

# UNITED STATES PATENT OFFICE.

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## MANUFACTURE OF MANGANESE-STEEL WIRE.

1,018,369.

Specification of Letters Patent.

Patented Feb. 20, 1912.

No Drawing.

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*To all whom it may concern:*

Be it known that I, WINFIELD S. POTTER, a citizen of the United States, and residing at the Apthorp Apartments, at the corner of Broadway and Seventy-eighth street, in the borough of Manhattan, in the city, county, and State of New York, have invented certain new and useful Improvements in Manufacture of Manganese-Steel Wire; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to the manufacture from manganese steel of wire of circular, oval, rectangular or other desired cross-section appropriate to the particular use for which the product is intended and including such products as thin flat tapes capable of being produced by the manipulation and heat-treatment hereinafter set forth.

In an application for Letters Patent of the United States filed by me under date of December 28th, 1911, Ser. No. 668,276, I have described the production of a billet of manganese steel in a strong, uniform, austenite state and the formation of a bar or rod therefrom under conditions which give a continuous fine-grained structure of the steel throughout the bar or rod.

In carrying out my present invention, the billet is rolled to a rod and the rod is finished with the fine-grained structure referred to and at such temperatures (temperatures which in the finishing stage of the rolling of the rod will lie within the range of say 800° C. to 975° C.) as will avoid any rapid recrystallization. The rod thus formed is then worked further until at temperatures below 420° C. and until of the desired gage, the reductions of the cross-section gradually diminishing from one drawing or reducing operation to the others in series as the metal cools, and the pressure or work being applied with but slight intervals between the successive reductions. I have found that the pressure thus exerted opposes the tendency to separation of the carbids in the mass and affords during the cooling of the steel a longer continuation of its ductility. Or, if, for any reason, it should be preferred to finish the rolling at a temperature higher than 420° C., avoidance of carbide separation and other objectionable slow-cooling effects may be secured by

rapidly cooling the rod or wire when it has reached the predetermined temperature above 420° C.

If the rod or wire produced as last described has not the required gage and needs further reduction, it may be reheated and drawn through dies having moving surfaces (such as roller dies) at any temperature; but, in order to avoid a coarse regaining of the steel, the temperature for reheating should not exceed about 1050° C., and if the reheating is at any temperature above 640° C. its duration should be short. By avoiding these long periods of heating at an equalized temperature above 640° C., certain inter-grain separations with an attendant loss of cohesion between the grains are also avoided, and not only will the wire be stronger and tougher, but will be non-laminated, that is, free from non-coherent fibers and internal weak cleavage surfaces. If the rod or wire is reheated to above 420° C. it is preferable to finish its further reduction before it is again cooled to below 420° C. in those instances where the rod or wire, during the reheating or previous cooling may have lost, in part, its austenite condition, and where, consequently, the metal, if now lacking in ductility, would be unduly strained if drawn below that temperature. Or, if the metal has not been permitted to pass out of the austenite state during the reheating operation and the subsequent cooling to 420° C. with coincident working, the drawing operation may be continued during the cooling to lower temperatures. For example, the rolled rod may be finished at say 800° C. to 1000° C. and then immediately further worked for example, by die drawing or immediately quenched or otherwise immediately water-cooled and afterward quickly heated to between 720° C. and 1050° C. (say 1000° C.). It may then be immediately worked and passed quickly as it cools from one reducing die to the next of the series with corresponding compression and gradual reduction in cross-section during the cooling, the cooling being rapid and the working being continued until the wire has a temperature as low as 420° C. It may then still be capable of enduring additional reduction at temperatures below 420° C. without serious straining, especially if the total percentage of reduction from the last reheating to 1000° C. or thereabouts has been moderate in amount, that is to say, has

not exceeded, for instance, 75 per cent. reduction in area of section while cooling from say 720° C. to 420° C. or 25 per cent. reduction while cooling from say 500° C. to 400° C. In general, however, it will be found that the manganese steel wire will require recrystallization to relieve it from strain and to restore its ductility lost in part, during the drawing operation. This may be effected by winding the wire from one reel on to another, and passing it through a suitable heating medium interposed between the two reels. The heating operation should be so conducted as to heat the wire throughout for a few seconds to a temperature ranging from about 72° C. to about 1025° C., the higher temperature referred to being preferable in order to restore more promptly to solution throughout the mass any carbids which may have separated during the prior working and cooling operation. I have found that a temperature of 1025° C. throughout and for a few seconds only, is sufficient to practically restore into solution the limited carbid separations which have taken place during the formation of the wire from the billet.

