

UNITED STATES PATENT OFFICE.

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METHOD OF REDUCING AND FINISHING WIRE.

SPECIFICATION forming part of Letters Patent No. 377,000, dated January 24, 1888.

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To all whom it may concern:

Be it known that I, JAMES WITHINGTON, a citizen of the United States, residing in the borough of Chambersburg, in the county of Mercer, and State of New Jersey, have invented certain Improvements in Reducing and Finishing Wire, of which the following is a specification.

My invention relates to the manufacture of annealed iron and steel wire, and it comprehends means whereby all operations of cleaning are dispensed with excepting the first cleaning of the rod.

As is well known, after wire has been drawn to a certain degree it becomes stiff and hard and requires to be softened or annealed before it can be further drawn. For certain purposes also, wire, when finished, requires to be annealed, and is sold as annealed wire. It is usually coated more or less with oxide scale or soot, and is distinguished from bright unannealed wire by its darker color and greater pliability, ductility and softness. For certain purposes again unannealed or stiff and elastic bright wire is in demand; while for yet other purposes, notably that of making wire cloth, in the weaving of which the scale upon dull or blue annealed wire tends to cut out the reeds, annealed bright wire is called for.

My invention aims to disclose a method whereby bright annealed small size wire, a product heretofore both costly and difficult of production, can be cheaply made.

For the better understanding of my invention I regard it as essential to briefly state the present practice of wire making:—

A billet of highly heated iron or steel is first successively reduced through the gradually lessening passes of any suitable rolling mill until it emerges from the last pass as what is known as a "wirerod," the usual diameter of which is a little less than a quarter of an inch. These wire rods are immediately and while hot wound upon reels into coils. These coiled rods after cooling are next immersed in tubs containing acid, preferably dilute sulphuric, or muriatic, to remove the scale or oxide,—sulphuric acid permeating the coat of scale, loosening it by attacking the iron itself, and combining with it to form sulphate of iron or green copperas (or if muriatic acid is used chloride of iron), which dissolves out and is held in so-

lution until the liquid becomes so impregnated as to cause further additions of acid to lose their effect upon the rods, when the liquid is run off and replaced by fresh water and acid. When the scale has been sufficiently loosened by the acid, the rods are taken out of the tubs and either suddenly immersed in a tub of clear water or else subjected to a stream from a hose (the more thorough as well as the more expensive method) in order that, by washing, all traces of scale and acid adhering to the surface may be removed. Immediately after washing the rods are immersed in a bath of milk of lime, or other suitable coating material, and quickly dried, whereby a white coat is imparted to the rods which preserves them from rust. In some instances the lime is omitted, but this occurs only when the rods are to be tinned, coppered, or galvanized, or drawn down into qualities of wire which do not require a bright finish. After coating with lime, the wires are drawn or reduced in diameter by pulling through a series of holes or dies in plates of cast steel or cast iron especially adapted for the purpose, the holes or dies being lubricated by any kind of grease, such for instance as tallow. This method of drawing wire through greased dies is technically known as "the dry method," and its object is not only to reduce the diameter of the wire but also to efface the pits or marks caused by the eating of the acid and render the wire perfectly smooth upon its surface.

Repeated operations of drawing, each time to a smaller size, harden or stiffen the wire, making it more and more elastic, until a point is reached when further drawing would destroy the nature of the wire and cause it to become quite brittle. In drawing down to the finer sizes, therefore, it becomes essential to soften the wire at certain sizes before it can be further drawn down. This is done by annealing or heating to redness in suitable vessels, the temperature depending upon the size of the wire, the larger sizes requiring the greatest heat. At predetermined stages of the drawing processes, therefore, or after the wires have been reduced to predetermined sizes, annealing must be resorted to, and subsequent to each annealing the operation of cleaning, washing, and lime-coating above described must be repeated. The sizes at

which annealing is resorted to vary with different manufacturers and with the character of wire desired. The sizes known as Nos. 6, 9, 12, 15, and 18, are the sizes at which annealing is best resorted to.

