



J. REESE.

Burnishing and Ductilizing Cylindrical Bars, Tubes, &c.

No. 236,696.

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Fig. 2.

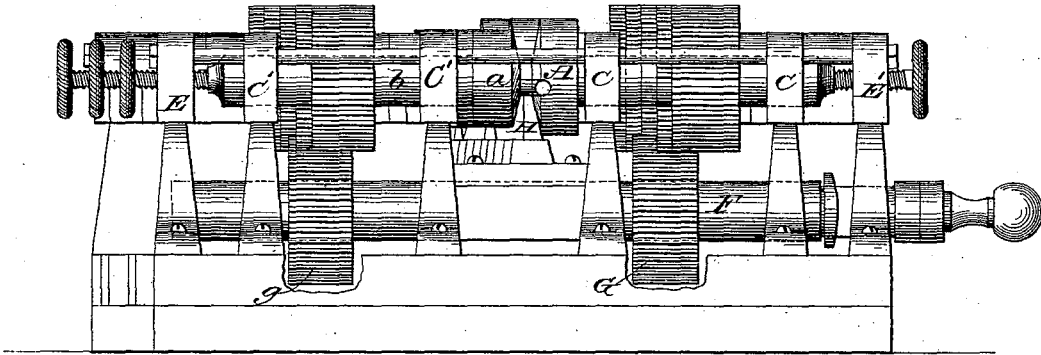


Fig. 3.

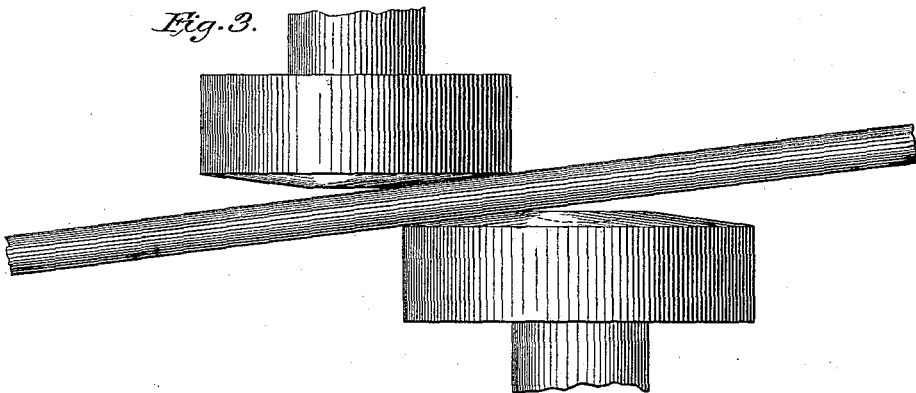
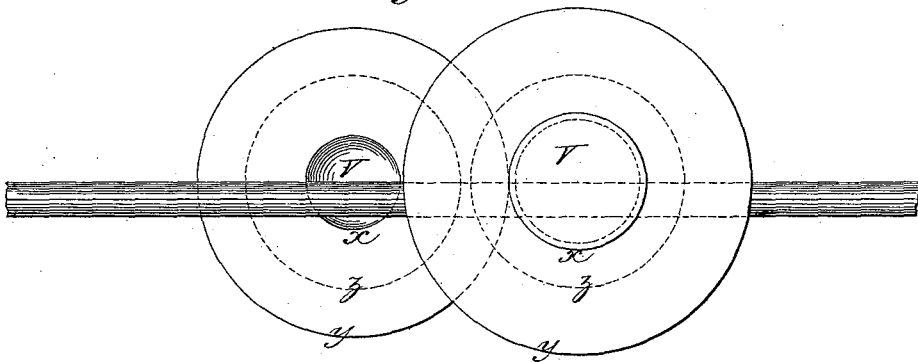


Fig. 4.



Witnesses:

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# UNITED STATES PATENT OFFICE.

