

Sept. 12, 1933.

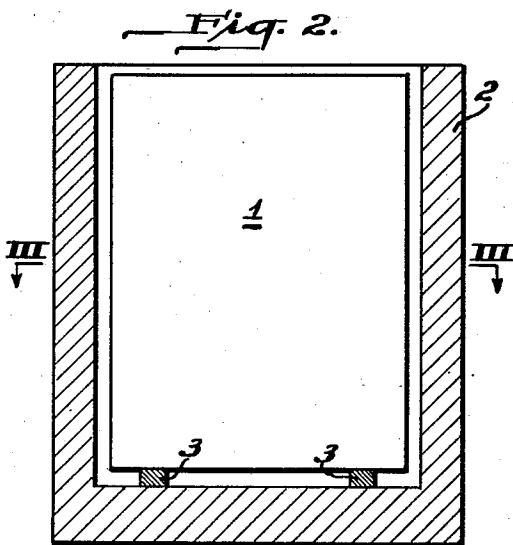
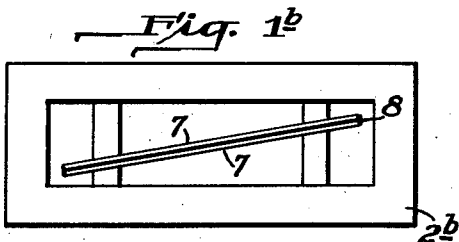
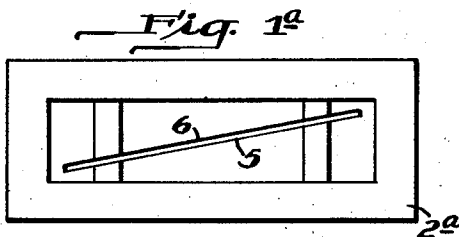
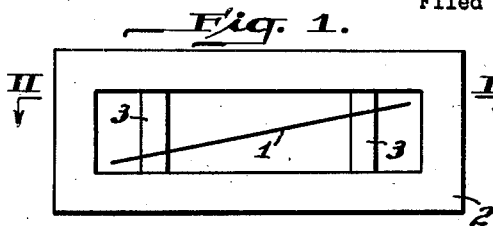
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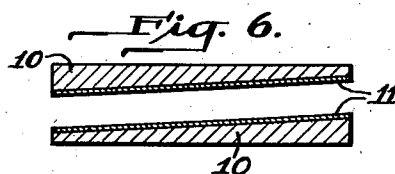
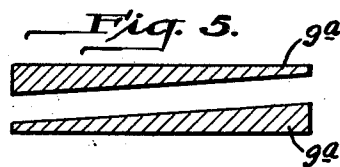
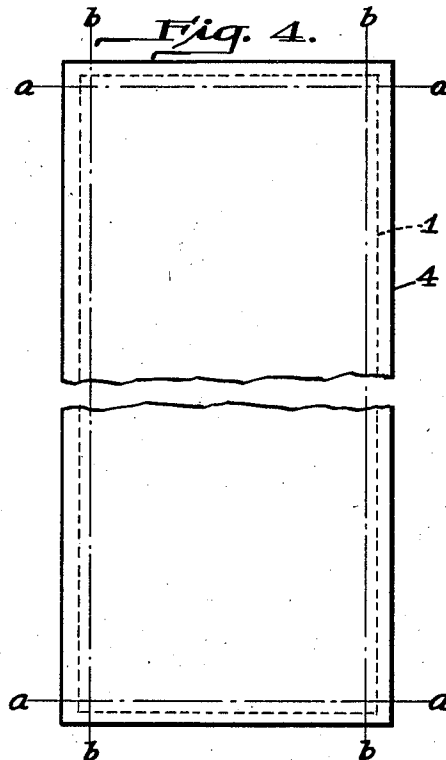
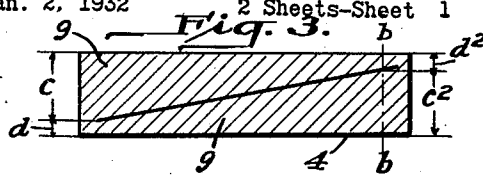
METHOD OF MAKING TAPERED METAL PLATES

