

May 27, 1952

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2,598,344

APPARATUS FOR MAKING METAL STRIPS

Filed July 27, 1948

3 Sheets-Sheet 1

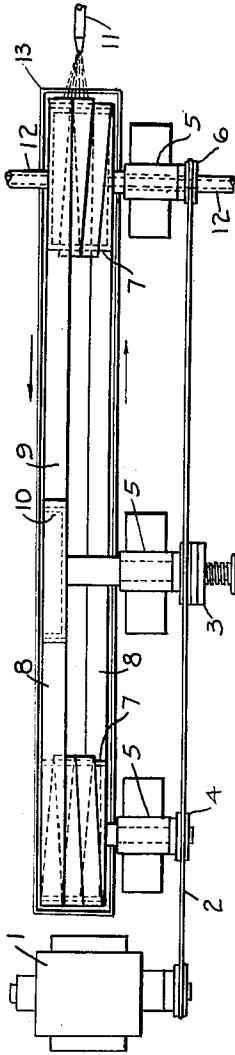


Fig. 1

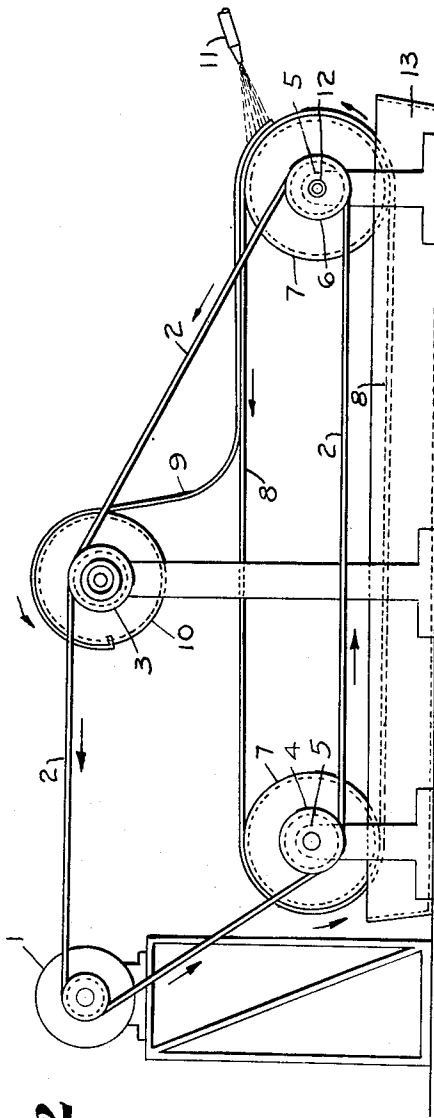


Fig. 2

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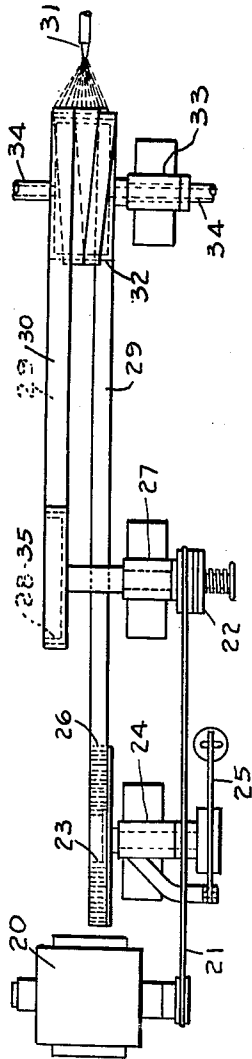


Fig. 3

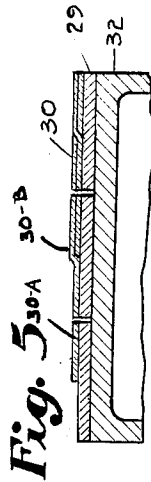


Fig.