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## BURNISHING AND DUCTILIZING CYLINDRICAL BARS, TUBES, &c.

SPECIFICATION forming part of Letters Patent No. 236,696, dated January 18, 1881.

Application filed March 21, 1879.

*To all whom it may concern :*

Be it known that I, JACOB REESE, of Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Burnishing and Ductilizing Cylindrical Metallic Bars, Rods, Shafts, Pipes, Tubes, &c., which is fully set forth in the following specification.

In order that my invention may be readily and clearly understood before describing it, I shall first refer to the art of burnishing as practiced heretofore.

The art of burnishing metals is of extreme antiquity, and has been used immemorially to produce a highly-finished surface upon metallic bodies. The operation of burnishing consists in rubbing with slight pressure a finely-finished surface of one metallic body upon and over that of another until, by the frictional action thus developed, the facets of the metal are smoothed down and all lines, scratches, and marks are obliterated. The distinctive features of this method are, first, each body acts upon and burnishes the surface of the other; secondly, there is no cutting or grinding action of abrasives present, as in polishing and grinding operations, and therefore the metal must be previously prepared by removing all scale and inequalities from its surface. In practicing this method it is necessary that the working-surface of the burnishing-tool should be brightly burnished and be kept free from all scratches, lines, and marks, as it is impossible to produce a higher finish upon the surface of the article operated upon than that of the burnishing face or tool.

When burnished iron and steel are produced, which is only in exceptional cases, for the art is almost entirely restricted to the production of soft or plated burnished metals, they are generally mounted in a lathe, turned, and then polished with emery until a highly-finished surface is obtained. A button-tool is then pressed with a considerable degree of force against the surface of the bar and gradually moved from point to point until the burnished surface is produced.

Another method of producing burnished bars of iron and steel is to first prepare the bars by scaling in an acid-bath. They are then subjected to an alkaline bath to neutral-

ize the effects of the acid, after which they are polished with an emery-wheel and then subjected to the burnishing operation, which may be conducted as in the preceding case or entirely by hand, in which case two burnishing-tools are used by the operator, who grasps them firmly and presses and rubs them over the bar longitudinally from end to end.

It is obvious that the operations described are slow, laborious, and costly. Consequently burnished copper, brass, and plated metals are used for many purposes where iron and steel would be very desirable if it were not for the excessive cost of burnishing; and in examining the state of the art it is found that it is not only not adapted to their production on account of the great cost, but that the art has retrograded so far as its product of iron and steel is concerned, and that its operations are still performed by hand.

I shall now describe my invention fully and clearly, so that others skilled in the art may make and use the same.

My invention relates, first, to a method or process of burnishing and of burnishing and ductilizing cylindrical metallic bars, rods, shafts, pipes, tubes, &c.; secondly, to the preparation of the machinery or mechanism therefor; and, thirdly, to the product of the process.

The object of my invention is to produce all kinds and sizes of burnished and ductilized bars, rods, pipes, tubes, &c., rapidly and economically, and in carrying out my invention to obtain this object several well-known kinds of machinery or mechanism, hereinafter more specifically pointed out, may be employed, if operated upon metal properly prepared by rolling to an exact gage and adjusted and operated in a peculiar manner discovered by me, and which I will more particularly describe in the body of this specification.

First, the metal to be burnished or burnished and ductilized must be held between two or more faces which are parallel to the line of the major axis of the article to be operated upon.

Secondly, in burnishing or burnishing and ductilizing cylinders the working-surfaces must move in opposite directions, or, if in the same direction, must move at different rates of speed.

Thirdly, the different portions of the working-surfaces should move at different surface rates of speed.

5 These essential features, which are requisite in carrying out my process, may be obtained in a more or less perfect state by the employment of the coned cross-rolls at present used for straightening tubes, pipes, &c., the Dyson cross-rolls, and other machinery well known to metal-workers, but especially in that class of disk-rolls shown in Letters Patent No. 65,832, granted to me June 18, 1867, and No. 190,983, granted to me May 22, 1877, which I devised, and have heretofore only employed for rolling and straightening cylindrical rods and bars. Therefore such mechanism may be employed when carrying out my process; but herein I make claim to no such devices.