Filed Jan. 2, 1932

2 Sheets-Sheet 1



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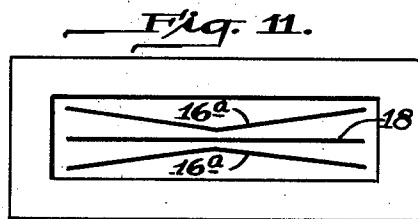
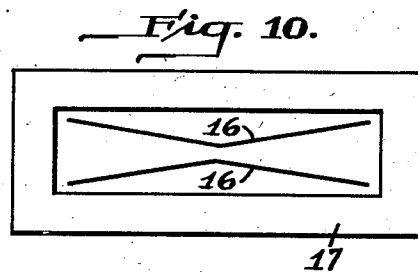
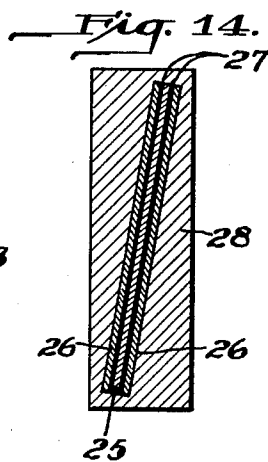
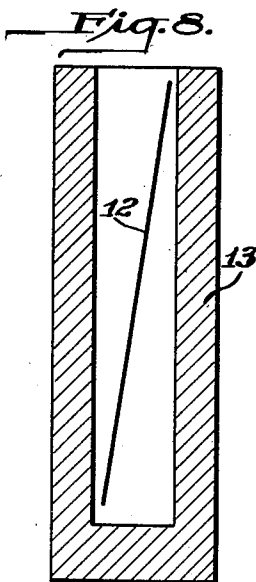
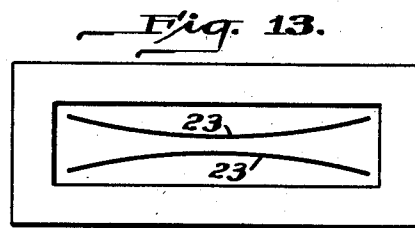
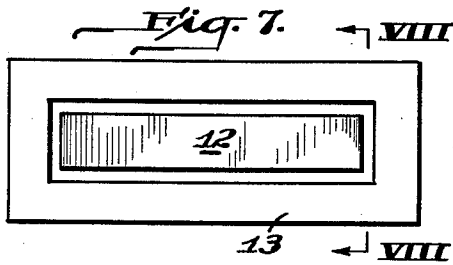
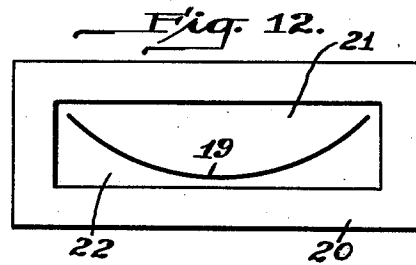
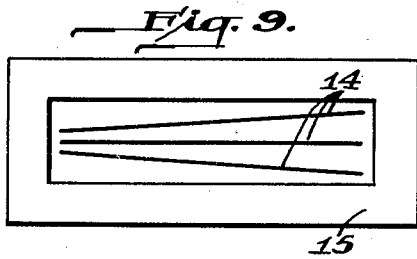
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METHOD OF MAKING TAPERED METAL PLATES

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2 Sheets-Sheet 2



WITNESSES

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## UNITED STATES PATENT OFFICE

1,926,320

## METHOD OF MAKING TAPERED METAL PLATES

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Application January 2, 1932. Serial No. 584,416

11 Claims. (Cl. 29—189)

This invention relates to the production of metallic plates and bars and related shapes of varying section by direct rolling methods.

Up to the time of this invention there has been available no simple and economical method of directly fabricating metallic plates, bars and sheets, and the like shapes having plane bevelled or curved surfaces, i. e. plates and the like of varying section. For instance, in order to produce plates tapered from edge to edge it has been necessary to roll an ordinary parallel side, rectangular section plate by ordinary rolling methods, and then to machine or grind off one of the faces to produce the desired taper. Such operations are expensive, incur substantial metal losses, and substantially increase the number of fabricating operations and amount of handling, as compared with direct rolling methods. The same disadvantages apply to the production of similar articles of varying section having one or more curved surfaces. Especially has it been difficult, if not wholly impracticable, to produce such sheets in relatively large widths and lengths.

It is among the objects of this invention to provide plates and the like rolled shapes of plane or arcuately tapered varying section by direct rolling of parallel surfaced ingots, which may be made cheaply, as rapidly and economically as ordinarily parallel side plates of rectangular cross section, of substantially any desired size, to relatively accurate dimensions and proportions, in the production of which two or more such plates may be formed from a single ingot, and in producing which the scrap losses heretofore present in the production of such articles are avoided.