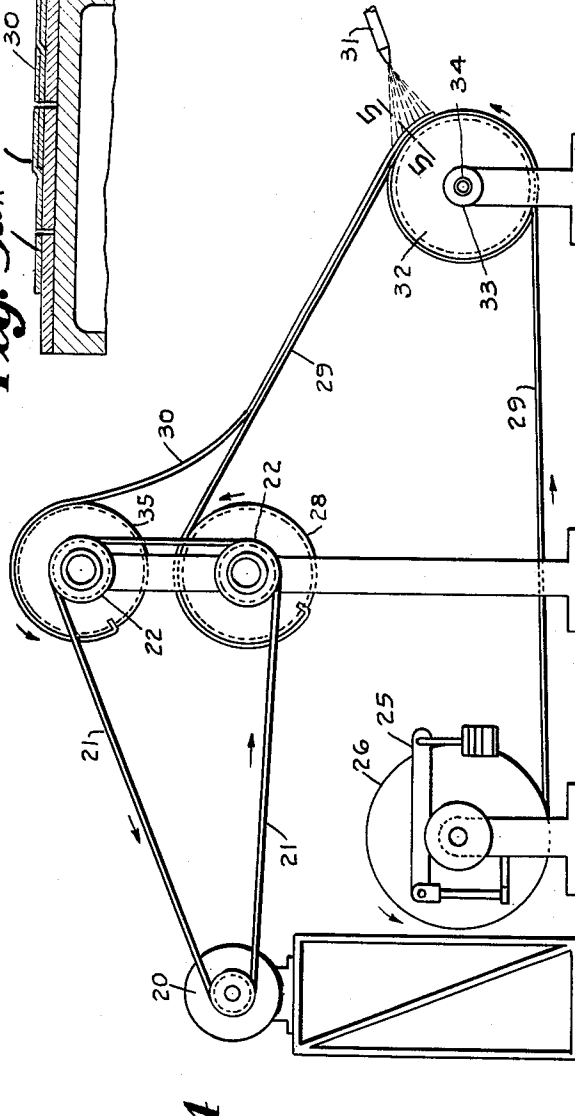


Fig. 4

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3 Sheets-Sheet 3

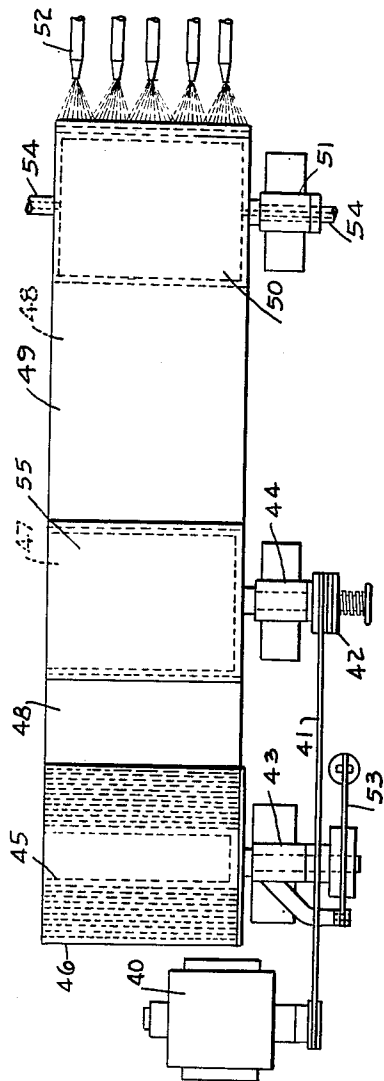


Fig. 6

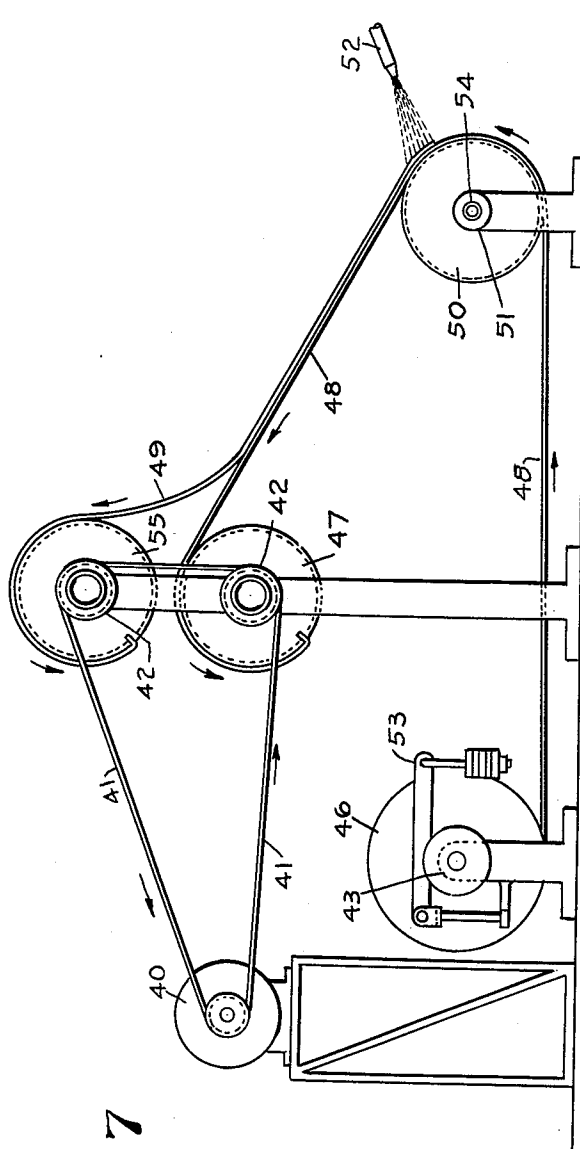


Fig. 7

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UNITED STATES PATENT OFFICE

2,598,344

APPARATUS FOR MAKING METAL STRIPS

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Application July 27, 1948, Serial No. 40,823

10 Claims. (Cl. 22—57.4)

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This invention relates to an apparatus for continuous production of thin strip metal.

According to one adaptation of this invention thin flexible bands of suitable material to which spray deposited metal does not firmly adhere under the controlled conditions of the invention are passed in sequence before one or more molten metal spray nozzles in such a manner that a substantially uniform layer thereof is deposited and is stripped therefrom thereafter.

As a modification of the invention a relatively wide not too adherent surface is passed before a crosswise spray with reference to the directional motion of the said relatively wide not too adherent surface and the spray nozzle or gun is oscillated in synchronism with the motion of the surface so that an overlapping spray deposited layer is produced of substantially uniform thickness.

As a further modification a large roll circumferentially many times the width of a single spray deposit pattern is passed before a series of spray guns to produce an overlapping series of somewhat parallel spray deposits which may be stripped from the roll and which has a substantially uniform thickness.

Spray apparatus suitable for accomplishing the purposes of this invention is described in my pending application Serial No. 1,926, filed January 13, 1948, and this application is a continuation-in-part thereof in so far as common subject matter exists.

