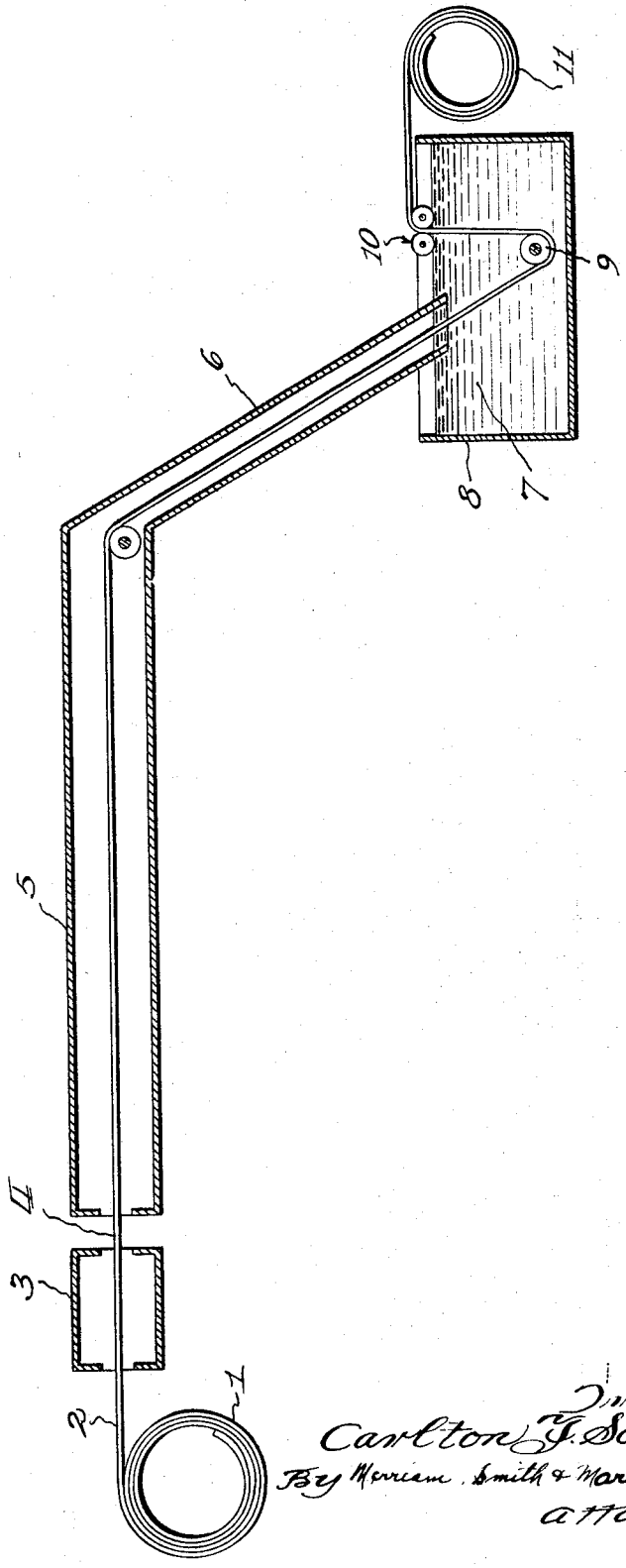
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PROCESS OF MAKING SOFT, DUCTILE, GALVANIZED MATERIAL

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PROCESS OF MAKING SOFT, DUCTILE, GALVANIZED MATERIAL

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4 Claims. (Cl. 29—527)

This is a divisional application of the present inventor's application Serial No. 146,199, filed October 19, 1961, and entitled "Soft, Ductile, Galvanized Material and Process for Producing Same," now Patent No. 3,149,928.

The present invention relates generally to galvanized steel material, and more particularly to soft, ductile, readily drawable galvanized steel material and to a process for producing this material.

Continuous galvanizing processes have been used to produce galvanized steel materials having a coating with good adherence characteristics, but these galvanized materials, produced by a process employing "in line" heat treatment, also have had an undesirably high relative hardness, in excess of 48 on the Rockwell B scale. The present invention provides galvanized steel material, produced by a process which may be continuous, having a coating which has adherence properties equal to those on galvanized materials heretofore produced by other continuous processes, and also has substantially superior softness and ductility. Furthermore, the subject material may be produced by a continuous process which utilizes substantially the same equipment heretofore conventionally utilized for the continuous production of harder galvanized steel material.

The single figure in the drawing diagrammatically illustrates typical commercial apparatus for producing galvanized steel material in accordance with what is known in the art as a Sendzimir type process. In this process a continuous sheet **2** of steel, constituting the base for the galvanized material, is fed from a coil **1** through a furnace **3** containing an oxidizing atmosphere for producing a thin film of oxide coating on the surface of the steel sheet. The oxide-coated steel sheet **4** is then passed through a furnace **5** having a reducing atmosphere whereby the oxide coating on the surface of the strip **4** is reduced to form a highly adherent impurity-free, surface layer of metal on the steel sheet; said surface layer having excellent coatable properties from the standpoint of coating adherence thereto due to the layer's freedom from impurities. Following the reducing step the strip is fed through a hood **6** into a coating bath of zinc **7** contained in a dip pot **8**. The zinc-coated strip is then moved around an idler roller **9** and upwardly through a pair of thickness-regulating rollers **10** for producing a uniform thickness of coating on the steel sheet. The coated sheet is then cooled by means not shown and wound into a coil **11**. A more detailed description of this type of conventional galvanizing process is given in Sendzimir Patent 2,197,622, issued April 16, 1940. Galvanized steel material produced by such a process generally has a hardness in excess of 48 on the Rockwell B scale.