The invention may be described in connection with the accompanying drawings in which Fig. 1 is a plan view of an ingot mold for use in the practice of the invention; Figs. 1a and 1b views similar to Fig. 1 showing modified embodiments; Fig. 2 a longitudinal section through the mold taken on line II—II of Fig. 1; Fig. 3 a cross section through an ingot made in the mold shown in Figs. 1 and 2, taken on the line III—III, Fig. 2; Fig. 4 a plan view of a slab rolled from the ingot shown in Fig. 3; Fig. 5 an unfolded sectional view of a pair of tapered plates produced from the slab shown in Fig. 4; Fig. 6 an unfolded view similar to Fig. 5 showing a modified embodiment of the invention; Figs. 7 and 8 views similar to Figs. 1 and 2 showing an ingot mold for producing plate tapered from end to end; Figs. 9 to 11 plan views similar to Fig. 1 showing other modifications of the invention productive of plane

surfaced articles of varying section; Figs. 12 and 13 views similar to Fig. 1 showing the application of the invention to the production of curved surface articles of varying section; and Fig. 14 a view similar to Fig. 3 showing still another embodiment.

The invention is predicated upon my discovery that articles of the type contemplated may be made by preparing and rolling an ingot divided internally by one or more unweldable planes into portions of varying section productive of that desired. Such an ingot is rolled to effect the change of ingot section needed to bring the divided ingot portions to dimension, and the rolled slab is then separated along the unwelded dividing plane referred to, whereby to produce two or more plates of the desired varying section. As used herein the term "plate" has reference to bars, slabs, sheets, bands and similar shapes which may be produced by rolling of ingots, and it is used for brevity to comprehend all such shapes.

The invention is not restricted to the production of articles of varying section of any particular metal or alloy, but is applicable to substantially all metals, and to the production of such plates in the form of ply metal. It may be described with particular reference to the production of ferrous base articles, to which it has been applied satisfactorily, and which constitute an embodiment of major importance because the ferrous base metals are used so widely.

Such unwelded dividing planes in the ingots used in the practice of the invention are formed by casting metal around an insert supported in an ingot mold, such insert being capable of providing a parting plane for separation of the varying section plates after the ingot has been rolled, and being appropriately supported in a manner described presently. Various types of insert may be used in the practice of the invention, the chief criterion being that it has a surface which does not unite with the metal used and is not destroyed in the casting or rolling operations, so that it remains as a dividing plane between contiguous portions of the ingot.

Most simply such inserts take the form of a single sheet of material capable of remaining separate from the body of the ingot, for example, thin asbestos sheet. However, in the preferred embodiment of the invention sheet metal inserts are used, and the entire exposed surface of the sheet may be in non-weldable condition. In some instances advantage may be taken of refractory oxide coatings which form on some materials,

for instance on stable surface chromium steels. These oxides may satisfactorily resist alloying and pressure welding between the insert and the metal composing the ingot.

5 For most purposes, however, it is preferred to form such surfaces by coating the surfaces of the insert with weld-preventing material, such as finely divided silica, alumina, or other refractory oxide. This may be accomplished suitably by  
10 applying a solution of sodium silicate to the surfaces of the sheet, dusting on finely powdered oxide, removing the excess of oxide, and drying.

The inserts may also have one surface provided with such a weld-preventing material, and  
15 another surface in clean metallic condition to permit welding to the ingot upon rolling. To this end the sheet is cleaned to remove oxide, dirt, etc. and provide a clean weldable surface, as by pickling, or preferably by sand blasting. One face  
20 is then coated with weld-preventing material in the manner just described.

In a particular embodiment of the invention the inserts may comprise two or more sheets held in fixed back-to-back relation. The adjacent  
25 faces of the sheets are provided with a weld-preventing material to permit parting after rolling has been completed, and the exterior surfaces of this two-part insert are placed in the clean weldable condition just referred to. These metal  
30 inserts capable of having one surface united with the body of the ingot may be of the same composition as the metal of which the ingot is formed, and this applies to single sheet and two-part inserts. However, advantage may be taken of such welding of the insert to the body to effect surfacing of the body of the resultant article, for example to  
35 coat cheap steels with stainless material.

After the insert has been prepared and positioned in the mold metal is poured in to form the ingot. Where welding of one surface of the insert is to be effected particular precautions are necessary. It has been considered that certain metals cannot be pressure welded. For instance, prior attempts to make ply metal from stable surface  
40 chromium irons and steels and baser steels by rolling composite ingots have been unsuccessful. I have found, however, that complete and satisfactory welding may be effected if the surfaces to be welded are in clean metallic weldable condition and if the inserts are completely enclosed within the metal of the ingot. Welding does not  
45 occur as a general rule, in making the ingot, but when such an ingot is rolled the weldable surface of the insert is protected by the gas-tight metallic envelope which surrounds it, and so it remains in weldable condition so that under the influence of heat and rolling pressure it unites satisfactorily with the adjacent ingot surface. Therefore, it is characteristic of the invention that in the use of  
50 inserts of which one surface is to be welded to the body of the ingot, the metal forming the ingot is cast to completely envelop the insert. Where the ingots are divided by non-metallic inserts or inserts having their entire surface provided with weld-preventing material, no particular precautions are necessary in making and rolling the ingot, although in these instances it is desirable also to envelop the insert completely.