Conventional molten metal spray apparatus may also be used in conjunction with this apparatus of and according to the methods of this invention to achieve the purposes thereof.

Any thermoplastic meltable material normally solid which becomes fluid under heat and which can be atomized when fluid and which solidifies on cooling can be used in conjunction with the apparatus and according to the methods of this invention.

The apparatus of this invention may be also used to make coated or laminated metal strip if control conditions therefor are introduced whereby the coating on a strip of base metal will be uniform in thickness. Thus a strip of cold rolled ordinary commercial steel may be lightly spray deposited with atomized or finely divided nickel particles which are fused thereto to form a lattice work on one side thereof and then a layer of leaded bronze is rolled against the so treated steel surface while the adjacent surfaces to be joined are rendered somewhat plastic condition by surface heating while the non-adjacent surfaces are cooled.

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In any case according to my invention a uniform thickness metal strip is produced when the spray deposit is stripped from the moving base.

It is possible to make removable non-uniform thickness layers and strip same from the base material also with apparatus of this invention but this is generally undesirable and wasteful and such strips have generally irregular edges and could only have very specific and relatively few uses.

I find that easier stripping is achieved with certain metals if the deposited strips are sharply bent back and away from the line of travel of base strip. This feature is not shown in the drawings. A parting knife, blade or edge can be of help in smooth stripping also but is not shown, as not always needed.

In case it is desired wide spray deposited strips may be slit and resprayed using the initial spray deposited strip as may be used as a base band for laminating a further deposit thereon.

