(No Model.) 2 Sheets—Sheet 1.

W. ROGERS.

PROCESS OF AND APPARATUS FOR MANUFACTURING TIN PLATE.

No. 604,195. Patented May 17, 1898.

Fig. 2.

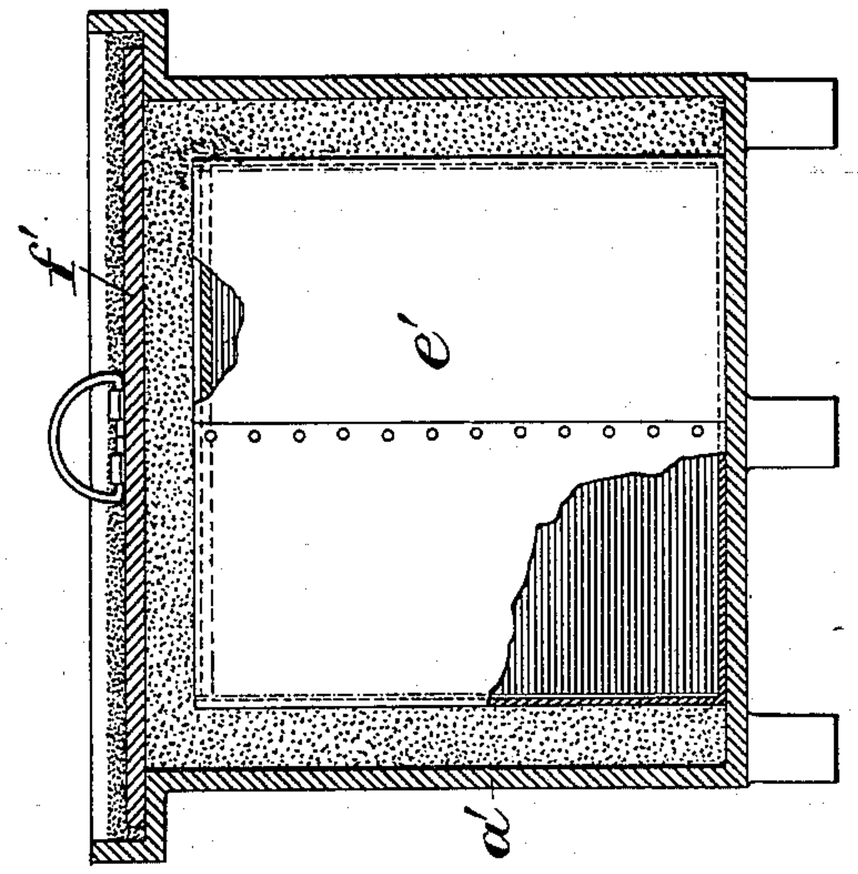
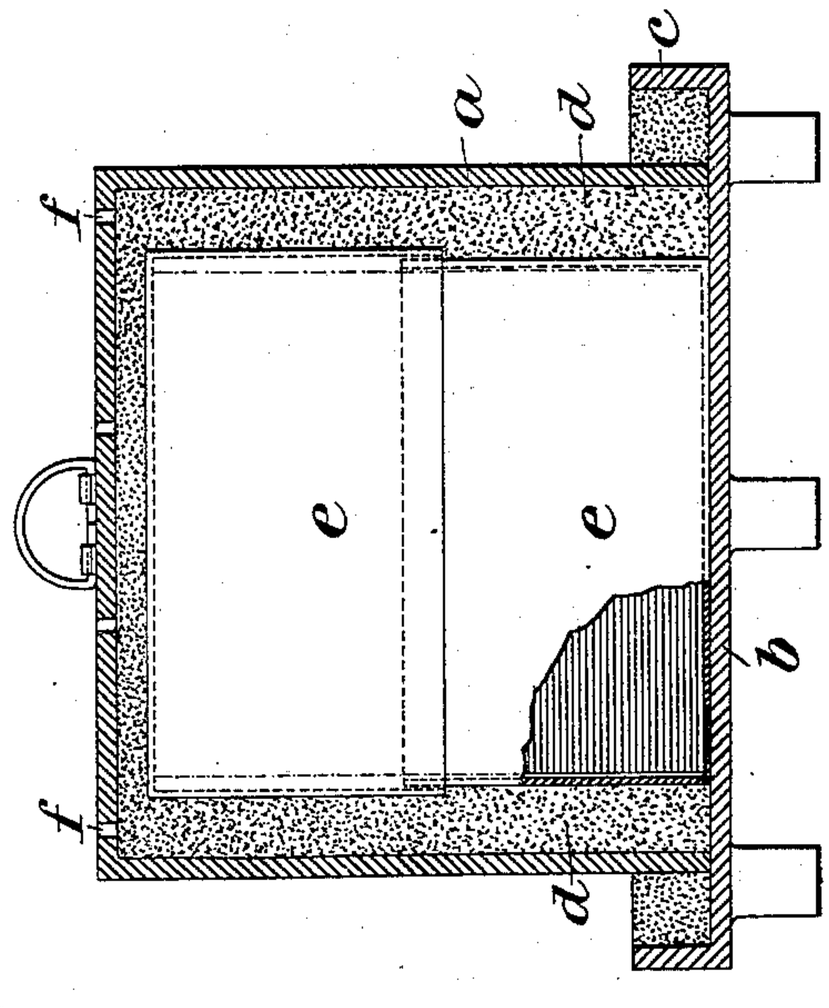