The inserts are shaped appropriately, according to the contour of the section desired. Thus, in the production of plane surfaced plates tapered continuously from edge to edge, or from end to end, flat sheet inserts are used, while to produce a discontinuous taper, for instance of double wedge shape, the sheets may be bent to the desired con-

tour. In order to produce curved surfaces the sheets are bowed appropriately, as will be understood from the following description and drawings.

The ingots are made by supporting an insert in  
80 an ingot mold so that it acts as an inner wall dividing the mold into portions productive of the desired varying section. For example, to form ingots varying in taper from side to side, the insert is positioned in the mold with its longitudinal axis parallel to or coinciding with that of the mold, and with its faces inclined angularly to those of the mold. In such case the degree of inclination of the insert is adjusted so as to produce the desired taper proportions in the resultant  
85 rolled article. In general, the insert is supported to divide the ingot into portions whose section is geometrically similar to the final section wished. Thus, to produce a pair of plane surface side tapered plates which are three times as thick at one edge as at the other, the insert would be supported with its longitudinal axis coinciding with that of the mold, and with its faces inclined to the mold faces at an angle such that the ends of the insert lie at a point three-fourths of the distance across the mold. To make end tapered  
90 plates the inserts are supported with their vertical axes parallel to that of the mold and are inclined from the top to the bottom thereof, and similarly other desired section variations may be produced by supporting the insert appropriately to that end.

Molten metal is then cast into the mold around the insert to form an ingot divided internally by the insert in the manner described. Because metallic inserts form the preferred embodiment of the invention, it will be described with particular reference to them. As indicated hereinabove, such inserts are completely surrounded by the metal comprising the body of the ingot. This is effected, of course, by supporting the insert with its faces and edges spaced from the walls and ends of the mold.

The ingots thus prepared are then rolled at normal rolling temperature, between parallel rolls in the manner customarily used in making ordinary uniform section parallel-side plates and the like. This rolling is carried out to bring the divided portions of the ingot to appropriate dimension, preferably to final dimension and both longitudinal and cross rolling may be used depending upon the result desired, as will be understood by those skilled in the art. After the ingot has been rolled the slab is cropped to remove excess metal and expose the edges of the parting plane, or insert, whereupon the rolled slab may be parted along that plane to provide finished plates of varying section.

The invention may be described and understood more in detail with reference to the accompanying drawings. Figs. 1 to 6 represent its simplest embodiment, namely, the production of a pair of identical plates having plane surfaces tapering from one side to the other, i. e. ordinary bevelled plates. Having reference to Fig. 1, an insert 1 is supported in an ingot mold 2, as by means of supporting members 3. The insert is positioned with its faces angularly disposed with respect to the mold walls, and with its longitudinal axis coinciding with that of the mold. It thus divides the mold along a plane extending from a point adjacent one corner of the mold to a point adjacent the diagonally opposite corner. Also, the insert is spaced from all contact with the mold, as shown in Figs. 1 and 2.

Insert 1 may comprise a sheet of non-metallic or other material whose entire surface is incapable of welding or alloying with metal 4. It may assume other forms also, such as a sheet 5, Fig. 1a, of metal provided on one or both sides with a surface coating 6 of silica or other weld-preventing material. Or, the two-part separable inserts described previously may be used. As shown in Fig. 1b such an insert comprises a pair of metallic sheets 7 held in fixed back-to-back relation, as by spot welding at the corners. The exterior surface of this plate is in clean metallic weldable condition, and the adjacent surfaces are separated by a layer 8 of weld-preventing material. Generally the use of these metallic inserts is desirable, since they may be shaped and handled readily, and because their weldable surfaces unite integrally with the body of the ingot. For this latter reason they may be used to make ply metal having their surface covered with a metal different from that of articles comprising a body of one metal, for instance cheap ferrous metal, and a surface coating of another metal, such as stable surface chromium alloy. In such case the insert is formed from sheets of the surfacing metal, e. g. stainless steel.