Referring to the drawings which accompany and are a part of this specification:

Fig. I represents in plan an endless band as of stainless steel driven by a preferably variable speed motor 1 Fig. I over drums 7 Fig. I spirally so that at least three passes are presented to a metal spray gun 11 Fig. I centrally located preferably and away from with reference to the drum 7 Fig. I over which the endless belt of stainless steel 8 Fig. I passes. The motor 1 Fig. I drives the drums 7 Fig. I by means of belt 2 Fig. I. The belt 2 Fig. I drives the slip friction clutch 3 Fig. I also which drives the wind-up drum 10 Fig. I onto which the spray deposited built-up strip 9 Fig. I is coiled as it is stripped from the last turn of the endless belt 8 Fig. I. The endless belt 8 Fig. I spirals around the periphery of the right-hand drum 7 Fig. I in one direction crosswise and spirals around the lefthand drum 7 Fig. I oppositely crosswise spirally. Guides not shown keep the belt 8 Fig. I in proper alignment on the drums 7 Fig. I and with reference to the spray nozzle 11 Fig. I so that the spray thrown out from the gun 11 Fig. I deposits partially on the inner halves of the outside spirals of the endless belt 8 Fig. I and all over the area in front of the nozzle 11 Fig. I on the central spiral of the endless belt 8 Fig. I as it passes over the right hand drum 7 Fig. I.

Referring to Fig. II of the drawings which is a longitudinal section of the apparatus of Fig. I like numerals designate like parts in both Fig. I and Fig. II. In Fig. II the metal strip 9 is shown being removed from the endless belt 8 and coiled on the reel 10 Fig. II. Also in Fig. II a pan 13 is

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shown into which the endless belt 3 passes for cleaning so that any metal particles remaining thereon may be removed. A stripper knife not shown or scraper may also be used in conjunction therewith. The tank or pan 13 Fig. II may also be used for anodizing the endless belt 3 Fig. II which anodizing prevents too great adherence of the metal strip deposit if the endless belt 3 Fig. II has a surface of film forming metal having anodized film formed thereon. As an alternative the tank 13 Fig. II may contain a light lubricant as of silicone lubricant and apply same to one pass of the endless belt 3 Fig. II to prevent too great adherence of the deposited metal strip. The hollow shaft 12 Fig. II is arranged for cooling the drum 7 Fig. II by suitable coolant which in turn assists in keeping the belt 3 Fig. II cool.

Fig. III of the drawings is a plan of an apparatus according to this invention for passing one or more long but not endless metal bands 29 Fig. III spirally about a large drum 32 Fig. III which is driven by motor 20 Fig. III by means of belt 21 Fig. III which drives wind-up clutches 22 Fig. III which coils up long band 29 Fig. III forming coil 28 Fig. III thereof and also coils up spray deposited strip 30 Fig. III onto drum 35 Fig. III. The spray nozzle 31 Fig. III deposits spray on the two inside halves of the outside spirals of the band 29 Fig. III about drum 32 Fig. III as well as over the entire cross-section of the middle pass of the band 29 Fig. III about drum 32 Fig. III so that after the third pass of the band 29 Fig. III about drum 32 Fig. III a uniform cross-sectioned strip 30 Fig. III has been spray deposited on the band 29 Fig. III and may be removed therefrom to coil up on drum 35 Fig. III.

Fig. IV is a sectional longitudinal view of the apparatus shown in Fig. III and shows more clearly the metal strip spray deposited and being parted 30 Fig. IV from base strip 29 Fig. IV and brake 25 Fig. IV on supply coil 26 Fig. IV which supplies the strip 29 Fig. IV to the drum 32 Fig. IV for at least triple passage therearound for spray producing the strip 30 Fig. IV thereon.

No cleaning means for base strip 29 Fig. IV is shown in Figs. III and IV. Cooling means by hollow shaft supplied coolant is shown at 34 Fig. III and Fig. IV.

Fig. V is section on line 5-5 of Fig. IV and illustrates successive buildup of spray deposit to achieve uniform cross-section. Fig. V is a partial view axially of the drum 32 showing the spiral bands 29 passing thereover and showing the resultant build-up of sprayed layers 30 over the spiral bands. 30-A illustrates the edge deposit on the spiral band as it makes the first pass over the drum 32. 30-B shows the build-up of a layer all the way across the top of the second pass of the spiral band over the drum 32 and 30 shows the completed build-up on the last pass after it has passed before the spray gun 31 Fig. III and illustrates the uniformity in cross-section of the finished porous metal strip.