20 Fourthly, the machinery must be so adjusted that the burnishing-surfaces shall exert a greater degree of frictional force in one direction of the major axis of the metal operated upon than in the opposite, so as to obtain an automatic feed.

25 Fifthly, the burnishing-faces must be adjusted so that certain degrees only of pressure, frictional action, and tractive force are exerted upon the metal: first, the burnishing-faces for the first pass should be adjusted so as to exert a sufficient pressure, frictional action, and tractive force to loosen and remove any or all scale upon the surface of the metal; and, secondly, as the removal of the scale will leave the metal in a rough or pitted condition, the burnishing-faces for the second pass should be adjusted so as to exert sufficient pressure to compress the inequalities upon the surface of the metal and develop a sufficient frictional action to smooth down the facets of the metal; thirdly, the burnishing-faces for the last pass or passes should be absolutely true and possess as highly a finished surface as the article to be produced; and, finally, all the burnishing-faces must be so adjusted that a sufficient pressure will not be had upon the metal to develop a tractive or drawing force sufficient to overcome the force of cohesion of the particles of the metal and draw them over the surface of the bar; nor should they be so adjusted as to exert sufficient pressure and frictional action to develop heat enough to expand the metal to such an extent as to choke the surfaces or cause a displacement or translation of the particles of the metal, as in rolling.

55 Sixthly, the metal operated upon must be of an exact or uniform gage, in order that when undergoing the operation an undue amount of pressure, frictional action, and tractive force may not be developed upon any part of its surface; and, finally, as the ability of the metal to resist the tractive force is governed by the force of cohesion of its particles, and as that is governed by its temperature, the metal should be operated upon while in a cold state, or at a temperature not exceeding 500° Fahrenheit.

In these last three conditions, which relate

to the process or method of operation, the characteristics of my invention or discovery exist.

70 Though the essential features of construction exist in several kinds of machinery, as before described, which will enable the operator to utilize them in carrying out my process, yet heretofore such machinery, being designed and employed only for rolling, reducing, and straightening, has not been prepared, adjusted, and operated in a manner suitable and essential to my process as set forth in the fifth and sixth statements.

80 The product of the process which constitutes a part of my invention has as its characteristics an exceedingly highly-burnished surface of a bluish cast, somewhat resembling nickel-plate, and is covered with very delicate spiral shading. It generally possesses an increased diameter, which indicates a slightly-decreased tensile strength, but greatly-increased ductility. It can be readily distinguished by the eye from all other burnished iron and steel by its color and peculiar shading. As the metal which has been rolled to an exact size is covered with scale, which would be liable to deface the burnishing-faces, it is submitted to auxiliary mechanism to remove the scale and grit, so that the same condition of the metal may be had as in ordinary burnishing operations, and to render the whole operation continuous and automatic a particular arrangement of the devices is desirable. This I have shown in the drawings and shall now proceed to describe as preliminary to the further description of my process of burnishing and burnishing and ductilizing metals.

100 In the drawings, Figure 1 is a top view of a continuous disk-machine. Fig. 2 is an end elevation of the same. Fig. 3 is a top view of a set of conical disks. Fig. 4 is a diagram, showing the working-face of one disk and the back of another.