The insert is positioned in the manner outlined above, so that the divided portions will produce the desired taper, and metal is then cast into the mold to form an ingot divided internally into portions 9 of tapering cross section, and to completely envelop the insert. Fig. 3 shows a cross section of the ingot, cast metal 4 surrounding insert 1.

The ingot is then rolled longitudinally to elongate it, the reduction in section being such as to bring the tapered portion 9 of the ingot to desired dimensions. Excess ferrous metal is then cropped off from the ends and sides of the plate, for example along the lines *a-a* and *b-b*, Fig. 4, thus exposing the edges of the insert. The slab may then be parted to form a pair of bevelled plates 9a, Fig. 5. If desired, the slab shown in Fig. 4 may be cut into lengths before cropping and parting, or may be otherwise treated according to need. Thus the bevelled plates are produced directly by ordinary rolling of ingots of conventional shape.

The positioning of the insert may be understood also by reference to Figs. 3 and 5, which illustrate the production of bevelled plates 9a having one edge four times as thick as the other. To this end insert 1 is supported in the mold so that its ends lie at a point  $\frac{1}{4}$  of the distance between the surfaces of the mold. Thus in Fig. 3, the end of insert 1 lies at a point such that it is spaced distances *c* and *d* from the faces of the ingot, *c* being equal to  $\frac{1}{4}$  and *d*  $\frac{1}{2}$  of the ingot thickness. In this manner each portion 9 of the ingot is four times as wide at one end of the insert as at the other end. These portions will be reduced in rolling proportionately, and the final plates 9a will have the desired 4:1 taper.

The invention may be understood further by reference to the production of high carbon tool steel plates 12 inches wide, 18 inches long, and tapering in thickness across the 12 inch width from  $\frac{1}{4}$  to  $\frac{1}{8}$  inch. An insert about  $13\frac{1}{2}$  inches wide and  $27\frac{1}{2}$  inches long is supported in a parallel side ingot mold 14 inches wide, 6 inches deep, and 30 inches high. The insert is positioned with its longitudinal axis coinciding with that of the mold, its edges being about  $\frac{1}{2}$  inch from the sides, and it is inclined to the mold faces with its edge ends about 2 inches from one face and

4 inches from the other. This provides internal portions tapering 2:1. The insert may comprise a single sheet of difficulty weldable steel, e. g. high chrome steel, oxidized or coated with oxide, over its entire surface. Or, it may be formed of the high carbon tool steel, such as a pair of sheets connected back to back and having adjacent surfaces coated, e. g. with silica, and the outer surfaces cleaned, and preferably roughened slightly, as by sand blasting, for welding. The mold is then filled with clean high carbon tool steel. The ingot is then elongated by rolling in one direction to reduce it from a thickness of 6 inches to  $\frac{3}{8}$  inch. This will form a slab about 480 inches long. The bottom of the slab is cropped off, for instance a length of 6 to 12 inches, and the slab is cut transversely into 48 inch lengths. The edges of the lengths are now cropped to make them 12 inches wide. This exposes the non-weldable dividing plane, and the lengths are parted, thus producing 18 bevelled plates of the dimensions specified.

In the practice of the invention as just described it is not possible, as a rule, to crop the rolled slab precisely at the edges of the insert, so that the plates are not dimensioned with perfect accuracy. Thus when the insert is supported with its edges in the position just described specifically (4" and 2" from ingot faces), and the slab is cropped along the line *b-b*, the exact dimensions of taper are not obtained, because owing to cutting inside of the insert edge, one wide will be slightly less than  $\frac{1}{4}$  inch, and the other slightly greater than  $\frac{1}{8}$  inch. In order to dimension the articles more perfectly it is necessary to compensate for this factor, and for spreading of the ingot. This may be done readily by supporting the insert so that the angle of inclination to the mold surfaces compensates for these factors. Generally speaking, the angle of inclination will be increased for this purpose.

In further explanation of these embodiments, and of the correct positioning of the insert to effect correct dimensioning of the products, the following example is given, showing the production of plates 12 inches wide and 57 inches long tapering in thickness longitudinally from  $\frac{3}{8}$  inch at one end to  $\frac{1}{8}$  inch at the other, and formed of chrome-vanadium steel surfaced on the tapering face with a 0.02 inch thick layer of high chrome steel. A mold 16 inches wide, 9 inches deep, and 24 inches high is used. To make the insert two plates of the high chrome steel  $15 \times 30 \times \frac{3}{8}$  are sand blasted and then one face of each is coated with silica as a weld-preventing material. The plates are assembled with their coated faces in contact, and spot welded at the corners, and preferably the exterior surfaces are again sand blasted.