Fig. 1.



WITNESSES

INVENTOR

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(No Model.) 2 Sheets—Sheet 2.

W. ROGERS.

PROCESS OF AND APPARATUS FOR MANUFACTURING TIN PLATE.

No. 604,195. Patented May 17, 1898.

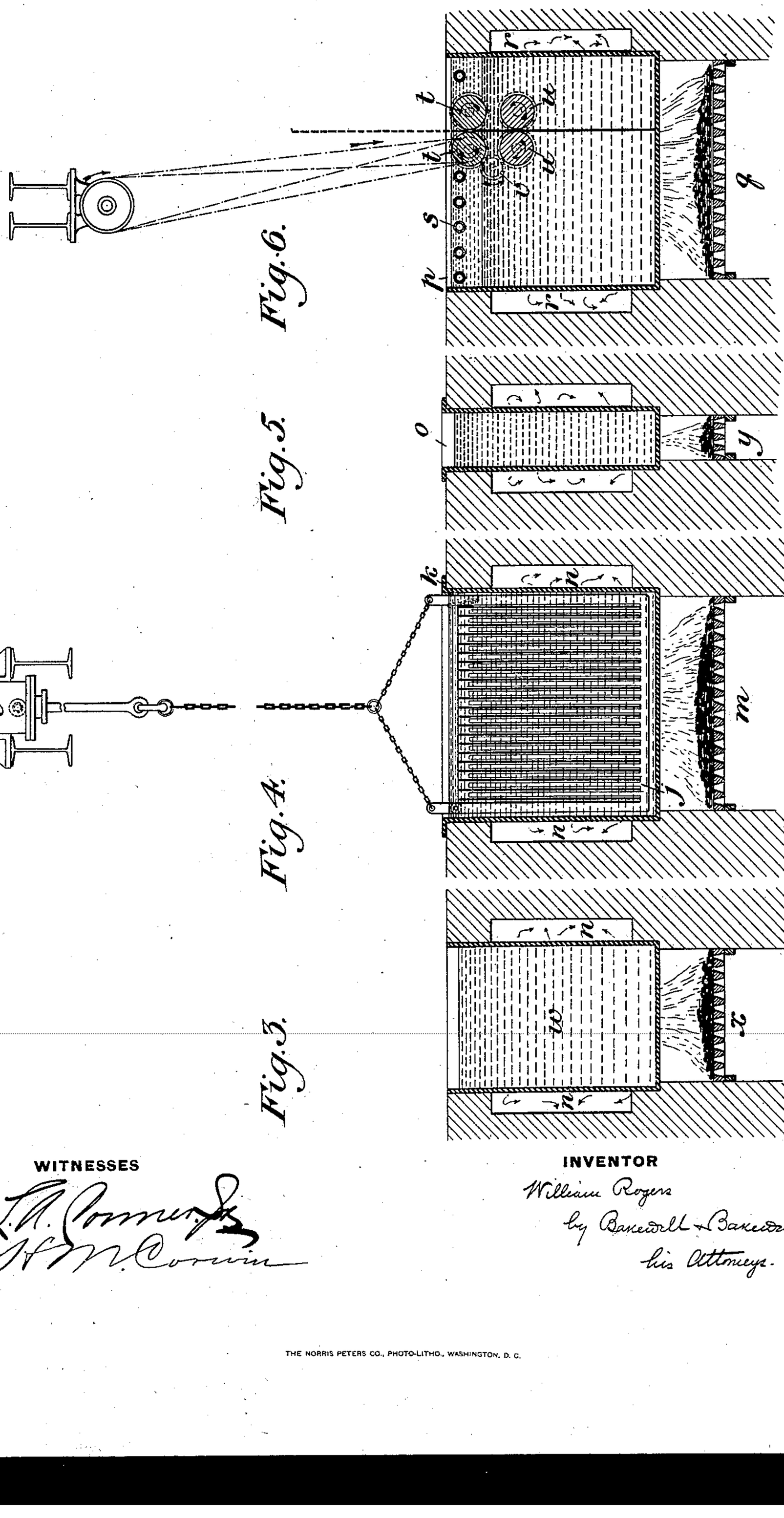

Fig. 6. Fig. 5. Fig. 4. Fig. 3.

WITNESSES

INVENTOR

William Rogers
by Bakewell & Bakewell
his Attorneys.

UNITED STATES PATENT OFFICE.

WILLIAM ROGERS, OF LEECHBURG, PENNSYLVANIA, ASSIGNOR OF ONE-HALF TO JAMES A. BEAVER, OF BELLEFONTE, PENNSYLVANIA.

PROCESS OF AND APPARATUS FOR MANUFACTURING TIN-PLATE.

SPECIFICATION forming part of Letters Patent No. 604,195, dated May 17, 1898.

Application filed October 24, 1896. Serial No. 609,958. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM ROGERS, of Leechburg, in the county of Armstrong and State of Pennsylvania, have invented a new and useful Improvement in Processes of and Apparatus for Manufacturing Tin-Plate, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming part of this specification, in which—

Figures 1 and 2 are vertical sections of the apparatus which I employ for containing the sheets of iron when subjected to the process of annealing, decarbonizing, and deoxidizing them preparatory to tinning. Fig. 3 is a vertical section of a grease-pot in which the annealed sheets are prepared for tinning. Fig. 4 is a vertical section of the tank for the melted tin and of the apparatus for suspending and dipping the sheets therein. Fig. 5 is a vertical section of a smaller tin-pot for second tinning. Fig. 6 is a vertical section of apparatus for subjecting the tinned sheets to final treatment, rolling, and compression.

In the several figures like letters of reference denote similar parts of my apparatus.

My improved process consists of two principal steps—first, the annealing and purifying of the sheets from oxygen and carbon before tinning, and, second, the coating of the sheets with tin.

In the ordinary process of making tin-plate the sheets having been hot-rolled to the desired size and thickness are first pickled in heated sulfuric or hydrochloric acid to remove the surface oxid or scale, which is called "black pickling," and then washed several times in water to remove all trace of the acid. They are then placed in a closed iron box and subjected to the heat of a furnace to anneal or soften them and gradually cooled out of access of the atmosphere. They are then cold-rolled between polished rolls to remove the roughness of the surface caused by the formation and removal of surface oxid, which gives them a close texture and a polished appearance. They are then again annealed in like manner as before, pickled, and washed, after which they are ready for tinning. This second pickling is usually necessary to remove the oxid from the edges of the sheet and is injurious to the central part of the sheet from which the oxid has been removed by the first pickling.

