J. E. CARNAHAN & A. J. MASKREY.

METHOD OF OXIDIZING STEEL OR IRON SHEETS.

APPLICATION FILED AUG. 16, 1912.

1,141,769.

Patented June 1, 1915.

3 SHEETS—SHEET 1.

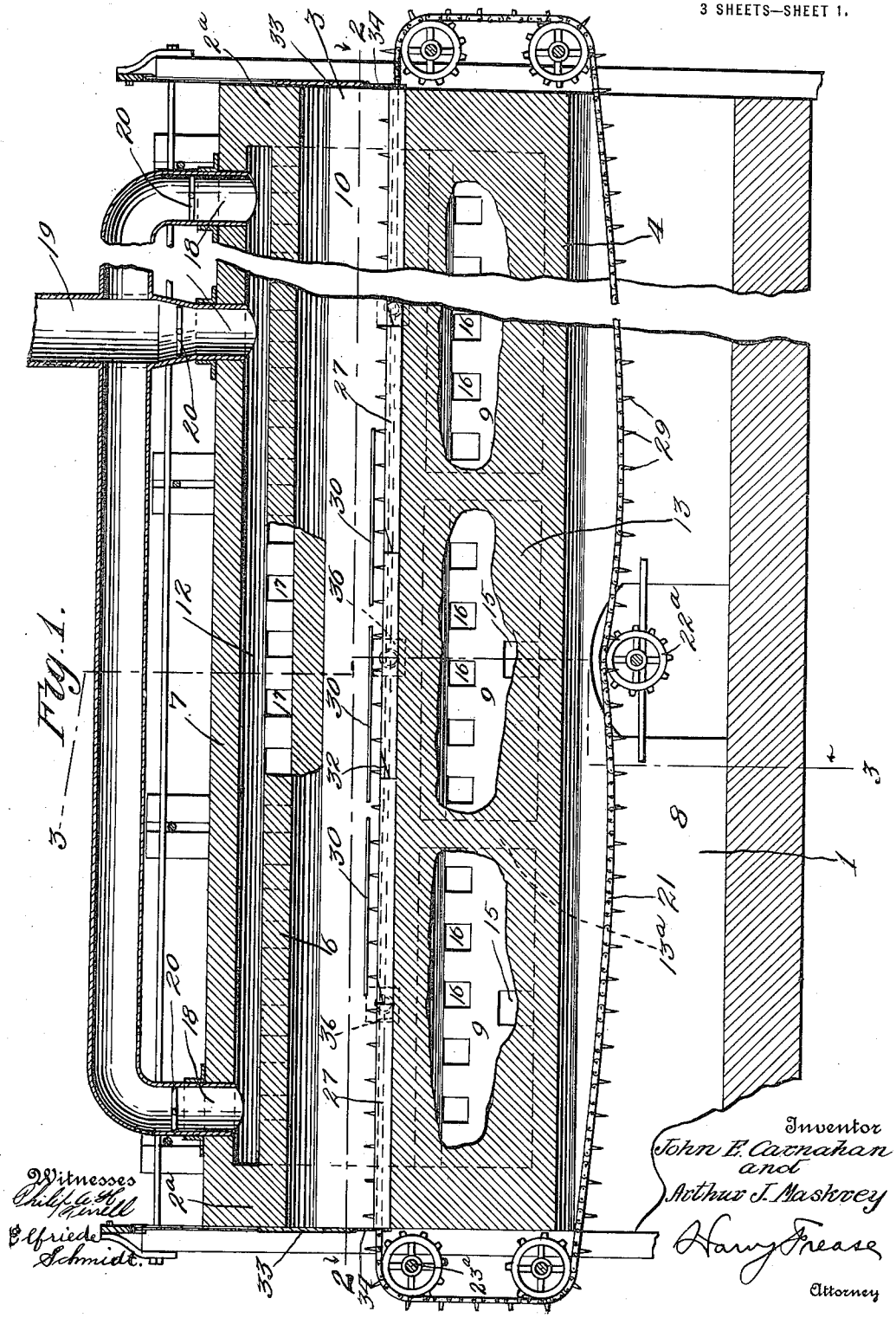


Fig. 1.

