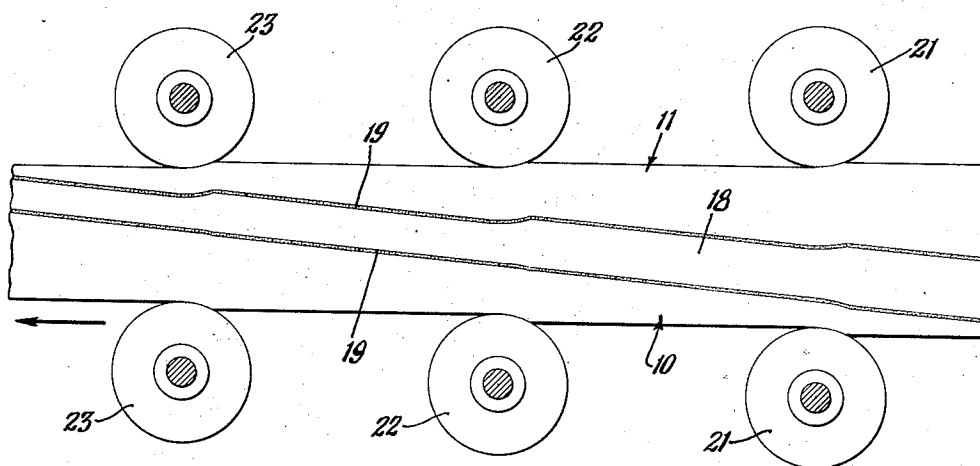


Fig. 4.

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METHOD FOR THE PRODUCTION OF METAL SHEETS OF COMPLEX CROSS-SECTIONAL FORM

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1 Claim. (Cl. 29—423)

This invention relates to a method for the production of metal sheets of complex cross-sectional form.

Metal sheets having a complex cross-sectional form are coming into industrial use for various purposes. A notable use for such sheets is in the production of airplane wings without the use of internal struts. Sheets, for example, having a longitudinally tapering cross-section with integral stiffening ribs on one surface are used for such wings. The production of these sheets has heretofore involved an extensive machining operation to produce the complex combination of the tapered sheet and integral stiffening ribs or a difficult rolling operation combined with the welding of the stiffening elements to the sheet.

Such metal sheets are frequently heat treated after they are produced in the desired form to alter the characteristics of the metal involved. This heat treatment has a tendency to cause them to become permanently warped.

Now, it is the object of this invention to provide a method for the production of metal sheets having a relatively complex cross-sectional form by the use of standard rolling equipment while avoiding the machining of large surface areas.

A further object of this invention is to provide a method for the production of metal sheets having a relatively complex cross-sectional form in which the metal sheets are heat treated without warping and loss of the desired form.

Other objects and advantages of this invention will become apparent from the description thereof which follows.

By the method in accordance with this invention, I form two metal sections which have a substantially plane surface and an opposite surface which is not a plane. These sections may be duplicates or they may be different in form. In either case, they are longitudinally foreshortened and thickness-magnified counterparts of the sheets which I desire to produce. I magnify the thickness in direct proportion to the longitudinal foreshortening of the section. Both the longitudinal foreshortening and the thickening of these sections are determined by the extent of the longitudinal elongation and the accompanying reduction in the thickness of the sections in a rolling operation which forms a subsequent step in this method. The width of these sections and the transverse proportions of their surface features are identical with those of the desired sheets since there is little or no change in transverse dimensions in the rolling operation.

In the foregoing I utilize the term "longitudinal" to mean the line along which the section moves in the subsequent rolling step but not the direction of the movement along that line. The movement may be in either direction. I use the terms "width" and "transverse" to refer to dimensions at right angles to the line along which the rolling occurs. It will be appreciated that these sections may be wider than they are long, despite

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the fact that the longitudinal dimension of my finished sheet is usually the greater of the two.

Further, I produce one or more dummy metal sections which are shaped as companion sections to the two foreshortened sections in a form or forms which will permit it or them to be positioned between the two foreshortened sections adjacent their surfaces which are not planes, with small surface clearances while placing the plane surfaces of the foreshortened sections in parallel planes.

I may produce these foreshortened and dummy metal sections by casting, by casting combined with grinding, or by a machining operation.

I then assemble two of the foreshortened metal sections and their companion dummy sections into a composite block having two parallel outer surfaces with the foreshortened sections positioned longitudinally in the same direction or in exactly reversed directions, i. e. with their plane surfaces rotated with respect to each other by 180 degrees. As I assemble this composite block I position a thin layer of a parting material between each of the adjacent surfaces to keep them from actual physical contact with each other.