In my process the preparing of the plates for tinning differs essentially from that just described, among others, in the following important particulars: First, great care is taken to protect the sheets after they are rolled and during the annealing process from the action of the oxygen of the atmosphere and to surround them with a substance which is neither carburizing nor oxidizing for the exclusion of atmospheric air, so that the formation of further scale on the surface of the iron is prevented, and by the mutual reaction of the oxid on the surface of the iron sheets and of the carbon contained in the body of the iron it may be both deoxidized and decarburized on exposure to the heat of the furnace. By this means the removal of the scale resulting from the exposure of the heated plates to the air during rolling is rendered not only unnecessary, but undesirable, and the roughness of the sheets caused by the formation of scale and its removal by acid treatment is largely prevented. The body of the metal in the sheets being thus purified by the complete decarbonization resulting from my process of annealing and by the reduction of any surface oxid the sheets acquire a remarkable degree of softness and flexibility, indicating an unusual degree of freedom from either carbon or oxygen. By my process, therefore, I dispense with the black pickling in acid ordinarily practiced after hot-rolling, because the surface scale then formed is not only removed by the annealing process, but serves a useful purpose in the annealing-chamber, and I also dispense with the cold-rolling ordinarily practiced after the first annealing, because such rolling has the effect of compacting the iron, and if practiced in my process would tend to destroy its porous condition resulting from decarbonization, and as a consequence I further dispense with the second annealing of the sheets, which is practiced in the usual method for the purpose of removing the stiffness due to the cold-rolling.

The result of the porous texture given to the iron sheets by my method of annealing is that the tin or other coating metal when in

a liquid condition enters the pores of the iron, forming a union more resembling a chemical than a mechanical combination of the iron and coating metal and is pressed into a very perfect union by the final rolling, besides which the great freedom of the iron from the presence of either carbon or oxygen gives it an extraordinary degree of softness and flexibility.

In practicing my invention the sheets of iron having been first hot-rolled in the usual way to the desired size and thickness are placed, without previous removal of scale by pickling or otherwise, in a pack of, say, five hundred to six hundred sheets, more or less, in an annealing-box so constructed as to permit of the sheets being easily placed therein and removed therefrom and at the same time to permit of the use of means to exclude the admission of atmospheric air.

In the drawings, Figs. 1 and 2, I have shown two constructions of annealing-box which I have devised for this purpose. Fig. 1 represents, partly in section, an annealing-box *a*, made, preferably, of cast-iron, though strong wrought-iron plates may be used in its construction or clay such as is used in the manufacture of glass-melting pots. This box *a* is closed at the top and at the sides, being made air-tight, and in use is set with the open bottom downward on a base-plate *b*, on which the open end of the box rests. The base-plate is surrounded with a flange *c*, so that pulverized material, sufficiently refractory to stand the heat of the furnace—such as pulverized iron ore, sand, or dolomite—is placed, as shown at *d*, so as to prevent the access of air into the box. The sheets of iron or steel are placed in a pack on the base-plate *b* and are covered by an envelop *e*, preferably of sheet-iron, which may be made in the shape of a box, either in one part with an open bottom or in two parts fitting telescopically one over the other. The outer box *a* is then placed over the envelop *e* and is large enough to leave a space of about two inches on top and around the inner box or envelop *e*, which covers the sheets, and in this space is introduced sand, pulverized iron ore, or dolomite, which will resist the action of the heat. This pulverized material is inserted into the space around the sheets through small openings *f* in the top of the outer box and may be rammed compactly by means of an iron rod. The other construction of annealing-box is shown in Fig. 2, which represents a box *a'*, of cast-iron or other suitable material, closed at bottom and open at top, where it is inclosed by a covering-plate *f'*. The sheets of iron or steel are placed in a pack surrounded by a case or envelop *e'*, preferably of sheet-iron, which is covered over at the top to prevent the entrance of sand, iron ore, or dolomite placed within the outer annealing-box *a'* and on top and around the sides of the inner box *e* to a thickness of about two inches and may be rammed in place. The purpose of this arrangement is not merely to exclude the atmospheric air, nor is the pulverized material designed to act chemically on the sheets of metal, but the purpose is to inclose them, as it were, in an oven, so that under the influence of the furnace heat to which the annealing-box is exposed the oxygen of the surface scale or oxid on the sheets and the carbon contained in the body of the iron may mutually react, forming carbon dioxid, which escapes from the iron sheets. It may in some cases be found desirable where the amount of oxid on the surface of the iron is considerable to place some sawdust or other carbonaceous matter around the bottom of the pile of sheets within the envelop *e;* but this I have found to be ordinarily unnecessary, and as a general practice I prefer to introduce nothing into the annealing-box around the sheets that will have any decided chemical action thereon; but I have also found that iron ore (oxid) in a pulverized condition operates well and does not seem to hinder the deoxidation of the sheets. The annealing-box, with its contents, is then placed in a reverberating or other suitable furnace and is therein exposed to a suitable heat—say about 2,500° Fahrenheit—for about ten hours, more or less, according to the size of the annealing-box and the amount of sheets of iron to be annealed. Preferably these annealing-boxes are removable from the furnace for the purpose of charging them and of removing the contents. It is necessary that the sheets when removed from the annealing-box should be cold or so nearly so as not to be liable to the danger of oxidation of the surface of the metal when exposed to the air.