Witnesses
Philip G. Hinell
Elfriede Schmidt.

Inventor
John E. Carnahan
and
Arthur J. Maskrey
Harry Grease
Attorney

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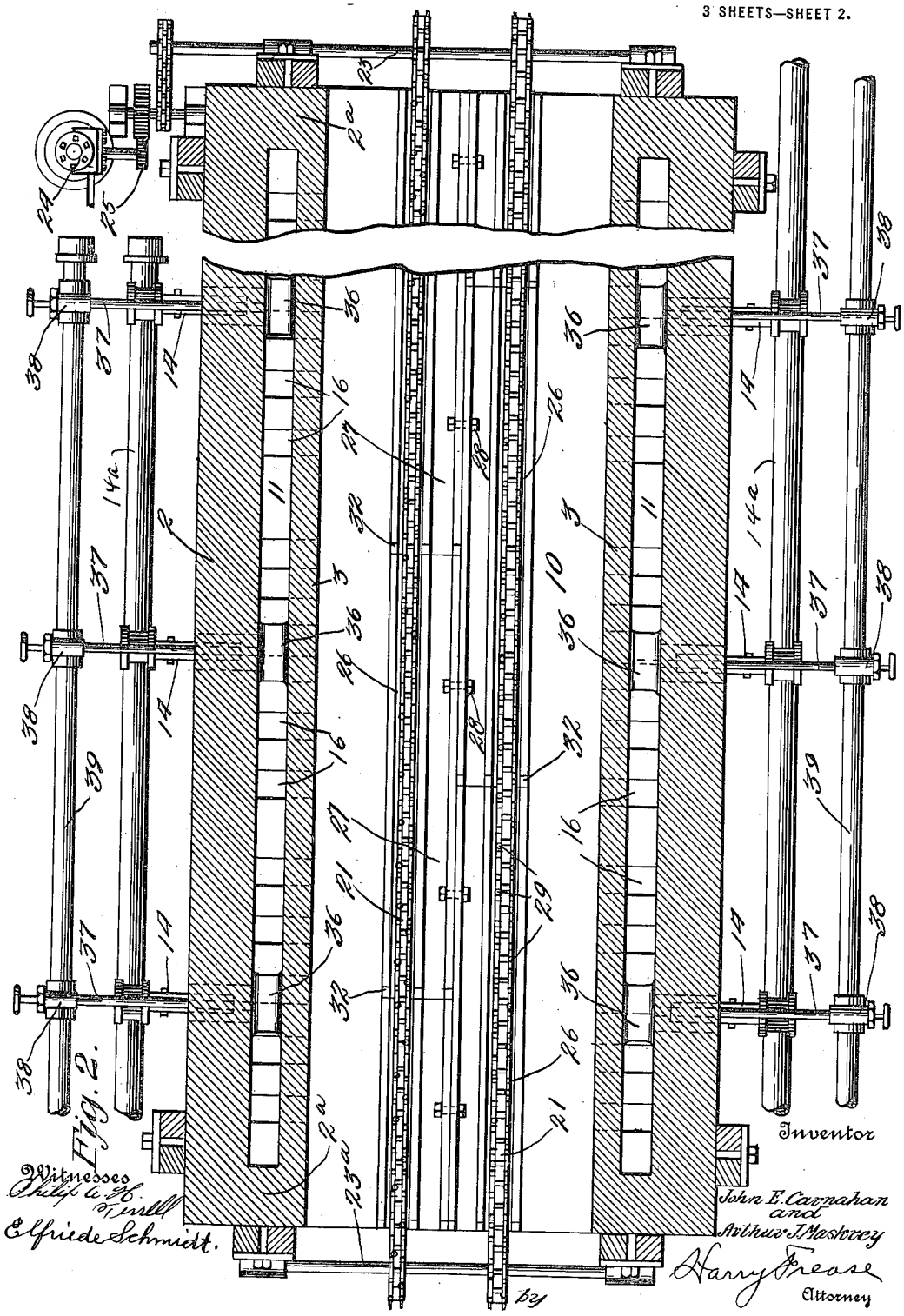


Fig. 2.

