

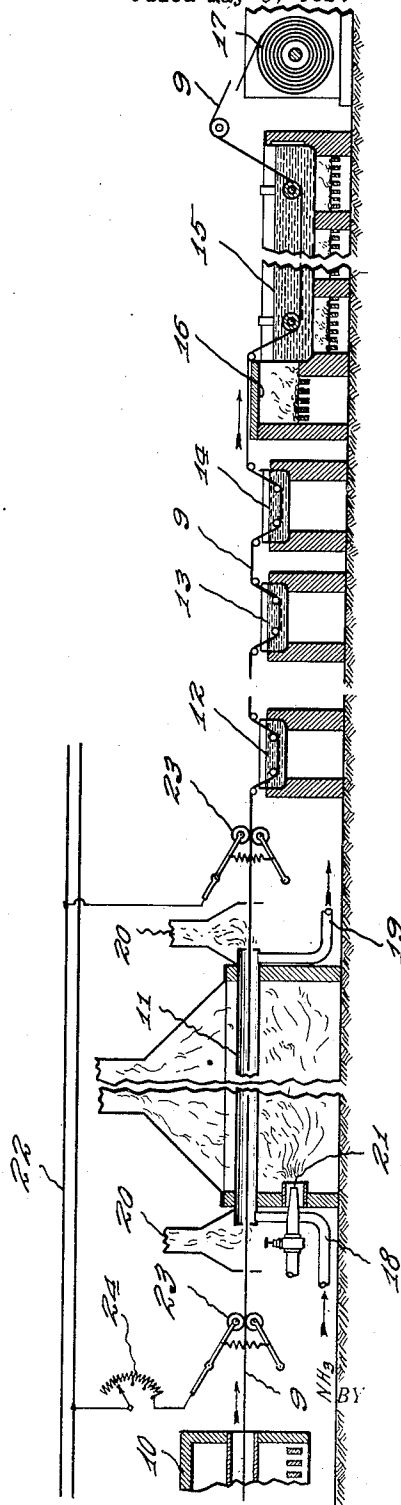
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PROTECTED METAL AND PROCESS OF MAKING IT

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# UNITED STATES PATENT OFFICE.

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PROTECTED METAL AND PROCESS OF MAKING IT.

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*To all whom it may concern:*

Be it known that I, FREDERICK M. CRAPO, a citizen of the United States, residing at Muncie, in the county of Delaware, and State of Indiana, have invented a new and useful Protected Metal and Process of Making it, of which the following is a specification.

The primary object of the present invention is to improve the zinc-coating of iron and steel articles, and especially iron and steel wire. More specifically, such primary object is to produce a zinc-coated article, especially iron or steel wire, the coating of which will adhere firmly and will not peel or flake off even when subjected to sharp bends or twists, as for example when wrapping wire around its own diameter. This is especially desirable with iron and low-carbon steel, with which such results cannot be obtained by ordinary galvanizing.

It is a further object to get this improved zinc-coating without adversely affecting the mechanical and electrical properties, such as tensile strength, elongation, and electrical resistivity.

Another object is to get a satisfactory and lasting zinc-coating with a smaller amount of zinc.

In accomplishing these results, I pass the iron-base article, such as iron or steel wire, advantageously after it has reached the gage at which it is to be coated, and desirably in a continuous operation in case of wire, through a suitable surface-nitrogenizing treatment, which somehow affects the surface so that a subsequently applied zinc-coating adheres more firmly thereto; and subsequently apply the zinc-coating.

A nitrogenizing treatment which I find very advantageous is heating the wire or other iron-base article in an atmosphere of ammonia, which may be in a tube through which the wire is passed. The wire or other iron-base article is suitably heated while in this atmosphere of ammonia so that the nitrogen of the ammonia somehow enters the surface of the wire, to a depth depending on the duration of treatment and the temperature. I prefer to make this treatment of sufficiently short duration so that the penetration of the nitrogen is relatively slight, and the interior save for a thin superficial layer is substantially unaffected by the nitrogen. The nitrogen and

the iron at and close to the surface of the article probably form an iron nitride, or iron nitrides, though I am not certain as to this. In any case, the nitrogen of the ammonia evidently produces a permeative addition by chemical change in the wire; and this permeative addition by chemical change promotes the adhesion between the wire and a subsequently applied zinc-coating, so that such zinc-coating is less apt to peel and flake off, even when the wire is subjected to sharp bends and twists.

The heating of the wire or other iron-base article in the ammonia may be obtained in any suitable way. Among these is an external heating of the container of the ammonia in which the nitrogenizing treatment takes place. Another is the heating of the iron-base article itself, either before or during its contact with the atmosphere of ammonia, as by direct heating by the passing of an electric current of suitable amperage directly through such iron-base article. These methods of heating may be used separately or in combination.

In the accompanying drawing, I have illustrated an apparatus for practicing my process and producing my improved product. The single figure of such drawing is a longitudinal sectional view showing diagrammatically such an apparatus.