110 Like letters refer to like parts wherever they occur.

The series of disks, which, in the present instance, are six in number, are arranged so that they all operate upon the bar at one and the same time. The faces of the disks are slightly conical, and the centers of the faces are turned concave, so that the working-face of each disk extends from the edge of the periphery to the outer edge or line of the concave portion of the disk. The disks are of two sizes, the larger being about sixteen (16) inches in diameter and the smaller about fourteen (14) inches. The large disks  $A A' A^2$  are placed upon the same side of the working-line, and the small disks  $a a' a^2$  are placed on the opposite side, the object being to secure a downward bite upon the bar by the large disks and an upward by the small disks and thereby keep the bar down firmly onto the rests. These disks are mounted on suitable shafts  $B B' B^2$  and  $b b' b^2$ , which are set in the standards or housings  $C$  and  $C'$  in such a manner that the large and small disks are not directly opposite

to each other, but bear such relative position as will bring the outer edge of the working-face of each disk directly opposite to the inner line of the working-face of the adjacent disk. This arrangement is not absolutely necessary, but renders the construction simpler than other modes of arrangement.

The disk-shafts are provided with pinions  $D D' D^2$  and  $d d' d^2$ , which mesh into idlers or pinions mounted on shafts, which are set into the standards between each pair of disks. It is necessary to have idlers for the disk-pinions to mesh into, because if they were to mesh into and communicate motion directly to each other every other disk on the same side of the working-line would revolve in an opposite direction, and consequently prevent the mechanism from working.

$E E'$  are end housings, provided with suitable adjusting-screws for the purpose of setting the machine for any given size of work to adjust the disk-faces in a parallel line and regulate the pressure upon the metal operated upon.

$F$  indicates the main driving-shaft, which is provided with pinions  $G g$ , which mesh into the central disk-pinions,  $D d$ .

$H H' H^2$  indicate rests, which are set in line beneath and between the disk-faces. These guides or rests are slightly less in width than the diameter of the piece of metal to be operated upon, and for ordinary work they are adjusted to keep the center of the bar a little below the center of the disks, that being necessary in order that the resultant action of the forces exerted by the movement of the disks may cause the bar to feed forward as it rotates. The forward speed will depend upon the altitude of the rests in relation to the disk-centers, and if they are adjusted so that the center of the bar is on the same line as the center of the disks it will rotate, but without forward or backward motion. If the rests are adjusted to throw the center of the bar above the center of the disks, it will have a backward movement as it rotates.

When power is applied to the main shaft  $F$  to rotate the same the pinions  $G g$  communicate motion to the central disk-pinions,  $D d$ , which turn the idlers, and thus communicate motion to the other disk-pinions, thus causing all the disks to rotate uniformly. In order to fit these disk for burnishing and ductilizing iron and steel it is necessary that their working-faces should be trued and highly polished, and this I accomplish by the following manner:

The machine having been adjusted for any given size of work and the guides or rests being in a line and adjusted to the proper height, I take a square piece of hard wood of suitable thickness and place it upon a rest in front of the machine. I then oil the disk-faces and sprinkle them with emery, and finally enter the block between the disk-faces, when it will be caught and drawn slowly forward, thus truing and polishing the entire train of work-

ing-faces at one and the same time, and also polishing and truing the working-faces of the rests. The machinery is now capable of burnishing and ductilizing the metal when properly adjusted for that purpose, and this adjustment is a matter which will require considerable skill and care upon the part of the operator, as a degree of pressure is necessary in some cases which would be entirely inadmissible in others.

By referring to the drawings it will be readily understood that when the rests are adjusted to any given height the feeding of the bar will be uniform and constant, and therefore the only method of increasing and decreasing the frictional action upon the surface of the metal will be by regulating the pressure as occasion may require. As a general rule, friction increases in ratio with the pressure, and the greater the friction the greater the tractive force which tends to draw or film the surface of the metal. The ability of the metal to resist this drawing force depends upon the attraction of cohesion of its particles. This varies in different metals and in the same metals at different temperatures, being greatest at the lowest and least at the highest temperature; and in iron and steel it depends greatly upon the amount of carbon in combination with the metal. Now, it is evident that when the bar is entered into the machine its temperature will be gradually raised by the frictional action at each successive pass, and therefore become less and less able to resist the tractive force, and that as its temperature increases the metal will gradually expand in diameter, so that if all the faces are previously adjusted to exactly the same distance apart, in such case not only will the metal become less able to resist the tractive or drawing force, but the increased temperature of the metals will, by causing such expansion, develop more pressure and frictional tractive force, so that the metal will then be very liable to draw or scab, hence the disk-faces should be so adjusted as to bring the greatest pressure at the first pass, and to apply a little less at each successive pass until the burnished bar is completed.