After the wire has been reduced by the dry method to a size known as No. 18, it is impossible to proceed further with the method of dry drawing, for the reason that such method in the finer sizes does not, by reason of the grease and lime employed, as herein fully explained, meet the requirements necessary to produce a sufficiently smooth and bright surface, and what is known as "the wet method" must be resorted to for the making of wire of smaller sizes than No. 18.

The wet method of drawing, briefly stated, consists in first immersing wire,—after it has been reduced to the smallest size practicable by the dry method of drawing, and after it has been in connection with said dry method of drawing annealed for the last time and thoroughly cleaned by pickling,—in a weak farinaceous glutinous or mucilaginous solution, such, for instance, as fermented rye flour, which forms upon its surface a mucilaginous film known among wire drawers as the "lees coat";—in then subjecting the wire with the lees coat upon it to the operation of being drawn down through a die; and in, finally, repeating the coating or immersion and the drawing down with a series of successively smaller dies. By this method only, has it been possible heretofore to draw iron or steel wire bright and perfectly clean. It has been inexpedient heretofore, however, to adopt the above method for the larger sizes of wire, by reason of the fact that, after each annealing in the cast iron pots heretofore alone employed in connection with the said wet drawing process, the wire, even when introduced in a clean and bright condition, has been taken out covered with scale and a dirty yellow or blue or dull black color, and this because of the gas generated in the pot notwithstanding the most complete exclusion of air possible,—for which cause thorough cleaning in acid became necessary, after the cleansing off of which, immersion in water became also necessary instead of coating with lime, for the reason that the lime, being coarse, when mixed with the lees solution would cut out the dies and scratch the wire;—all of which steps necessitate more skillful labor and a more expensive plant and therefore increase the cost of the larger products over and above their cost by the dry process.

It is proper to remark that in some instances, as in the case of harvester and broom wire which are completely finished at the size No. 20, the change from the dry to the wet method of drawing is effected at size No. 15. Whatever, however, be the size at which the wire is for the last time annealed before being finished by the wet method of drawing, it is after the final annealing cleaned thoroughly by immersion,

bathing, or washing in acidulated liquor, and is then thrown into a bath of clear water until it is ready to be drawn. The office of keeping the wire in water—which must in the first place be perfectly free from acids or salts—is to prevent the rusting which would occur if the wire was exposed to the air for any length of time while wet from its immersion in acidulated liquor, and also to dissolve out any traces of acidulated liquor that may remain in the wire. The water in the wet method, therefore, subserves the same purpose that the lime coat does in the dry method. In the fine sizes of wire, however, the strands lie so closely together in the hank that the operation of cleaning in acidulated liquor becomes a very laborious one, and it becomes necessary in order to remove the adhering particles of scale, after the coil or hank has been removed from the acidulated liquor, to loosen the fastenings of the coil, spread out its strands, and resort to what is known as "batting", a most lengthy and laborious operation. It is impracticable therefore to clean sizes finer than No. 18, so that it is absolutely necessary in the drawing down on these sizes that the surface of the wire should be kept perfectly clean and smooth. This condition also compels the operation of annealing of the sizes below No. 18 to be dispensed with, excepting of course such annealing as is resorted to with small wire which has broken or fallen out in the drawing before reaching its intended ultimate diameter, and which fits it to be sold as annealed fine wire, a product frequently disposed of below cost, because the falling out frequently happens at sizes for which there is no demand.