The sheets of iron should be allowed to become sufficiently cold to prevent oxidation on exposure to the external air before their removal from the annealing-box. The result of annealing the sheets in the manner described is that they are of a dull silver-like or leaden appearance and are when removed from the annealing-box very flexible, indicating that reaction between the oxid scale on the surface of the iron and the carbon contained in the body of the iron has resulted in the removal of the oxygen and carbon which were present on or in the sheets of iron before the annealing operation commenced.

If there should be any appearance of surface oxidation remaining on any of the sheets when removed from the annealing-box such sheets should be subjected for a few minutes only to immersion in a bath of a weak solution of muriatic or sulfuric acid in water, and then thoroughly washed with alkaline water, such as lime-water, to remove any trace of acid which would be injurious to the sheets.

Another advantage of the method of annealing the sheets which I have described is that the effect on each sheet is very uniform, so that the edges are deoxidized as thoroughly as other parts of the sheets, a result difficult to attain by the ordinary methods.

After the sheets have been annealed and freed from scale, as described, and cool enough to prevent oxidation they are immersed in water for about half an hour to wash off any particles of oxid which may yet remain adhering to their surface and are then ready for the tinning operation without further rolling, the effect of the annealing process, as before stated, being to leave the iron in a slightly porous condition, so that the coating of tin takes a firmer hold on the surface of the plates.

In the process of tinning I employ the apparatus shown in Figs. 3, 4, 5, and 6. The sheets are first dipped in a pot of grease *w*, such as shown in Fig. 3, which may be of any desired construction, and therefore does not need any special description. The grease I prefer to use is tallow, which should be as free as possible from acid and which is kept in a melted condition by the frequent contact with the iron sheets, which are still warm enough for the purpose; or if the grease used is of such consistency as to require it a furnace *x* may be placed under the grease-pot *w* with the side flues *n n*, as shown in Fig. 3. These sheets, with their coating of grease, are then placed one by one in a vertical position in a rack *j*, (see Fig. 4,) which may hold any convenient number of plates, say from fifty to one hundred. This rack is suspended vertically over the tin-pot *k* from a small steam-cylinder *l* or other device, by which the rack, with its burden of iron plates, may be repeatedly and rapidly raised and lowered. The tin-pot *k* is heated by a furnace *m*, placed underneath it, and hot-air flues *n n* at the sides, as shown in Fig. 4. The purpose of the rack *j* is not chiefly the convenience of handling, but it also enables the sheets to be repeatedly and quickly dipped into the molten tin, the effect of which is that as the molten tin has a greater affinity for oxygen than has the black plate (iron or steel) at a temperature of about 450° Fahrenheit this fact, together with the friction created between the melted tin and the surface of the sheet, aids in the removal therefrom of any particles of scale or oxid which may have been formed on their surface during the water-washing before mentioned. The tin in this pot or tank *k* should be kept at as nearly a constantly-uniform temperature of about 450° Fahrenheit as possible, or at a heat sufficiently above the melting-point of the coating metal, whatever it may be, to keep it in a perfectly liquid condition, and the immersion of the sheets in the tin-bath should be continued for about ten minutes. The sheets thus tinned are then removed from the rack *j* to another bath *o* of molten tin which is at a temperature somewhat—say about 25° Fahrenheit—lower than the tin in the tin-pot *k*. This bath *o* may be of less width than the tin-pot *k*, as shown in the drawings, Fig. 5, because the sheets need not be held apart at this dipping as they are by the rack *j*. This bath *o* may be heated, as shown in the drawings, by a furnace *y* with side flues *n n*. From this bath *o* the tinned sheets are removed one by one to the grease-pot *p*, (see Fig. 6,) which is heated by a furnace *q* and side flues *r r*. This grease-pot *p* contains grease, but, if desired, it may also contain molten tin if a third dipping in tin is deemed desirable. In the drawings, Figs. 6, the tank is shown filled with molten tin up to the line *x x*, and when this is the case the grease of course floats on the surface of the molten metal. In order to prevent the grease being set on fire by the heat of the molten tin, it is kept comparatively cool by means of a set of horizontal pipes *s s*, passed through the tank near to its upper edge, through which cold water or air is caused to pass, and then the grease is kept at a temperature of about 150° Fahrenheit. Into this pot, Fig. 6, whether it be filled with grease alone or also with melted tin, the sheets are immersed one by one in a vertical or substantially vertical direction and are immediately raised and delivered out of the pot, the delivering-rolls forcibly compressing the tinned sheet and giving it a polished surface. This is effected by means of two pairs of rolls, preferably, although one pair might suffice. The upper pair *t t* are made of polished steel, the lower pair preferably of copper. These rolls are placed near the top of the grease-pot *p*, so as to be immersed in the grease, and if tin is used in contact therewith, so that both pairs of rolls shall be coated with tin. The rolls *t t u u* of each pair are preferably geared together by cog-wheels located on their shafts outside of the grease-pot with an interposed idler-wheel *v*, so as to secure the requisite motion. Rotary motion is given to these rolls in any suitable manner, which may be conveniently effected by means of a pair of belts with fast and loose pulleys, so that the motion of the rolls may be reversed as the sheets are alternately dipped into and raised out of the grease-pot. This third dipping into tin may be dispensed with, if desired, in which case grease only is placed in the pot *p*.