In conducting the operation the object is to secure sufficient pressure to compress the inequalities from and to develop enough frictional or tractive force to overcome the attraction of cohesion of the particles composing the scale on the surface of the metal, yet not enough to overcome the force of cohesion of the particles which will then form the surface of the metal itself. If the metal has a great force of cohesion and does not possess a tough, tenacious scale, this may be readily effected; but where the conditions are opposite great care must be had and a constant watch kept for signs of filming. Therefore, as it is imperatively necessary that certain degrees only of pressure, frictional action, and tractive force be applied or developed upon the surface of the metal, it is necessary, first, that the metal should have been previously

rolled to an exact or uniform gage, so that when burnishing an undue amount of pressure may not be developed upon its surface at any point; secondly, as the ability of the metal is less to resist the tractive force when at high temperatures, it should be operated upon when in a cold state, or at a temperature not exceeding 500° Fahrenheit.

The machine being in condition, having its working-faces trued and polished, and the metal having been properly prepared by rolling to an exact gage, a test-bar may be entered and the working-faces gradually tightened up after each pass until a point is had at which the films begin to show upon its surface. This is an indication that the pressure is too great, and the tightening-screws should be relieved a little and the test-bar again entered, a careful watch being kept for further filming. If none appears, the machine is properly adjusted for that sized bar; but if films still continue to form the pressure must be further decreased until a point is had at which no films are formed. It is not necessary, however, that the machine should always be adjusted in the manner just described, as burnished bars may be sometimes produced although a very light pressure is used—as, for instance, where the scale upon the metal is not tenacious and the surface of the metal is very smooth; but in all cases the pressure will be light in comparison with that which is required for rolling and extremely light when compared with that required for cold-rolling. I am unable to give the required degree which will be necessary in all cases, as I find that the pressure varies upon any given point according to the difference in the diameters of the bars operated upon, the larger diameters burnishing under heavier pressure than the smaller; secondly, the pressure upon any given point may vary accordingly as the width of the burnishing-faces used varies. The wider the disk-faces the greater will be the amount of frictional action and tractive force upon any given part of the bar in any given time, and consequently the less must be the pressure. The converse of the proposition is also true—viz., the narrower the disk-faces the less the frictional action and the greater the pressure admissible; but the working-faces must never be made very narrow, as in such case so great a pressure would be required to develop the frictional action which is necessary that the operation would be entirely changed and cause a reduction of the metal and displacement of its particles, as in rolling. Finally, I find that the pressure may vary with the different temperatures and natures of the metal operated upon. Therefore no precise rule can be adhered to for all cases, except to first have all stock previously rolled to a uniform gage; secondly, have all the burnishing-faces turned perfectly true and give them a high polish; thirdly, have the burnishing-faces constructed of sufficient width to develop a sufficient amount of frictional action

when a light pressure is applied, and then feed the bar at a proper temperature and apply any pressure from an exceedingly light one to the highest the metal will stand without filming. 70

The machine being in the condition specified and adjusted as specified, rough bars of metal in a cold state are inserted one at a time between the receiving-disks, are caught, rotated rapidly, and drawn forward, traveling forward with a speed of from one to sixty feet per minute, according to the size of the bar, height of the rests, and speed at which the disks rotate, and are delivered perfectly straight, of a true cylindrical form and highly burnished. In some cases, however, when the bars are of a large diameter and are covered with a tough, tenacious scale, additional passes may be required to accomplish this result. 75 80