After the wire has been properly cleaned upon its final reduction by the dry method at No. 15 or No. 18 as the case may be, and when it is not essential that the ultimate product should be silver or liquor bright as it is termed, the wire, before being subjected to the wet drawing process, is lacquered or dipped for a few seconds in a weak solution of a salt of copper, such, for instance, as the sulphate of copper, which deposits a film of metallic copper on its surface that serves not only to protect said surface from rust but also to assist the lees-coat in lubricating the dies through which the wire is subsequently drawn. The lacquered wire is next immersed in a tub of lees from which it is continuously drawn, according to the wet method, through a die. This operation of immersing in lees and drawing through a die is repeated through a series of dies each smaller than its predecessor until the final reduction is attained. The lacquering may also, in connection with the above operations, be either occasionally repeated or may, if desired, be repeated before each drawing, provided however, as already stated, a silver or liquor bright finish be not desired, for the reason that, while the lacquer greatly assists the lubrication of the dies and is therefore advantageously employed, it yet, when once applied, adheres

so closely to the wire that it affects its ultimate tint and, while not affecting its brightness, imparts to it a distinct reddish cast.

Throughout the entire conduct of the above wet drawing or reducing process, it has, for reasons already fully stated, been impracticable to anneal the wire; and the result has therefore been that, although the percentage of each reduction has been comparatively small, yet the tensile strain on the gradually stiffening very fine sizes (from No. 26 to No. 36) has been so great that only the very best material endures to the ultimate reduction, and much even of the very best material in the best practice "falls out", as it is technically called, or breaks in the drawing before reaching the ultimate size. This wire has heretofore, therefore, been annealed and disposed of at a sacrifice. Of course if it were practicable to clean fine wire this difficulty would be avoided, but it is obvious that between the oxidation in the operation of annealing and the consumption of iron by the acid in the operation of cleaning, to say nothing of the excessive labor in batting, there would not be sufficient substance of wire left to pay for the cost of drawing.

Having now described the usual operations of manufacturing the various sizes of wire, it is proper for me to add that heretofore for many years it has been a desideratum with manufacturers of wire to anneal in such a manner that after the annealing process the wire could be immediately drawn without being first subjected to the laborious and expensive operation of cleaning, or pickling, heretofore described. Two serious conditions or obstacles however have heretofore existed to prevent, viz: the formation of scale upon the metal and the deposit of soot. The formation of scale results from the oxidation occurring when the wire is heated to redness in contact with air. The film of soot is produced by the carbonization of grease existing upon all bright wires drawn by the dry method and more especially upon the larger sizes. Many experiments to prevent the formation of the light scale of iron oxide have been made, such, for instance, as the construction of pots which when charged with wire would leave but a minimum air space, such space being filled with sand, roll scale, mineral wool, asbestos, and various refractory substances, the result of which has been to decrease to an appreciable extent the oxidation, but yet not to such an extent as to enable the operation of cleaning to be altogether dispensed with or to permit of a commercial adoption to any great extent. The film of soot is even more difficult to remove than the scale as it is unaffected by acids, and must, especially on the finer sizes of wires, be manually removed by washing with water and by the operation of batting. It is by reason of the formation of scale and deposit of soot also that the dry method of drawing wire is inapplicable for the finer

sizes which are therefore drawn by the wet method as heretofore explained.

Having now not only described the operations usual and heretofore necessary for the manufacture of the various sizes of wire, but also fully explained why, although desirable, it has been heretofore impossible to anneal wires so bright and clean as to avoid subsequent cleaning processes,—it is proper for me to state that my invention comprehends the production or discovery not only of a method of making bright annealed wires of the various larger sizes without having recourse to any other process of cleaning than that employed to clean the rods from which said wires are subsequently drawn,—but also a process or method of making the finest sizes of bright annealed wires, or those below the diameter of No. 18, without either the loss of great quantities of the same by breakage or falling out in the drawing before the ultimate size is reached, or without dulling their surface or destroying that brightness which is essential to make these smaller varieties of the highest commercial value.