Witnesses
Philip A. Hunnell
Elfriede Schmidt.

Inventor
John E. Carnahan
and
Arthur J. Maskrey
by Harry Grease
Attorney

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3 SHEETS—SHEET 3.

Fig. 3.

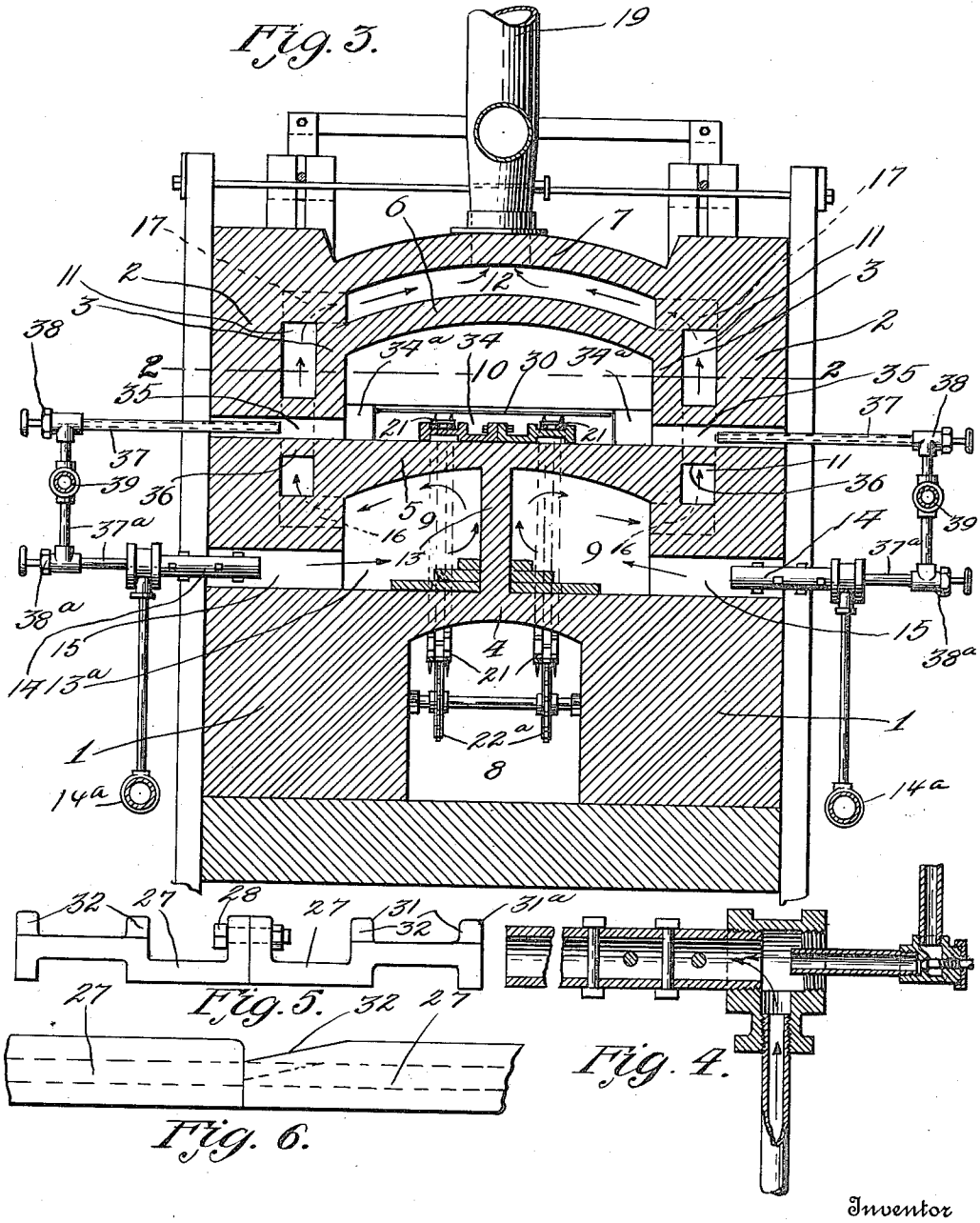






Fig. 5.