Fig. VI is a plan of apparatus showing a relatively wide long band of base material 48 being passed over drum 50 supported by bearings 51 and fed from coil 46 on drum 45 supported on bearings 43 held back by brake 53 said strip 48 being drawn by wind-up drum 47 supported by bearings 44 driven by slip clutch and pulley 42 through belt 41 from motor 40. As the wide base band 48 passes over the drum 50 before the spaced spray nozzles 52 an overlapping parallel series of sprayed layers is deposited thereon to form the strip 49 which is wound up on the drum 55 sup-

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ported on bearing 44 driven by belt 41 through clutch 42. The hollow shaft 54 is for circulating coolant through drum 50 to assist in cooling base band 48 and facilitate stripping of layer 49 therefrom. It is also contemplated that instead of a single band 48 a number of narrower parallel bands may be used as base for spray depositing layer thereon and these may be coiled in parallel relation and have multiple strips removed therefrom continuously instead of the single wide strip 49.

Slitters not shown may be inserted at and between the edges of parallel base bands to facilitate removal of multiple bands deposited.

Any useable thickness of spray deposited layers may be achieved by having successive sets of nozzles build up the amount of metal sprayed or by slowing down or speeding up the rate of travel of the band 48 Figs. VI and VII.

Fig. VII is a sectional view of apparatus shown in Fig. VI using like numerals to designate like parts.

The nozzles 52 Fig. VI may be conventional spray guns or multiple movable nozzles attached to spray apparatus explained and shown in my pending U. S. patent application Serial No. 1,926, filed January 13, 1948.

The density and porosity of the spray deposited layers are regulatable during deposition by regulating base temperatures, atmospheric temperatures and constituents of the atmosphere.

Subsequent rolling and/or heat treatment of the monometal or alloy strip so produced is contemplated using this invention if desired. The production of multiple or wide laminated metal strips by this apparatus is also contemplated. If laminations are desired additions to this apparatus are desirable not shown to effect better bond of base strip and the deposited metal.

When a wide metal band or parallel multiple metal bands as shown in Fig. VI and Fig. VII have a layer deposited thereon and across the width thereof a certain amount of edge spray is lost but it is much less percentage wise than when a single narrow band is sprayed with a single spray device and a single pass and uniform gauge crosswise is not attainable without the overlapping sprays without great loss of the sprayed metal. Thus in spraying a single band 2" wide with a type E Metco spray gun as much as 50% of the sprayed $\frac{1}{8}$ " wire may be lost and non-uniform gauge in deposit secured whereas with the wide band, multiple parallel bands or spiral bands of this apparatus less than 10% of the sprayed metal need be lost under similar conditions.

It is contemplated to produce alloy strip by this apparatus by spraying more than one metal at once and blending them proportionately or by spraying alloyed molten metal. Also it is contemplated to spray other materials with the metal spray for interlocking and embedment if desired.

Instead of the elongated wide metal band shown in Fig. VI and Fig. VII, an endless single pass wide metal band may be used running over both the drum 50 and over the drum 47 continuously and having the deposit stripped therefrom continuously. This endless belt or band may be anodized or otherwise treated to prevent too great adherence and a scraper may be installed on the inside edges of the drum 50 to scrape off excess spray deposit from the edges of the drum. The stripped metal 49 Fig. VII may also be passed over another set of rolls for spraying additionally

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if desired as may any other strip here produced and illustrated according to my invention.

After the first spray strip 49 Fig. VII deposit is removed one surface thereof is smooth and shiny and the outside surface is rather rough.

Having thus described my invention what I claim is:

1. Apparatus for producing strip metal comprising a molten metal spray depositing device which makes a spray field having an elongated, transversely tapered cross-sectional deposit of maximum thickness at the center thereof, a moving belt of a width of approximately one-half that of said deposit, and a rotatable drum adjacent said spray depositing device, said belt being wound in at least three helical convolutions about said drum, said spray depositing device forming a tapered deposit on a center convolution and a tapered deposit on the adjacent edge of each adjacent convolution, said moving belt successively passing through different zones of said spray section to overlap upon said belt a plurality of cross-sectionally tapered deposits into a layer of substantially uniform section.

2. Apparatus for producing strip metal comprising a molten metal spray depositing device which makes a spray field having an elongated transversely tapered cross-sectional deposit of maximum thickness at the center thereof, a moving belt of a width of approximately one-half that of said deposit, and a pair of rotatable drums one of which is adjacent said spray depositing device, said belt being wound in at least three helical convolutions about each of said drum and being looped therebetween with the portions of the belt extending between said drums being offset axially of the drums from each other, said spray depositing device forming a tapered deposit on a center convolution and a tapered deposit on the adjacent edge of each adjacent convolution, said moving belt successively passing through different parts of said spray field to overlap upon said belt successive cross-sectionally tapered deposits into a unitary layer of substantially uniform section.