The rolls of the upper pair *t t*, or, if desired, also of the lower pair *u u*, are furnished with screws or other well-known device by which they can be forced into close surface contact with each side of the tinned sheet as it passes between them. The object of this pressure thus applied to the delivering and finishing rolls is not only to lower and raise the sheets into and out of the pot and to give them a smooth surface and finished appearance, but also and chiefly to cause the tin to penetrate the pores of the sheet which have been left open by reason of the deoxidation and decarbonization, as before described, and by the absence of rolling before tinning.

Instead of having separate furnaces *m*, *q*, *w*, and *y* under the grease-pot and tin-pots, they may be so arranged as to be heated by a

common furnace, the degree of heat applied to each pot or tank being regulated by means of dampers connected in the usual way with the flues *n n*, surrounding each of these vessels.

In the above description I have spoken of my invention as applied to the purpose of making tin-plate; but it is also applicable to the manufacture of terne-plate or sheet-iron covered with a mixture in various proportions of tin and lead or of zinc or other metal which is capable of being coated onto the surface of sheet metal.

My invention is also applicable to the manufacture of tin-plate from rolled sheets of steel; but in this case it will be necessary to introduce into the annealing-boxes some pulverized oxid in order to decarburize the steel plate, the proportion of which will depend upon the percentage of carbon in the steel and of oxygen in the oxid; and I desire it to be specially observed that sheets of steel decarburized and then tinned in the manner I have described produce a very superior quality of tin-plate.

By the terms "iron" and "wrought-iron" in the specification and claims as applied to sheet-iron to be treated as described in this specification I refer to sheet-iron substantially such as is produced by the ordinary processes of manufacturing sheet-iron having the property of malleability and containing carbon in a less amount than either cast-iron or steel.

I desire it to be understood that I do not claim, broadly, as preparatory to the tinning of sheet metal subjecting the sheets to heat in a closed box and then cooling before exposure to the atmosphere; but

What I do claim as my invention, and desire to secure by Letters Patent, is—

1. As a step in the process of coating sheets of iron or steel with tin or other coating metal or alloy, preparing the sheets by subjecting them, after rolling and without previous pickling for removing the scale, to heat in a suitable furnace while inclosed in a pack in a suitable vessel or box, and protected from the access of atmospheric air by surrounding them with pulverized sand, lime, iron ore, or other suitable material, whereby is effected a mutual reaction between the external oxid scale and the internal carbon of the sheets; substantially as and for the purpose described.