Fig. 6.

Fig. 4.

Witnesses

Philip A. Terrell

Elfriede Schmidt.

Inventor

John E. Carnahan

and

Arthur J. Maskrey

By Harry Grease

Attorney

# UNITED STATES PATENT OFFICE.

JOHN E. CARNAHAN AND ARTHUR J. MASKREY, OF CANTON, OHIO.

## METHOD OF OXIDIZING STEEL OR IRON SHEETS.

1,141,769. Specification of Letters Patent. Patented June 1, 1915.

Application filed August 16, 1912. Serial No. 715,371.

*To all whom it may concern:*

Be it known that we, JOHN E. CARNAHAN and ARTHUR J. MASKREY, both citizens of the United States, and both residing at Canton, in the county of Stark and State of Ohio, have invented a new and useful Method of Oxidizing Steel or Iron Sheets, of which the following is a specification.

The invention relates to the oxidation of the surface of steel or iron sheets, for the purpose of giving them a uniform bluish color; as, for instance, sheets which have been pickled and annealed.

The process of annealing the sheets leaves them with a well-defined marginal band of blue color, and the remaining middle portion of the sheets with a distinctly lighter or silvery color, which different colors are emphasized by the ordinary method of cold rolling the sheets before bluing the same, which bluing is usually done by heating them in packs and then exposing the sheets to an oxidizing element, as, for instance, the air. And more generally, in most if not all of the prevailing processes for bluing steel sheets, the sheets are heated for annealing purposes, usually in packs, to a temperature considerably higher than that which causes the maximum degree of oxidation; and the bluing of the sheets is accomplished, or is supposed to be accomplished, by subjecting them to an oxidizing agent after they have been partially cooled and separated, or during a gradual cooling of the sheets.

In tempering steel or iron in the presence of an oxidizing agent, it has been found that there is substantially no oxidation on the surface until the metal is heated to some 400° F., until which time the surface remains in the natural whitish or silvery color. That at 430° F. it is oxidized to a faint yellow color; that at 450° F. it is oxidized to a straw color; that at 470° F. it is oxidized to a yellow or gold color; that at 490° F. it is oxidized to a brownish color; that at 510° F. it is oxidized to a brown with purple spots; that at 530° F. it is oxidized to a purple color; that at 550° F. it is oxidized to a bright blue color; that at 560° F. it is oxidized to a darker blue color; that at 600° F. it is oxidized to a deep blue color; and that at all temperatures higher than 700° F., or thereabout, the surface is oxidized to a grayish blue color, which is the final color for the oxidized surface of iron or steel; and furthermore, that no material change of color takes place at temperatures higher than some 700 to 900° F.

It is evident that, in all processes where the sheets must be cooled, and especially where they must be separated from a pack before being subjected to the oxidizing agent, it is practically impossible to have all the sheets and the various portions of the several sheets reduced to an equal or uniform temperature for oxidation, with the result that there is a lack of uniformity of oxidation throughout their surfaces, which gives different shades of color to the several sheets and to different parts of the same sheet. For these reasons, it has heretofore been practically impossible to satisfactorily supply the insistent demand of consumers of sheet metal for the several different colors of oxidation and the various shades thereof which are desired for use in the several arts. In this connection, we have discovered that when steel or iron sheets have been cold rolled or polished before they have been blued, and have then been brought to a heat sufficiently high to finally oxidize them to a grayish blue color, as, for instance, from 700 to 900° F., the sheets will begin to lose the polish and gloss which has been produced on the surface by the cold-rolling process, and the damage or destruction to the polished surface is increased in proportion to the additional excessive heat to which the sheet is or may be subjected; and finally, such excessive heat causes such a depth of oxidation as will result in a scaling of the same when the sheet is bent; all of which results in a loss by destroying the commercial value of the sheet, and by the useless expenditure of fuel for producing the excessive heat. And again, it is believed that steel or iron sheets which have been oxidized in the presence of superheated steam, are more susceptible to rust or corrosion when they are subjected to the action of the atmosphere or other elements, than are those sheets which have been oxidized by other well known agents, as, for instance, atmos-

pheric air, and the like; and especially, when oxidized sheets have been immersed in water, as for cooling, they are all the more susceptible to rust and corrosion, unless they are thoroughly dried without delay.