3. Apparatus for producing strip metal comprising a molten metal spray depositing device which makes a spray field forming a transversely tapered deposit of gradually decreasing edge thickness, a belt of a width of approximately one-half that of said deposit, means for moving said belt through said spray field, and means for producing at least three helical convolutions of said belt in said spray field which convolutions are aligned and in edge contact, said convolutions being centered in said spray field.

4. Spraying apparatus comprising a longitudinally moving belt and drive means therefor, a metal spray depositing device producing a spray field directed toward one face of said moving belt, such spray field being wider than such one face of said belt, means supporting said belt for simultaneous longitudinal movement of longitudinally spaced sections thereof in side by side relation past such spray field, the combined width of the adjacent sections of said belt being greater than that of such spray field whereby the spray metal from said device is deposited on one face of said belt without substantially any overspray.

5. Apparatus for producing strip metal across the entire width of a longitudinally moving belt, comprising means for driving said belt, a molten metal spray depositing device producing a spray field directed toward one face of said moving belt, such spray field being wider than such one face

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of said belt, means supporting said belt for simultaneous longitudinal movement of longitudinally spaced sections thereof in side by side relation past such spray field, the combined width of the adjacent sections of said belt exceeding that of such spray field and being such that an initially unsprayed portion of the width of such one face is sprayed at the same time that a preceding adjacent section of said belt is being sprayed whereby to produce a spray deposited strip on said belt which extends across the entire width of said belt without substantially any overspray.

6. Apparatus for producing flexible strip metal comprising a molten metal spray depositing device which makes an elongated tapered cross-sectional deposit, a longitudinally movable belt and drive means therefor to move said belt so as to have a layer of metal sprayed thereonto by said device, and means supporting longitudinally spaced sections of said belt in adjacent relation and in longitudinally curved form opposite said device whereby cross-sectionally tapered deposits are overlapped on such longitudinally curved sections and means supporting said belt in at least a partially straightened form, subsequent to spraying of metal thereonto, whereby to facilitate stripping of the spray deposited layer from said belt to produce flexible strip metal.

7. Apparatus for producing strip metal comprising a molten metal spray depositing device which makes a spray field having a transversely tapered cross-section deposit of maximum thickness at the center thereof, a moving belt of a width less than that of said spray field, and a rotatable drum, said belt being looped in such a number of convolutions around said drum that an aggregate of at least two widths of said belt are exposed to said spray field, said spray depositing device forming a tapered deposit within the outside edges of the aggregate, said moving belt successively passing through zones of different density of said spray field to overlap upon said belt successive cross-sectionally tapered deposits into a layer of substantially uniform thickness.

8. Apparatus for producing strip metal comprising a molten metal spray depositing device which makes a spray field having a transversely tapered cross-sectional deposit of maximum thickness at the center thereof, a moving belt of a width of less than that of said spray field, a pair of rotatable drums one of which is adjacent said spray depositing device, said belt being wound in at least two convolutions about each of said drums with the portions of the belt extending between said drums being offset axially of the drums from each other, said spray depositing device forming a tapered deposit on a portion central of said convolutions and extending to within their outside edges, said moving belt successively passing through zones of different density of said spray field to overlap upon said belt successive cross-sectionally tapered deposits into a unitary layer of substantially uniform thickness, and means for stripping said unitary layer from said belt.

9. Apparatus for producing strip metal comprising a molten metal spray depositing device which makes a spray field forming a transversely tapered deposit of gradually decreasing thickness toward the edge thereof, a belt of a width less than that of said spray field, means for moving said belt through said spray field, and means for producing at least two convolutions of said belt

in said spray field which convolutions are aligned and substantially in edge contact.

10. Spraying apparatus comprising a longitudinally moving belt and drive means therefor, means supporting said belt for simultaneous longitudinal movement of longitudinally spaced sections thereof in side-by-side relation, a metal spray depositing device producing a spray field directed toward a portion of said side-by-side sections, said spray field being wider than one of such sections of said belt, the combined width of the adjacent sections of said belt being greater than that of said spray field whereby the spray metal from said device is deposited on said one section of said belt without substantially any overspray beyond the outside edges of said adjacent sections.

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