The reheating of the wire to the range of temperature referred to, that is to say, from about 720° C. to about 1025° C. causes it to recrystallize into a regained, fine, uniform, strong, tough, austenite state. The reheating of the moving wire as it passes from one reel to the other may be effected by passing it through a furnace having a suitable non-oxidizing atmosphere and by radiation from the furnace lining, without actual contact with the furnace hearth; or by passing it through a bath of molten slag or salt glass maintained as a temperature-balancing mass on the furnace hearth, or by passing the wire over and out of contact with such bath of molten slag or glass. As the wire issues from the furnace, it is immediately cooled down to atmospheric temperature by means, for example, of a number of water jets, or it may be similarly cooled by passing it through a bath of a melted lead alloy having a temperature below 420° C. The wire having now the desired gage and being in the uniform, strong, tough, austenite state referred to, may be used in this condition. If, however, a smoother surface or stiffer state is required, the wire may be given a correspondingly determined percentage of reduction by further wire drawing. In any case, however, the wire should not be considerably reduced in cross-section during low temperature or cold drawing without being afterward again subjected to the recrystallizing and toughening operation already described.

The production of manganese steel wire of the configuration of cross-section desired, in accordance with my invention, should be

conducted in such manner that as great a proportion as possible of the total reduction from the billet to the rod and from the rod to the finished wire will be executed at temperatures above 720° C. or thereabout, inasmuch as the manganese steel is readily rendered stiff and weak by a reduction of any considerable percentage in any one reducing die at a temperature below 720° C. or even by a series of reductions amounting in the aggregate to a considerable proportion in one heating below 720° C. Furthermore, since fixed dies are not easily made to endure temperatures above 600° C. or thereabout, it will be found most suitable to first roll the billet down to a very small rod (say  $\frac{1}{8}$  inch in diameter) and then to draw the rod to a wire through dies having moving die-surfaces, after first reheating the rod to a temperature of from 800° C. to 1000° C. Thus the rod may be drawn through the grooves of passes of rotating dies consisting of small rollers arranged in pairs or in two or more pairs for each drawing operation, and, as the wire leaves the rotating dies, it may be water-cooled, or it may be reheated and cooled as hereinbefore described to effect such recrystallization and toughening as may be desired.

As hereinbefore indicated, the finishing stages of the rolling of the billet to the rod will usually be conducted at temperatures between 800° C. and 1050° C. and the roller die drawing will usually be conducted at temperatures between 420° C. and 1050° C. The wire may then be finely wire-drawn through fixed dies and preferably at a temperature between about 300° C. where the metal has a considerable degree of ductility when in the uniform, toughened, austenite state, and a temperature of about 420° C. below which there is no reversion out of the uniform, austenite condition. I have found that at temperatures within the range of about 300° C. and 420° C. the wire will endure several times the reduction that could be given to it if the reduction were carried on at a lesser heat.

In order to secure the rapid reduction of the rod while at high temperatures as already described, I recommend the use of short stiff rolls mounted in multiples of two adjacent pairs. One pair will preferably have its axes parallel but at an angle (for example 90°) to the parallel axes of the adjoining pair, so that one pair may reduce the rod in one direction and the adjoining pair will then so reduce the rod as to maintain its symmetry. For instance, one pair of the roller dies rolls a round rod to an oval and the next in the series reduces the oval section to a round of smaller diameter than the original rod.

In operation, the hot rod is introduced into the first roller pass and at this time the

rolls are driven as by direct electrical drive at a moderate speed such that as the reduced rod emerges from the last pass of the series it may be readily seized and attached to the moving tension member of the wire drawing apparatus, and the wire is thereafter drawn through the roller dies. If the total reduction in the series of roller dies is considerable, the rod is suitably cooled before it enters the last rolling die pass and may also be cooled further as it leaves the last pass, by the application of steam or water jets, for example, to the moving rod in order to increase its strength so that the rod will be drawn through the successive dies of the series, without unsuitable or very irregular stretching of the drawn section.