The function of the parting material is to prevent any tendency of these surfaces to weld themselves together during the rolling step of my method. The material selected for this purpose is determined to some extent by the particular metal involved and upon the conditions under which the rolling operation is carried out. Powdered magnesium oxide, powdered magnesium silicate, powdered aluminum oxide, graphite and heavy oils of low volatility are useful parting materials. I have found that a finely powdered mixture of 50% magnesium oxide and 50% magnesium silicate is generally useful for this purpose.

In the case of aluminum and aluminum alloys, I have found that the film of aluminum oxide which forms on the freshly cut surfaces of the sections will function as a parting material in operations in which the rolling operation is not particularly severe. However, I have found that it is usually desirable to supplement these aluminum oxide films with an additional layer or film of a parting material.

After this composite block is assembled with its adjacent surfaces separated by layers or films of a parting material, I attach the adjacent edges of each of the adjacent surfaces together. It is essential to have strong attachments between all adjacent edges on the side or edge of the composite block which is first to pass between the rolls in the rolling step. I prefer to form this attachment by a continuous weld along each of the adjacent edges on the outside of the block to avoid any loss of the parting material during the rolling operation. However, the attachment may be made by spot welding the adjacent edges together at intervals and reasonable care used in handling the resulting composite to avoid loss of the parting material.

This composite block is then rolled into a sheet. In the rolling operation, I roll the parallel surfaces of the composite block in the direction of the foreshortening of its two outer sections. Ordinarily, I use a hot rolling operation and heat the composite billet to a uniform elevated temperature below its melting point prior to the beginning of the operation, and in some cases interrupt the operation to reheat the partially reduced composite. In any event, this operation is carried out by the use of the same equipment and under the same conditions which would be used for a solid billet of the particular metal involved.

After the rolling operation has been completed and the composite block is entirely reduced to a composite sheet, I may subject it to a heat treating step to change the characteristics of the metal. The heat treatment

which I use is identical with that normally employed for the treatment of individual sheets of the particular metal which forms my composite sheet. The individual metal sections forming this composite sheet are mutually supporting and together form a composite of uniform thickness, with the result that the individual sections cannot warp into distorted forms during this treatment.

The composite sheet produced by the rolling step, or after the heat-treating step, if one is used, is then separated into its component sections. This may be accomplished, for example, by merely trimming the edges of the composite to eliminate the welds and pulling the outer sheets apart and removing the dummy sections. The outer sheets, resulting from the elongation and thinning of the original foreshortened sections during the rolling operation, each have one plane surface and one surface of the desired complex form. The original dummy sections are also elongated and thinned and may themselves be useful as rods or bars depending upon their particular shape. In any event, they may be melted and the metal again used.

This method may be used with any structural metal, such as, for example, aluminum, alloys of aluminum, iron, iron alloys, including both carbon steels and stainless steels, copper, copper alloys, zinc and zinc alloys. However, I use the same metal for each of the component sections of my composite block.

I will now proceed with a description of a specific embodiment of my method by which I produce an integrally stiffened sheet suitable for use in the construction of an airplane wing, with reference to the accompanying drawings, in which like reference characters are used to refer to like parts. In the drawings:

Figure 1 is a perspective view of the integrally stiffened sheet of varying thickness which I produce by this embodiment of my method.

Figure 2 is a cross-section of the composite block which I roll to produce two sheets such as that illustrated by Figure 1, taken along the direction in which the rolling is carried out and along the section line 2—2 of Figure 3.

Figure 3 is a cross-section of this composite block taken along the section line 3—3 of Figure 2, and

Figure 4 is a diagrammatic illustration of the rolling step of my method in which I reduce the composite block of Figures 2 and 3 to a composite sheet.

Referring to Figure 1, it will be seen that the sheet there illustrated consists of a sheet section 1 which has a longitudinal gradation in thickness from the thicker end designated by the numeral 2 to its opposite end designated by the numeral 3 which is uniform throughout its length. The lower surface 4 of this sheet is a plane while the upper surface 5 carries a plurality of parallel stiffening ribs 6—6 which are integral with the metal of the sheet section 1 and which give the sheet high strength in proportion to its weight. The thickness of the sheet section 1 is uniform across its width.

To produce two sheets such as that illustrated by Figure 1, I assemble the composite block illustrated by Figures 2 and 3. It will be noted that this block comprises two sections 10 and 11 which consist of base sections 12 and 13, respectively, and a plurality of parallel projecting sections 14—14 and 15—15 respectively. These sections 10 and 12 are identical in shape except as to the relationship of the positions of their projecting sections 14—14 and 15—15, respectively, to the edges of their base sections 12 and 13, respectively, to which they are parallel.