When burnishing cold metallic bars I prefer to place narrow pans containing petroleum or other oil beneath the second and third pair of disks. These pans are of sufficient size to contain the required quantity of oil, and are shaped so as to form a sheath or trough, in which the lower portions of the disks revolve. The effect of the application of the oil is to prevent the working-faces of the disks from scratching and marring, and it also has a certain effect upon the finished product, of which I shall speak hereinafter. 85 90 95

When it is designed to straighten and burnish metal directly as it comes from the rolls during its manufacture the process should be the same as before specified, except that considerable water should be let upon the first set of disks and upon the bar, to reduce the temperature of the metal to the proper degree, and so that in its rapid contraction the scale will be loosened. A steam or air blast should be used to carry the scale away, and the first and second set of disks will then readily remove any portion which may still adhere to the bar. The metal will then pass from the first to the second set of disks thoroughly deoxidized and partially burnished, and the second and third pair of disks will, by the frictional action, which also burnishes, heat the surface of the bar. Consequently the hydrogen of the oil and lighter components, or at least a considerable portion thereof, will be vaporized, leaving the bar coated with carbonaceous matter, which is apparently forced into the pores of the metal by the action of the disks, and the bar, when burnished, is found to have a much finer appearance than if it had been burnished without the oil, and it is also enabled to resist oxidation to a greater degree. 100 105 110 115 120

For the purpose of illustrating the frictional action which may be obtained by the employment of disk-rolls, I will again refer to the drawings, in which Fig. 3 represents a top view, and Fig. 4 is a diagram, of a set of disk-rolls, the latter showing the back of a sixteen-inch and the working-face of a fourteen-inch disk. V indicates the concave portion of the disk-faces, which is five inches in diameter in 125 130

the fourteen and seven inches in diameter in the sixteen inch disk. X indicates the inner lines or edges of the working-faces; Z the neutral lines, or those portions of the disks at which their rate of speed when working is equal to the surface speed of the bar in rotating; and Y indicates the outer edges or lines of the working-faces of the disks at their peripheries. It is well understood that the different portions of the disk-faces travel at different rates of surface speed, according to their position with relation to the disk-centers.

When a cylindrical bar is fed into the disks it will rotate, and, all portions of the surface of the bar being at the same distance from its axis or center, will travel at the same surface rate of speed, and as the working-faces of the disks travel, having differential rates of surface speed, as before stated, great frictional action is produced on the working-surface of the disks and the surface of the bar; or, in other words, this result follows because the surface speed of the bar and disk-faces is the same only on the theoretical or neutral lines indicated by the letter Z, the disk-faces traveling at a gradually-increasing speed from the neutral line to the peripheries and at a gradually-decreasing speed from the neutral line to the inner lines of the working-faces of the disks. If, therefore, (as in ordinary practice,) the working-faces of the disks are four inches in width from the outer to the inner edges of the working-faces, the area of the small disk will be one hundred and thirteen thousand and ninety-six square inches and that of the large disk will be one hundred and thirty-eight thousand two hundred and twenty square inches, thus making a total area of two hundred and fifty-one thousand three hundred and sixteen square inches of frictional surface which slips or rubs over the surface of the bar at each revolution of the disks.

In addition to the frictional action of the disk is that of the rests. A bar one and one-eighth inch in diameter will rotate (the rests being at the proper height) eight (8) times to each revolution of the disks and feed forward about two inches to each revolution of the disks, or one-quarter of an inch to each revolution around its own axis. The length of the rest's working-surface is usually about five (5) inches, so that the bar will revolve twenty (20) times over the polished surface of the rest during the time any given portion of it passes from one end to another of the rest, and the rest acts the same as if the bar were rotated in a lathe and a burnishing-tool pressed against it with the same degree of force during twenty revolutions around its axis. Finally, I obtain the frictional action which arises from the forward movement of the bar over the burnishing disks and rests.