I have discovered that the foregoing desirable conditions can be fulfilled and results secured in the following manner, to wit:—

I first take the rod which has been rolled from the billet, and pickle and cleanse it in the manner hereinbefore described. I then coat the cleansed product by means of a farinaceous, glutinous, or mucilaginous solution, such for instance as a weak solution of rye flour, and such as is known as a "lees" solution because forming upon the surface of the wire a mucilaginous film known among wire-drawers as the "lees coat,"—and draw the coated product through a die, not only to reduce its diameter but also to smooth its surface and efface the acid pits. If the ultimate product is not to be silver or liquor bright but simply bright, I preferably not only at this stage but subsequently from time to time as the lacquer wears off resort to lacquering in connection with the lees coating. The lacquering, however, is not essential. I then repeat the coating and drawing through a smaller die as frequently as may be necessary or desirable and until the wire requires to be annealed. I then seal the wire in its thoroughly cleansed condition and in such sufficient quantity to as nearly as possible fill the pot, in tight pots or vessels of sheet or tank metal, boiler or armor plate, being preferably wrought iron although they may be of steel, and subject the wire so contained or inclosed to the action of heat in order to anneal it. When the process of annealing is completed and the pots and contents have cooled, I then remove the annealed wire from the vessel in which it has been annealed, and find that said wire is clean and as bright as it was before being annealed. I then again subject the clean and bright annealed wire to the lees solution (either with or without lacquering) in order to coat it, and draw the clean coated product

through a die, all in the manner above set forth, and subsequently repeat both the immersion in a "lees" solution and the drawing through a die as frequently as may be desired, 5 in order, by a series of gradually smaller dies, to draw the wire down from the size at which the operation is commenced to the ultimate diameter desired.

In connection with the above wet-coating 10 and drawing down, the operation, above described, of annealing in wrought iron or steel is usually to be repeated three or four times before the size No. 18 is reached, and at no stage of the operation is pickling, inseparable 15 from the dry drawing process, necessary.

After the last annealing in wrought iron resorted to at or before size No. 18, and when a very small size of bright annealed wire, known as "stone wire," is the product had in view, the 20 wire is subjected to repeated lees coatings (and, if the silver or liquor bright finish be not desired, lacquerings) and to repeated drawings, each time through a smaller die, until the ultimate desired diameter is reached. With the 25 very best stock the above operation, such is the virtue of annealing a clean product in wrought iron, is possible without other annealings than such as are resorted to before the size No. 18 is reached, but with some material, which a skilled workman will readily 30 recognize, it becomes necessary to repeat the operation of annealing in wrought iron once, and in exceptional cases several times, between the size No. 18 and the ultimate size; 35 this annealing is however readily performed without any process of cleaning, for the reason that the wire being clean and bright when it is put in the annealing vessel comes out of it clean and bright, as hereinbefore fully explained. 40

It is manifest that the wet method of drawing, or drawing by the aid of a "lees" coat, is the only one applicable in the process which I have discovered, practiced, and above described, as it is essential that the wire when 45 put in the annealing pot should be perfectly clean in order that it may be taken out in the same condition, and as it is impossible either to draw wire after the method of dry drawing 50 with grease, the surface of which is in the slightest degree coated with scale, soot, or dirt, without soon cutting out the dies, or to anneal it bright even in wrought iron without first subjecting it to thorough cleansing.

The wrought iron annealing pots which I 55 employ in connection with the above process, having been filled with wire, are in the practice of that process placed in an annealing furnace preferably provided with a cast iron receptacle or chamber adapted to receive them 60 and to prevent their coming into direct contact with the flame of the fires. After being heated to the required temperature they are taken out and allowed to become perfectly 65 cold before they are opened and the wire removed and subjected to the subsequent drawings. I have said that the pots may be com-

posed of steel as well as of wrought iron, and this is by reason of the fact that steel can be made so low in carbon that there is chemically 70 no difference between it and some grades of wrought iron, the distinction between the natures of steel and iron being now admitted to be merely a molecular one produced by their different modes of manufacture. 75

By the above method of annealing bright in wrought iron pots, and in connection therewith of drawing the bright annealed wires when coated with the "lees"-coat through 80 dies, I am enabled to entirely dispense with all the operations of cleaning except the first cleaning of the rod, and also to dispense with the hitherto objectionable method of dry drawing by the aid of grease, and to employ the wet or "lees"-coat drawing with the sizes 85 above as well as with those below No. 18. I am also able, when it becomes necessary to anneal below size No. 18, to anneal bright and, without cleaning, by the aid of the "lees"-coat draw to any degree of fineness the sizes under 90 the said No. 18, and to thus certainly even with poor stock produce those sizes which have hitherto been difficult to manufacture because the wire drawn down to make them 95 has frequently hitherto broken or fallen out before reaching the said ultimate sizes, and I produce moreover a softer and superior quality of wire than that heretofore made and which has not required such annealing.