The sections 10 and 11 are longitudinally foreshortened versions of the sheet illustrated by Figure 1, having a uniformly magnified thickness. The foreshortening is in the direction longitudinally of their projecting sections 14—14 which is, in turn, the direction in which the composite block is rolled. From a comparison of section 10 with the sheet of Figure 1, it will be appreciated that its base section 12 becomes the sheet section 1 of the finished sheet, while its projecting sections 14—14 become the stiffening

ribs 6—6 of the finished sheet when it is elongated and reduced in thickness by the rolling step of my method.

It will be noted that the sections 10 and 11 are positioned in the composite block of Figures 2 and 3 with their plane surfaces 16 and 17 parallel to each other and with their projecting sections 14—14 and 15—15 adjacent and alternatively positioned to each other. The dummy sections 18—18 are positioned between these alternating projecting sections and all adjacent metal surfaces are separated by a layer or film 19 of a parting material. The edges of the adjacent sections are attached together by continuous welds 20—20 which serve the dual purpose of holding the various sections of the composite block in their assembled position and of retaining the layer or film 19 of parting material between their adjacent metal surfaces.

After the composite block is assembled and welded as illustrated by Figures 2 and 3, I then heat it uniformly to the desired temperature for the rolling step of my method. This temperature is that used in the ordinary rolling of the particular metal involved. This rolling operation is illustrated diagrammatically by Figure 5 which shows the composite block passing successively between three pairs of reducing rolls 21, 21, 22, 22, and 23, 23.

After the composite block has been rolled to a composite sheet of the desired thickness by the rolling operation I may subject the sheet to a heat treatment to relieve strains in the metal, or alter its grain structure or both, and in any case, I then trim off its edges and separate the two sheets formed by the reduction of the sections 10 and 11, and the bars resulting from the elongation of the dummy sections 18—18.

A wide variety of different types of sheets can be produced by this method. Thus, in the foregoing example of a specific embodiment of this invention I may produce an integrally stiffened sheet having stiffening ribs which are integral with a sheet section of uniform thickness, by using instead of sections 10 and 12, sections in which the base sections are of uniform instead of varying thickness. Again, I may produce integrally stiffened sheets in which the ribs are in the form of the letter T by the corresponding change in the form of the projecting sections 14—14 and 15—15, respectively, and the substitution of two or three dummy sections for each dummy section 18, which is in effect the dummy section 18 split longitudinally to facilitate its removal from the under-cuts of the sheets after the rolling operation is complete.

As will be readily appreciated from the foregoing this method provides several important advantages over prior art procedures. The foreshortened sections from which I produce the complex sheets can readily be produced by casting. Even in the alternative in which they are produced by machining, the area which is machined is a minor fraction of the areas which are machined in prior art procedures. Further, the rolling of my composite block both from the standpoint of the temperatures used and the equipment utilized is the usual mill procedure and requires no deviation from the normal routines of the rolling mills.

What I claim and desire to protect by Letters Patent is:

A method for the production of uniformly tapered aluminum sheets having parallel integral stiffening ribs extending outwardly from one of its surfaces, which are adapted for use in the production of airplane wings, which comprises the steps of assembling a composite metal block having two substantially parallel outer surfaces consisting of two duplicating aluminum sections, each of which has a plane surface forming one of said parallel surfaces of the composite metal block and an opposite generally plane surface which carries outwardly extending parallel integral stiffening ribs, each of which is uniformly tapered longitudinally of the said ribs,

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each of which is foreshortened longitudinally of the said ribs and is a thickness magnified counterpart of the desired sheet and each of which is positioned with its longitudinal foreshortening in the same direction as that of its counterpart with respect to the block as a whole, but rotated with respect to the variation in its own thickness and that of its counterpart, a plurality of dummy aluminum sections positioned between and completely filling the interstices between the inwardly facing surfaces of the outer said sections, except for small clearances between the adjacent metal surfaces, and a thin layer of parting compound filling the spaces provided by the said surface clearances; attaching the outer adjacent edges together by a continuous weld which seals the said parting material within the com-

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posite block; rolling the resulting composite block in the direction of its outer metal sections to reduce it to a composite sheet; shearing off the still welded edges of the said composite sheet, and separating the component parts of the said composite sheet.

References Cited in the file of this patent

UNITED STATES PATENTS

1,378,442	Chalfant	May 17, 1921
1,926,320	Trembour	Sept. 12, 1933
1,950,571	Trembour	Mar. 13, 1934
2,144,915	Derby	Jan. 24, 1939
2,193,231	Gibbons	Mar. 12, 1940
2,393,697	Lornitzo	Jan. 29, 1946