One of the effects produced by the frictional action to which I have referred, or by the action of the heat developed by the friction, is to gradually expand the metal during the

burnishing operation, so that as the bar travels forward the pressure will become augmented unless the tightening-screws are adjusted lighter for the latter passes, and I have found that when they are properly adjusted the metal will in some cases retain permanently its increased diameter, which I have found in all cases to indicate a slightly decreased tensile strength, elastic limit, and a greatly increased ductility in the metal. When, however, the tightening-screws were adjusted so as to compel the bar to retain its original diameter, I have found the elastic limit and ductility are the same as in the original state, and that the tensile strength remains almost the same as in the original state previous to the operation.

The following record of tests made by tension shows clearly the changes which are effected in the physical nature of the metal by the process:

Condition of pieces	Rough.	Bright.	Bright.	Bright.	Bright.	Rough.
Condition of pieces marked....	459	460	461	462	463	464
Diameter or dimension, original in inches	1.013	1.014	1.016	1.012	1.015	1.012
Diameter or dimension after fracture	.955	.853	.851	.969	.910	.952
Measure of cross-section, original	.806	.807	.811	.804	.809	.804
Measure of cross-section after fracture	.716	.571	.569	.737	.650	.712
Elastic limit, pounds	51,000	47,500	49,500	48,000	47,500	48,000
Elastic limit per square inch, pounds	63,283	58,823	61,058	59,674	58,704	59,674
Maximum or breaking load, pounds	88,235	86,795	88,395	88,305	87,365	87,500
Breaking load per square inch, original section	109,486	107,486	109,035	109,782	107,972	108,782
Elongation in five inches	.547	.953	.797	.500	.656	.500
Elongation per cent.	10.94	19.06	15.94	10.00	13.12	10.00

Nos. 459, 460, and 461 were cut from the same bar of steel. No. 459 was cut from the rough end, which was in the same condition as it came from the rolling-mill. Nos. 460 and 461 were bright and were cut from the end that had been burnished.

No. 459 broke just above the top center punch-mark. No. 460 broke between the points of measurement. No. 461 broke at the top center punch-mark.

Nos. 462, 463, and 464 were cut from one bar of steel each end of which had been burnished. No. 464 was cut from the middle of the bar, which was rough as it came from the rolling-mill. No. 462 was cut from one end and No. 463 from the other end, both of which had been burnished.

No. 462 broke one and one-half inch above the top center punch-mark. No. 463 broke one-half inch below the top center punch-mark. No. 464 broke one inch above the top center punch-mark. No. 462 did not break at its smallest diameter, which was midway between the points of measurements.

Smallest diameter, .964. Smallest area, .730.

All the changes or phenomena which present themselves in the finished product show that the operation to which it has been subjected embodies some principle which has never before shown its effects in the product of any rolling, hammering, or compressing operation, nor in the product of any burnishing, brightening, or polishing operation known heretofore to the art of metallurgy. For instance, that indicated by the permanent increase in the diameter of the metal, although at the time it is confined between parallel surfaces and under pressure, and that, too, although the operation be conducted so that the heat developed does not generally exceed 250° Fahrenheit, which would not be sufficient, no matter how long continued, to anneal or ductilize heavy cold bars of steel by any other process known to the art of metallurgy.

When steel is required for structural purposes it must be able to resist concussion, sudden shocks, rapid vibration, and deflection, and give due warning, before final rupture takes place, by elongating within certain degrees. Consequently heretofore the steel has been made low in carbon to secure the required ductility, and therefore possessed a low tensile strength. This steel is annealed after its manufacture, to bring it back to its normal condition and destroy in a measure the effects produced in its physical nature by the ordinary rolling operation, as all rolling, hammering, and drawing operations leave the physical nature of the metal in an abnormal condition, producing hardness, brittleness, and liability to rupture from compression, vibration, or rapid deflection.