The formability of galvanized steel material can be improved in accordance with the present invention by incorporating titanium into the mild steel base and operating the reducing step of the continuous process at a temperature in excess of 1650° F. Steel containing small additions of titanium is free from strain aging, and has improved drawing characteristics. However, it has been found that the coating on continuously galvanized material having a base made of titanium-containing steel is poorly adherent unless the continuous galvanizing operation includes a reducing step carried out at a temperature

exceeding about 1650° F. Otherwise the coating which is applied to the base following the reducing step is less adherent than desired. This is due to the formation of adherence-offsetting iron-zinc intermetallic compounds at the interface between the steel base and the zinc coating. These intermetallic compounds are formed even if the zinc bath contains traces of aluminum, conventionally provided to retard the formation of said iron-zinc intermetallic compounds. In other words, when the steel base contains Ti, it has been discovered that in order to prevent the formation of iron-zinc intermetallic compounds between the steel base and the zinc coating, and to obtain a zinc coating with good adherence properties, it is necessary to operate the reducing step at temperatures in excess of about 1650° F.

At temperatures in excess of 1650° F., there is substantial grain growth in the steel base resulting in a finished product having a grain size of about between 4 and 6 on the ASTM scale. Although this grain size range is somewhat in excess of the size range generally thought necessary to endow the steel with good drawing characteristics, it has, nevertheless, been found that the drawing quality of the subject material is equivalent to that of material having the smaller grain size.

Thus, galvanized steel material produced in accordance with the present invention whereby the mild steel base contains a small amount of titanium and whereby the reducing step is carried out at a temperature in excess of about 1650° F., has a tightly adhering coating, has a hardness level of 46 or less on the Rockwell B scale, is not susceptible to strain aging and quench aging, and has excellent drawing characteristics.

A typical base for the subject galvanized material is made from mild steel having a titanium to carbon ratio in excess of 4 to 1 and preferably in excess of about 4.5 to 1. Lesser amounts of titanium will fail to combine with all the carbon in the steel at room temperaure, thereby imparting an undesirable substantial increase in hardness to the steel base material. A typical composition for the steel from which this base may be rolled is as follows:

	Percent
C	0.05
Mn	0.30–0.50
S	0.030
P	0.02
Si	0.002
Al	0.000–0.090
Ti	0.25–0.45

As used herein, the term "steel base" refers to steels conventionally used in the continuous galvanizing of sheet or strip. A general classification of the grades of steel conventionally used in continuous galvanizing, and the composition thereof, are given on pages 666–7 of The Making, Shaping and Treating of Steel, 7th edition, United States Steel Corporation, Pittsburgh, Pennsylvania, 1957. In accordance with the present invention, titanium is added to said steel base in amounts exceeding four times the carbon content.

The steel base may be either sheet material, strip material, or the like; and it may be produced by either a hot rolling or a cold rolling process.

It should be noted that the subject process can be practiced on conventional apparatus already employed for galvanizing operations, thereby eliminating the expense of providing new equipment to produce the subject material.

The foregoing detailed description has been given for clearness of understanding only, and no unnecessary limitations should be understood therefrom, as modifications will be obvious to those skilled in the art.

What is claimed is:

1. A process for producing a soft, ductile, galvanized flat material, said process comprising:

rolling a base from mild steel containing titanium in an amount between four and nine times the carbon content of the steel;

exposing said base to an oxidizing atmosphere to produce a thin film of oxide on the surface of the base;

then exposing said base to a reducing atmosphere at a temperature in excess of about 1650° F., whereby said oxide film is reduced to provide a clean surface layer of metal suitable for coating;

and then coating said base with zinc containing a trace of aluminum to retard formation of iron-zinc intermetallic compounds at the interface between the base and the zinc coating.

2. A process as recited in claim 1 wherein said base is heated at a temperature for producing a grain size in the finished flat material of about between 4 and 6 on the ASTM scale.

3. A process for producing a soft, ductile, galvanized flat material, said process comprising:

rolling a base from mild steel containing titanium in an amount between four and nine times the carbon content of the steel;

exposing said base to an oxidizing atmosphere to produce a thin film of oxide on the surface of the base;

then exposing said base to a reducing atmosphere and at a temperature in excess of 1650° F. for producing a grain size in the finished flat material of about between 4 and 6 on the ASTM scale;

and then coating said base with zinc containing a trace of aluminum.

4. A process as recited in claim 1 wherein said base is rolled from steel having Ti to C ratio of about 4.5 to 1.

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