This insert is then supported in the mold in the manner described in the preceding example and it is swung about its vertical axis to bring its lateral edges into such position that distances *c* and *d* between the 16 inch faces of the mold and the insert are approximately 7 and 2 inches. The insert being supported out of contact with the mold, chrome-vanadium steel is cast into the mold to make an ingot which is then hot rolled longitudinally to make a slab about 100 inches long, 2 inches thick and 16 inches wide. A strip 6 to 9 inches long is cut transversely from the bottom end of the slab, and the slab is then cut into three pieces about 25 to 26 inches in length, the upper remaining end being discarded. These pieces are now cross rolled to a thickness

of 0.5-inch, bringing them to a length of about 65 inches, the 25 inch width remaining substantially the same. The plates are trimmed at the sides to a width of 24" and cut in two longitudinally, and finally the ends are trimmed to produce the desired length of 57" and to part them. Before cutting the edges and parting it may be desirable to anneal and flatten the slabs.

The separated plates taper from  $\frac{3}{8}$  inch at one end to  $\frac{1}{8}$  inch at the other. This was accomplished by inclining the insert somewhat more than in the preceding example, as shown by the dimensions given for each, so that the ratio of the distances  $c$  and  $d$  was somewhat greater than the 3:1 desired. Upon cutting off the excess metal to expose the insert, the 3:1 ratio is then obtained.

The embodiment just described is productive of articles of homogeneous character throughout where the insert is totally unweldable, or is formed of the metal which composes the ingot and is provided with a clean surface which under the effect of heat and rolling becomes welded to the body of the ingot. Such welding as explained previously, is effected by enveloping the insert in a gas tight envelope of metal, which keeps the surfaces in condition for pressure welding.

The invention is applicable also to the production of ply metal articles, and one such embodiment is shown in Fig. 6, which shows tapered plates comprising a body 10 of one metal surfaced on the tapered side with a thin layer 11 of another metal. Plates of this type are produced in the manner just described by the use of two-part inserts such as are shown in Fig. 1b, formed of sheets 7 of the surfacing metal. For example, this procedure may be applied to making stainless surface plates, the body of the plates comprising cheap ferrous metal, and the surface comprising a coating of chromium steel.

Still another embodiment is shown in Figs. 7 and 8. An insert 12 is supported in a mold 13 so that it slants from the bottom of the mold at one corner to the diagonally opposite corner at the top of the mold, as seen in Fig. 8, and where the two plates are to be alike, the horizontal axes of the insert and mold coincide. Metal is cast around the insert, and the ingot is rolled, cropped and parted, in the manner just described. This embodiment is frequently desirable in producing plates tapered from end to end.

The invention is applicable generally to the production of plane surfaced plates of varying section. Figs. 9 to 11 are illustrative of three further applications of this embodiment of the invention. In Fig. 9 three inserts 14 are supported in a mold 15 so that they radiate from one edge of the mold toward the other. Ingots cast in this mold are productive of four plates tapered continuously from side to side. In Fig. 10 a pair of angularly bent inserts 16 are supported in mold 17. The ingot formed in this mold produces three plates whose cross section will be understood from the drawings. Two of these plates will be, in effect, double wedges. A modification of the embodiment shown in Fig. 10 appears in Fig. 11, in which an insert 18 is disposed between angular inserts 16a. Numerous other shapes may be made by appropriately shaping and positioning the inserts.

The invention is applicable further to the production of curved surface articles of varying section. Two embodiments of this aspect of the invention are shown in Figs. 12 and 13. In Fig.

12 a curved insert 19 is supported in mold 20, and metal cast around it, to make an ingot which is rolled and treated, all as described hereinabove. This is productive of a plano-convex plate 21, and a plano-concave plate 22. As shown in Fig. 13, two plano-convex plates, and a double concave plate may be formed by the use of curved inserts 23 positioned in the manner shown.

A modification of the embodiments shown in Figs. 9, 10, 11 and 13 resides in the use of a three-part insert for simultaneously rolling a parallel side sheet. This is shown in Fig. 14. The insert comprises a sheet 25 supported between two sheets 26, there being weld-preventing material 27 between the contiguous surfaces of the sheets. The outer surface of the insert is cleaned, as before, and a desired metal 28 is cast therearound to make the ingot for rolling. Sheet 27 is reduced in rolling, and is recovered upon parting. This embodiment is desirable for rolling sheets of materials such as high chrome steels, as the surfaces of the sheet are perfect and free from scale.

Thus the invention makes it possible to roll such plates of varying section by ordinary direct rolling methods. This avoids the disadvantages of prior procedures, and substantially reduces their cost. Economies result, not only from elimination of the operations and scrap losses of prior methods, but also from the fact that two or more plates are made from a single ingot. A particularly important advantage of the invention is its applicability to producing wide or long plates. Other advantages will appear to those skilled in the art.