The iron-base wire 9, of iron or steel, is presumed to have been passed previously through the desired sizing dies, until it has reached the gage at which it is desired to zinc-coat it; for although it is not necessary that the nitrogenization of the wire be after the final reduction in size, as it may be at any point during or even before the wire drawing, it is very convenient to produce the nitrogenization after the drawing is completed. The drawn wire may be annealed or otherwise heat-treated if desired, as in a tube-type annealing furnace 10. Then the wire is passed through a tube 11, which contains an atmosphere of ammonia; and is hot as it passes through such tube. After the wire leaves the tube, it may pass through any desired baths, such as a suitable acid bath 12 for cleaning, a water bath 13 for washing, and a fluxing bath 14, of any suitable flux, such as hydrochloric acid or zinc chloride. After passing through these various baths, the wire is zinc-coated, conveniently by passing through a bath 15 of molten zinc. It is usually desirable to pass

the wire over a hot plate 16 just before it enters the zinc-coating bath 15. From the zinc-coating bath 15, the wire passes to the winding reel 17. All this may be done in a continuous process, with the wire continuously moving in the direction of the arrows.

The tube 11 may be one of a battery of any desired number. I have not attempted to show how the ammonia is supplied to the tube 11, other than to indicate an ammonia-supply pipe 18 and a pipe 19 for carrying off gases from the tube. Hoods 20 may be provided over the ends of the tube 11 for carrying off any gas leakage.

The heated condition of the wire 10 as it passes through the ammonia atmosphere in the tube 11 is obtained in any suitable way. This may be by heating the entire tube 11, or battery of tubes, by suitable flames from below, as from a fuel burner 21. On the other hand, the wire may be directly heated, as by being made part of an electrical circuit before or during its passage through the tube. I have illustrated this by showing an electrical supply-circuit 22, the two sides of which are connected to two contact devices, such as contact wheels 23, which bear on the wire beyond the respective ends of the tube 11; there preferably being a rheostat 24 in the connection between one of the contact wheels 23 and the supply circuit, to regulate the current. It is sometimes convenient to use both the electrical heating of the wire itself and the flame-heating of the tube 11, as illustrated in the drawing. This heating of the wire while in the tube 11 may be lessened, or even eliminated, by carrying the wire 9 into the tube 11 already hot, as from the annealing furnace 10; this may be used alone to provide the desired temperature, or may be supplemented by heating the wire in the tube, either by electricity or by flame, or both. The temperature of the wire in the tube 11 is regulated, as by rheostat 24 or by the burner 21, or both, and/or by controlling the duration of passage between the annealing furnace 10 and the tube 1. I have found that a very considerable range of temperature may be used, and that a dull-red heat of the wire produces good results.

While the zinc-coating may be applied in various ways, the way I prefer to apply it, especially to wire, is by passing the wire through a bath of molten zinc. The zinc-coating bath 15 is advantageously maintained at about 840° F. to 900° F., in any convenient way; though that temperature may be varied in the judgement of the operator.

As the hot wire passes through the atmosphere of ammonia, the iron of the wire at and near its surface takes up nitrogen.

I am not sure just what compound or compounds are formed, for there may be several, but there is a permeative addition of the nitrogen into the wire, producing a chemical change. This action with whatever resultant chemical change or changes occur, so affects the surface of the wire that when the zinc-coating is subsequently applied, as in the bath 15, such zinc-coating will better adhere to the wire, thus making it possible for the wire to be subjected to sharp bends and twists without causing the zinc-coating to flake and peel off.

I claim as my invention:

1. A zinc-coated iron or steel article, comprising an iron-base body which has a relatively high-nitrogen surface condition in comparison with the interior, and a coating of zinc upon and adhering to said surface.
2. Zinc-coated iron or steel wire, comprising an iron-base core which is superficially nitrogenized, and a zinc-coating upon and adhering to said nitrogenized surface.
3. The process of zinc-coating an iron or steel article, which consists in nitrogenizing the surface of said article, and subsequently applying a zinc coating.
4. The process of zinc-coating an iron or steel article, which consists in subjecting the article while hot to an atmosphere of ammonia, and subsequently applying a zinc coating.
5. The process of zinc-coating an iron or steel article, which consists in subjecting the article to a nitrogenizing fluid, and subsequently applying a zinc coating.
6. The process of zinc-coating iron or steel wire, comprising passing said wire through an atmosphere of hot ammonia, and subsequently zinc-coating such wire.
7. The process of zinc-coating iron or steel-wire, comprising passing said wire through hot nitrogenizing fluid, and subsequently zinc-coating such wire.
8. The process of zinc-coating iron or steel wire, comprising nitrogenizing the surface of said wire, and subsequently zinc-coating it.
9. The process of zinc-coating an iron or steel article, which consists in subjecting the article while hot to an atmosphere of hot ammonia, and subsequently applying a zinc coating.
10. The process of zinc-coating iron or steel wire, comprising passing said wire while hot through an atmosphere of hot ammonia, and subsequently zinc-coating such wire.

In witness whereof I have hereunto set my hand at Muncie, Indiana, this 6th day of May, A. D. one thousand nine hundred and twenty four.

FREDERICK M. CRAPO.