By the practice, therefore, of this invention, 100 I am enabled to utilize a large quantity of wire heretofore broken or fallen out in the process of drawing down, and which has heretofore therefore of necessity been annealed and disposed of at a sacrifice as dull or blued annealed fine-size or stone wire, and in this particular I effect a material saving which in 105 large wire mills will amount to many thousands of dollars in a year.

It will of course be readily understood that 110 many solutions other than that of fermented rye flour may be resorted to in order to provide the surface of the wire with a mucilaginous film or coating of lubricating material adapted to facilitate the operation of drawing 115 through dies, and it is proper for me to state that I do not restrict myself to any special solution or coating, although fermented rye flour is perhaps preferable. I, also, do not lay stress upon any specific form or construction 120 of annealing pot, or furnace within which to heat such pot, as many forms and constructions can be profitably employed, and as the gist of the thing so far as the annealing is concerned resides in the employment of wrought 125 iron *per se* for the inclosing of wire, and in the subjecting of it so inclosed to heat necessary to anneal it.

I am aware that I am not the first to employ wrought iron vessels in which to conduct operations of annealing, where the product to be 130 annealed was both introduced and removed from the annealing vessel in a dull, dirty, deposited, or artificially coated condition, but,

so far as my knowledge extends, I am the first to have discovered that when thoroughly cleaned or bright metal products are introduced into a wrought iron annealing vessel in quantities sufficient to completely fill it they can be removed therefrom in the same bright and clean condition in which they existed when introduced. This discovery I do not, however, claim in this application (and its consideration *per se* is not pertinent here) as it constitutes the subject matter of another application of mine now pending in the Patent Office. It is also proper for me to explain that I lay no claim to the invention of the process known as the "wet drawing" process, or a process consisting of the drawing down of a wire through a die when the wire has been previously coated with a farinaceous, glutinous, or mucilaginous film or coat, as this process in connection with the employment of cast iron annealing pots has been, as herein previously explained, long in use, but

What I do claim and desire to secure by Letters Patent is:—

1. The method of finishing wire hereinbefore described, which consists: first, in subjecting cleansed wire rods or annealed wire contained or inclosed in a wrought iron or steel vessel to the action of heat in order to anneal it bright; second, in coating the bright annealed wire, after it has been cooled in and then removed from the annealing vessel and without any intermediate operation of pickling or cleaning, with a farinaceous, glutinous,

or mucilaginous solution; third, in drawing the coated bright annealed wire through a die; and, fourth, in repeating the above named steps of coating, and drawing, until the ultimate desired diameter of wire is reached,—all substantially as hereinbefore set forth.

2. The method of finishing wire hereinbefore described, which consists:—first, in pickling and cleansing wire rods or annealed wire; second, in coating the cleansed product with a farinaceous glutinous or mucilaginous solution and in drawing the coated product through a die; third, in subjecting the cleansed and drawn product contained or inclosed in a wrought iron or steel vessel to the action of heat in order to anneal it bright; fourth, in coating the bright annealed wire after it has been cooled in the closed annealing vessel and removed therefrom, and without any intermediate operation of pickling or cleaning, with a farinaceous glutinous or mucilaginous solution, and in drawing the coated bright annealed wire through a die; and, fifth, in repeating the above named steps of coating and drawing (and if required of annealing) until the ultimate desired diameter of wire is reached, all substantially as hereinbefore described.

In testimony whereof I have hereunto signed my name this 12th day of March, A. D. 1883.

JAMES WITHINGTON.

In presence of—

J. BONSALL TAYLOR,
W. C. STRAWBRIDGE.