According to the provisions of the patent statutes, I have explained the principle and mode of practicing my invention and have illustrated and described what I now consider to represent its best embodiment. However, I desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

I claim:

1. A method of rolling plates of tapered, beveled, curved, or otherwise varying section, comprising supporting an insert having an unweldable surface in an ingot mold with its opposite major faces at a continuously varying distance longitudinally of the mold from the respectively adjacent faces of the mold and cooperating with said mold faces to form an internal plane dividing an ingot cast in the mold into portions productive of the desired varying plate section, casting molten metal into said mold to completely envelop said insert and form said ingot, rolling the ingot, cropping off excess metal to expose said dividing plane, and parting along said plane to separate said plates of varying section.

2. A method of rolling plates of tapered, beveled, curved, or otherwise varying section, comprising supporting an insert having an unweldable surface in an ingot mold with its opposite major faces at a continuously varying distance longitudinally of the mold from the respectively adjacent faces of the mold and cooperating therewith to divide an ingot cast in the mold into portions similar to the desired varying plate section, casting molten metal into said mold to completely envelop said insert and form said ingot, rolling the ingot while maintaining the sectional proportions of said portions, cropping off excess metal to expose said dividing plane, and parting along said plane to separate said plates of varying section.

3. A method of rolling plates of tapered,

beveled, curved, or otherwise varying section, comprising supporting an insert having an unweldable surface in an ingot mold with its opposite major faces at a continuously varying distance longitudinally of the mold from the respectively adjacent faces of the mold and co-operating therewith to divide an ingot cast in the mold into portions similar to the desired varying plate section, casting molten metal into said mold to completely envelop said insert and form said ingot, rolling the ingot between parallel surfaced rolls with the ingot faces corresponding to said unweldable surface parallel to the roll axes, cropping off excess metal to expose said dividing plane, and parting along said plane to separate said plates of varying section.

4. A method of rolling plates of tapered, beveled, curved, or otherwise varying section, comprising supporting a metallic insert having one of its surfaces in clean weldable condition in an ingot mold with its opposite major faces at a continuously varying distance longitudinally of the mold from the respectively adjacent faces of the mold, the other surface of the insert being covered with a layer of weld-preventing material to divide an ingot cast in the mold into portions similar to the desired varying plate section, casting molten metal into said mold to completely envelop said insert and form said ingot, hot rolling the ingot between parallel surfaced rolls with the ingot faces corresponding to said mold insert surfaces parallel to the roll axes, maintaining the sectional proportions of said portions during said rolling, cropping off excess metal to expose said dividing plane, and parting along said plane to separate said plates of varying section.

5. A method of rolling plates of tapered, beveled, curved, or otherwise varying section, comprising supporting a ferrous metal insert in an ingot mold with its opposite major faces at a continuously varying distance longitudinally of the mold from the respectively adjacent faces of the mold, one of said surfaces being in clean weldable condition, the other of said surfaces being covered with a layer of weld-preventing material dividing an ingot cast in the mold into portions similar to the desired carrying plate section, casting molten ferrous metal into said mold to completely envelop said insert and form said ingot, hot rolling the ingot between parallel surfaced rolls with the ingot faces corresponding to said insert surfaces parallel to the roll axes to effect welding between the body of the ingot and said weldable surface while maintaining the sectional proportion of said portions, cropping off excess metal to expose said dividing plane, and parting along said plane to separate said plates of varying section.

6. A method of rolling plates of tapered, beveled, curved, or otherwise varying section, comprising supporting a metallic insert in an ingot mold with its opposite major faces at a continuously varying distance longitudinally of the mold from the respectively adjacent faces of the mold, one of said surfaces being in clean weldable condition, the other of said surfaces being covered with a layer of weld-preventing material dividing an ingot cast in the mold into portions similar to the desired varying plate section, casting a different metal into said mold to completely envelop said insert and form said ingot, hot rolling the ingot between parallel surfaced rolls with the ingot faces corresponding to said insert surfaces parallel to the roll axes to effect welding between said weldable surface and the body of the ingot while maintaining the sectional proportions of said portions, cropping

off excess metal to expose said dividing plane, and parting along said plane to separate said plates of varying section.