Annealing steel greatly reduces its ability to resist tensile, compressive, and torsional strain, as well as its elastic limit, and increases its elongation or ductility. It is a slow operation, lasting generally from five (5) to twenty-four (24) hours, and leaves the metal covered with scale. By my process the ductility of the metal may be greatly increased without the formation of a scale upon its surface, and in a very rapid manner. In comparing it with ordinary annealing operations the following facts become apparent:

First, as the metal is previously rolled to any exact size and the disk-faces are adjusted to exert exactly the same degree of pressure and frictional action upon all parts of the bar, the ductility of the metal should be constant and uniform at all points, whereas in annealing the temperature of the furnace varies at different parts. Consequently the metal cannot be uniformly annealed.

Second, as the bars are all of the same size previous to the burnishing operations, the same degree of ductilizing action should be had upon each, and consequently they should all be regularly ductilized, whereas in annealing the process is not automatic and the bars are charged and drawn by hand, so that they

are exposed to heat for irregular periods of time.

Third, the ductilizing effect is produced by this process at a heat never exceeding 500° Fahrenheit, and this is too low to rob the bar of carbon, or, if it does so to any extent, it does it uniformly, whereas in annealing the bar loses considerable carbon and loses it unequally, so that not only is the tensile strength reduced considerably, but it varies at different points of the bar.

Fourth, as the ductilizing of the metal is constant and uniform, its internal strains should be regularly and uniformly relieved, whereas in annealing the temperature always varies upon different parts of the bar; hence its internal strains should be irregularly relieved.

Fifth, as the temperature in this process is very low and uniform upon all parts of the bar, it remains perfectly straight in cooling, whereas in annealing the high and uneven temperature of the metal causes it to warp and become distorted in cooling.

Sixth, by my process I am enabled to ductilize metal at the rate of one foot per second, whereas annealing operations require several hours or days for their completion.

My process will be found to be peculiarly adapted to the production of steel shafting, piston-rods, and also for very light work, such as burnished steel for pivots for watches and clocks, &c., in which latter case it is evident that the mechanism employed must be of a reduced size suitable for the work to be produced.

Having described my invention, what I claim, and desire to secure by Letters Patent, is—

1. The method of burnishing and increasing ductility of metallic cylinders herein described, which consists in first rolling the metal to uniform gage, and, secondly, submitting the metal, while at a temperature not exceeding 500° Fahrenheit, to the frictional action of highly-polished revolving burnishing-surfaces, which exert a light pressure upon the metal, one less than will film or draw the same at the temperature specified, substantially as specified.

2. As an improvement in the art of burnishing and increasing the ductility of metallic cylinders, the method of giving the splendent polish herein described, which consists in first rolling the metal to a uniform gage; secondly, submitting the metal, while at a temperature not exceeding 500° Fahrenheit, to the frictional action of highly-polished revolving burnishing-surfaces, which exert a light pressure, one which will not film or draw the metal at the temperature specified; and, finally, gradually decreasing the pressure by increasing the distance between the burnishing-surfaces at each succeeding pass, substantially as and for the purpose specified.

3. As a new article of manufacture, the metallic cylinders described, having a highly-burnished or splendent surface of a bluish

cast, resembling nickel, and covered with delicate spiral shadings, ductile, and whose tensile strength equals or approximates that of the same quality unannealed metal, substantially as specified.

5 4. As an improvement in machinery for bur-  
nishing metallic cylinders, &c., the combina-  
tion of two or more sets of disks, the faces of  
one or more sets being highly polished, the  
10 disks of each set arranged with the center of  
one next the periphery of its fellow, and the  
working-faces of the sets arranged in the same

planes, whereby the article operated upon will  
be automatically fed from one set of disks to  
the next, and may be operated upon by all the 15  
disks at the same time, substantially as speci-  
fied.

In testimony whereof I, the said JACOB  
REESE, have hereunto set my hand.

JACOB REESE.

Witnesses:

A. C. JOHNSTON,  
FRANK M. REESE.