2. In the process of preparing sheet-iron for coating with tin or other metal or alloy, deoxidizing and decarburizing the sheets without removal of the iron scale, by inclosing them in a pack within a suitable receptacle, and preventing the access of atmospheric air by surrounding them with sand or pulverized material, such as dolomite or iron ore, placed within the receptacle, the sheets being protected from actual contact with such pulverized material by an envelop or inclosure composed preferably of sheet-iron, and subjecting the sheets thus surrounded to heat in a suitable furnace and thereby effecting a mutual reaction between the external oxid (scale), and the internal carbon, of the sheets, substantially as described.

3. The process of reducing the oxid and largely eliminating the carbon from sheets of rolled wrought-iron, at one operation, by subjecting them, without previous removal of the oxid coating, to furnace heat, when inclosed in a substantially air-tight receptacle, and protected from access of external air, effecting thereby a mutual reaction between the oxid of the external scale and the internal carbon, of the sheets, substantially as described.

4. As a finishing step in the process of manufacturing tin-plate, or other metal-coated sheets, subjecting the sheets to the compressive and polishing action of burnished steel rolls coated wholly or partially with grease, said sheets having been first treated, without removal of the surface oxid to a simultaneous deoxidizing and decarburizing operation of heating in a substantially air-tight receptacle, and then coated by dipping in molten metal substantially as described.

5. The process of making tin-plate or other metal-coated sheet-iron, by subjecting the metal sheets to a process of simultaneous deoxidation and decarburization, by exposure to heat in a suitable vessel protected from access of external atmosphere for the purpose of effecting a mutual reaction between the external oxid (scale) and the internal carbon, of the sheets, then coating the wrought-iron sheets by dipping in tin, or other coating metal in a molten condition, and finally subjecting the sheets to the compressive action of polished steel rolls, to compact the pores of the metal sheet, and effect a firmer adherence of the coating metal, substantially as described.

6. The process of coating sheet-iron with tin or other metal or alloy, consisting in the following steps, viz: deoxidizing, decarburizing and softening the sheets in the manner hereinbefore described without previous removal of the surface oxid, by subjecting them to heat in a furnace when inclosed in a substantially air-tight receptacle, protected from access of external atmosphere, then coating such sheets with melted grease, then dipping the sheets repeatedly in a tank of melted coating metal, then dipping each sheet separately in a tank of melted metal at a lower temperature, and finally subjecting sheets so prepared and coated to rolling pressure while immersed in melted grease; substantially as described.

7. The apparatus hereinbefore described for finishing sheets of wrought-iron after immersion in molten coating metal consisting of a tank for holding grease, or grease and molten coating metal, means for heating said tank,

cooling-pipes horizontally traversing said tank to prevent the overheating of the grease, said tank being furnished with one or more pairs of rolls, one pair at least arranged to be in contact with or immersed in grease, and adapted to exert a compacting and polishing pressure on both surfaces of each coated sheet, passing through between them, and for feeding and delivering the metal-coated sheets, substantially as described.

In testimony whereof I have hereunto set my hand.

WILLIAM ROGERS.

Witnesses:
J. D. ORR,
J. B. KIFER.

Disclaimer in Letters Patent No. 604,195.

DISCLAIMER.

604,195.— *William Rogers*, Leechburg, Pa. PROCESS OF AND APPARATUS FOR MANUFACTURING TIN-PLATE. Patent dated May 17, 1898. Disclaimer filed June 23, 1902, by the executor of said WILLIAM ROGERS and the present assignees.

Enter their disclaimer—

"To those parts of the specification which are in the following words:
On line 102 of the first page of the specification the words "or other coating metal."
Page 4, the 6th, 7th, 8th, 9th, 10th, 11th, 12th, and 13th lines, as follows:
"In the above description I have spoken of my invention as applied to the purpose of making tin-plate; but it is also applicable to the manufacture of terne-plate or sheet-iron covered with a mixture in various proportions of tin and lead or of zinc or other metal which is capable of being coated onto the surface of sheet metal."
Claim 1, lines 2 and 3, the words "or other coating metal or alloy."
Claim 2, line 2, the words "or other metal or alloy."
Claim 4, lines 2 and 3, the words "or other metal-coated sheets."
Claim 5, lines 1 and 2, the words "or other metal-coated sheet-iron."
Claim 5, line 10, the words "or other coating metal."
Claim 6, line 2, the words "or other metal or alloy."—[*Official Gazette, July 1, 1902.*]