7. A method of rolling plates of tapered, beveled, curved, or otherwise varying section, comprising supporting in an ingot mold an insert formed of a pair of metallic plates fastened together in fixed back-to-back relation, the exterior surfaces of the insert being in clean weldable condition and the adjacent faces of the plates being separated by a weld-preventing material, said weld-preventing material acting as a longitudinal internal dividing plane in an ingot cast therein, and the insert being shaped and positioned in the mold so that the opposite major faces of said weld-preventing layer are at a continuously varying distance longitudinally of the mold from the respectively adjacent faces of the mold, whereby to divide said ingot into portions productive of the desired varying section, casting molten metal into said mold to completely envelop said insert and form said ingot, hot rolling the ingot between parallel surfaced rolls with the ingot faces corresponding to said insert surfaces parallel to the roll axes to effect welding between said exterior surfaces of the insert and the cast metal and to dimension said portions while maintaining their sectional proportions, cropping off excess metal to expose said dividing plane, and parting along said plane to separate said plates of varying section.

8. A method of rolling plates of tapered, beveled, curved, or otherwise varying section, comprising supporting in an ingot mold an insert formed of a pair of metallic plates fastened together in fixed back-to-back relation, the exterior surfaces of the insert being in clean weldable condition and the adjacent faces of the plates being separated by a weld-preventing material, said weld-preventing material acting as a longitudinal internal dividing plane in an ingot cast therein, and the insert being shaped and positioned in the mold so that the opposite major faces of said weld-preventing layer are at a continuously varying distance longitudinally of the mold from the respectively adjacent faces of the mold, whereby to divide said ingot into portions similar to the desired varying section, casting a different metal into said mold to completely envelop said insert and form said ingot, hot rolling the ingot between parallel surfaced rolls with the ingot faces corresponding to said mold insert surfaces parallel to the roll axes to effect welding between said exterior surfaces of the insert and the cast metal and to dimension said portions while maintaining their sectional proportions, cropping off excess metal to expose said dividing plane, and parting along said plane to separate said plates of varying section.

9. A method of rolling plates of tapered, beveled, curved, or otherwise varying section, comprising supporting in an ingot mold an insert formed of a pair of stainless ferrous metal plates fastened together in fixed back-to-back relation, the exterior surfaces of the insert being in clean weldable condition and the adjacent faces of the plates being separated by a weld-preventing material, said weld-preventing material acting as a longitudinal internal dividing plane in an ingot cast therein, and the insert being shaped and positioned in the mold so that the opposite major faces of said weld-preventing layer are at a continuously varying distance longitudinally of the mold from the respectively adjacent faces of the mold, whereby to divide said ingot into portions productive of the desired varying section, casting

molten mild steel into said mold to completely envelop said insert and form said ingot, hot rolling the ingot between parallel surfaced rolls with the ingot faces corresponding to said insert surfaces parallel to the roll axes to effect welding between said exterior weldable surfaces of the insert and the mild steel and to dimension said portions while maintaining their sectional proportions, cropping off excess metal to expose said dividing plane, and parting along said plane to separate said plates of varying section.

10. A method of rolling tapered metal plates comprising supporting a flat surfaced metallic insert having one surface in clean weldable condition and having its other surface provided with a weld-preventing coating in an ingot mold with said surfaces inclined with respect to the adjacent mold faces so that an ingot cast therein is divided internally by said unweldable surface into longitudinally tapered portions productive of a plate of the desired taper, casting molten metal into the mold around said insert to completely envelop it and form an ingot, hot rolling said ingot between parallel surfaced rolls with the ingot faces corresponding to said insert faces parallel to the roll axes to cause welding between said weldable surface and the cast metal and

to dimension said portions, cropping off excess metal, and parting along the dividing plane formed by said unweldable surface to separate said plates of varying section.

11. A method of rolling curved surface metal plates comprising supporting an arcuately shaped metallic insert having one surface in clean weldable condition and having its other surface provided with a weld-preventing coating in a rectangular ingot mold, said surfaces being at a continuously varying distance from the adjacent mold faces, and the weld-preventing coating acting as an internal plane dividing an ingot cast in the mold into curved portions similar to that of the curved plate desired, casting molten metal into the mold around said insert to completely envelop it and form an ingot of rectangular section, hot rolling said ingot between parallel surfaced rolls with the ingot faces corresponding to the insert surfaces parallel to the roll axes to cause welding between the body thereof and said weldable insert surface and to dimension said portions, cropping off excess metal to expose said dividing plane, and parting along said plane to separate said curved surface plates.

MAX R. TREMBOUR.

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|----|-----|
| 30 | 105 |
| 35 | 110 |
| 40 | 115 |
| 45 | 120 |
| 50 | 125 |
| 55 | 130 |
| 60 | 135 |
| 65 | 140 |
| 70 | 145 |
| 75 | 150 |