Manganese steel of an analysis particularly suitable for the practice of the invention would contain say 11 per cent. to 14 per cent. of manganese, and from .70 per cent to 1.30 per cent. of carbon, according to the stiffness or ductility required; or the metal may have a proportion of copper or nickel in order to increase its resistance to corrosion.

Having thus described my invention, what I claim is:

1. The method of making manganese steel wire, which comprises producing a manganese steel rod in a fine-grained, austenite condition, and then, while the metal is in that condition and in a highly heated state working the rod with gradually diminished reductions as the metal cools, the working being continued from the higher temperatures to temperatures below 420° C.; substantially as described.

2. The method of making manganese steel wire, which comprises producing a manganese steel rod in a fine-grained, austenite condition, and then, while the metal is in that condition and in a highly heated state working the rod with gradually diminished reductions as the metal cools, the working being continued from the higher temperatures to temperatures below 420° C. with intermediate rapid cooling and reheating before the final stage of the working; substantially as described.

3. The method of making manganese steel wire, which comprises producing a manganese steel rod in a fine-grained, austenite condition, and then, while the metal is in that condition and in a highly heated state working the rod with gradually diminished reductions as the metal cools, the working being continued from the higher temperatures to temperatures below 420° C. with intermediate rapid cooling to below 420° C. and reheating for a short time to a temperature within the range from 720° C. to 1050° C. before the final stage of the working; substantially as described.

4. The method of making manganese steel

wire, which comprises producing a manganese steel rod in a fine-grained, austenite condition, and then, while the metal is in that condition and in a highly heated state working the rod with gradually diminished reductions as the metal cools, the working being continued from the higher temperatures to temperatures below 420° C., restoring such ductility as has been lost during the working of the drawn product and toughening it by heating the drawn product to a temperature within the range from about 720° C. to about 1025° C., and immediately rapidly cooling; substantially as described.

5. The method of making manganese steel wire which comprises producing a manganese steel rod in a fine-grained, austenite condition, and working the rod with gradually diminished reductions as the metal cools, the working being continued from higher temperatures to temperatures below 420° C., heating the drawn product to a temperature within the range from about 720° C. to about 1025° C., immediately rapidly cooling, and further wire-drawing to impart to the product additional smoothness or stiffness; substantially as described.

6. The method of making manganese steel wire from manganese steel, which comprises producing a manganese steel rod in a fine-grained, austenite condition at a finishing temperature between 800° C. and 1050° C., roller-drawing the rod with gradual decreasing reductions until at below 420° C., and plate-drawing the rod at temperatures below 420° C. and above 300° C.; substantially as described.

7. The method of making manganese steel wire from a manganese steel rod, which comprises roller-drawing the rod at temperatures above 420° C., and completing the reduction to finished gage by plate-drawing at temperatures below 420° C. and above 300° C.; substantially as described.

8. The method of making manganese steel wire from a manganese steel rod, which comprises producing a manganese steel rod in a fine-grained, austenite condition, and working the rod until of the desired gage at temperatures including a range of 640° C. to 420° C., a substantially continuous pressure being maintained upon the forming wire thereby minimizing possible carbide separations; substantially as described.

9. The method of making manganese steel wire from a manganese steel rod, which comprises effecting the maximum reduction of the rod at temperatures above 720° C. and with gradually diminished reductions as the metal cools; substantially as described.

10. The method of making manganese steel wire from a manganese steel rod in a fine-grained, austenite condition, which comprises effecting die drawing operations

within the range of 300° C. to 420° C. whereby the metal is subjected to the said drawing operations while in a condition of considerable ductility and below temperatures at which there is a tendency to reversion out of the uniform austenite condition; substantially as described.

11. The method of making manganese steel wire, which comprises producing a manganese steel rod in a fine-grained, austenite condition and substantially devoid of inter-grain separations, and working the rod to

wire with one or more reheatings of short periods of duration temperatures above 640° C. thereby producing a strong, tough wire free from internal weak cleavage surfaces; substantially as described.

In testimony whereof I affix my signature, in presence of two witnesses.

WINFIELD S. POTTER.

Witnesses:

JOHN C. PENNIE,  
MINERVA LOBEL.