The object of the present invention is to avoid the difficulties and losses incident to the prevailing processes, some of which are thus enumerated, and more particularly, to oxidize steel or iron sheets uniformly throughout their surfaces by a continuous process, to any one of the various colors or shades of color within the range of the natural colors produced by the oxidation at the various degrees of temperature; and this object is attained in a general way, by subjecting the sheets to the action of a preferably indirect heat in the presence of a suitable oxidizing agent, until the temperature of the sheet is raised to the degree necessary for oxidizing the surface to the desired degree or particular color, after which the sheet may be cooled by any of the well known and ordinary methods without affecting or varying the color.

The improved process, in so far as the step of bluing the sheets is concerned, is preferably performed in a longitudinally extended furnace, as illustrated in the accompanying drawings, forming part hereof, in which,—

Figure 1 is a vertical-longitudinal section of the furnace; Fig. 2, a plan section thereof on 2—2, Figs. 1 and 3; Fig. 3, a cross section thereof on line 3—3, Fig. 1; Fig. 4, a longitudinal section of the gas burner; Fig. 5, an end view of the track plates; and Fig. 6, a fragmentary side view showing a track joint.

Similar numerals refer to similar parts throughout the drawings.

The walls of the furnace may be made of any suitable material, as for instance of brick laid in fire clay, and include the base walls 1, the side walls 2, and the spaced walls 3 of the tunnel chamber; which walls are respectively connected by the base arch 4, the combustion chamber arch 5, the tunnel chamber arch 6, and the crown arch 7; the said walls and arches being so spaced apart as to form the base tunnel 8, the combustion chambers 9, the tunnel chamber 10, the fire flues 11, and the crown flue 12; the combustion chamber 9 being laterally separated by the longitudinal partition 13 and longitudinally by the transverse partitions $13^a$, while the fire flues 11 and the crown flue 12 preferably extend continuously between the end walls $2^a$ of the furnace.

Any desired form of fuel may be used for heating the furnace, and when gas is employed the same is supplied by the main pipe $14^a$ and introduced through the series of burners 14 discharging into the lateral ports 15, leading into the combustion chamber 9, whence the gases of combustion and the heat pass laterally through the fire ports 16, then rise through the fire flues 11, then converge through the crown ports 17, into the crown flue 12, and are carried off through the stack flues 18, and the stack 19. One stack flue 18 is preferably located adjacent to each end of the furnace and one or more intermediate stack flues may be provided, and all are supplied with dampers 20, by means of which the draft can be controlled so that the furnace will be uniformly heated from end to end. By this construction and arrangement of the furnace it is evident that the tunnel chamber 10, will be entirely surrounded, excepting at the ends, by the various flues and ports, thus enabling this chamber to be intensely heated by an indirect heat, that is to say, by heat conducted through and radiated from the walls on all sides of the tunnel. While it may not be essential to inclose the heating tunnel on all sides, as for instance, the tunnel chamber arch 6, might be omitted, yet it is preferred to use this arch so as to positively prevent the gases and products of combustion from entering the tunnel chamber to impinge and discolor the sheets therein.

The sheets are conveyed through the tunnel chamber by means of the endless chains 21, operating around the sprocket wheels on the shafts 23 and $23^a$ journaled at the ends of the furnace, and preferably driven by the engine 24 and gearing 25. Two chains are preferably employed, the upper strands of which travel lengthwise through the tunnel chamber in the longitudinal channels 26 formed in the track plates 27; and the lower strands of the chains travel through the base tunnel 8 and may be supported at intervals by the idle sprocket wheels $22^a$ located at intervals therein. The track plates 27, are made in lateral sections joined together by the bolts 28, and longitudinal sections abutted together, and the joints formed by the abutting ends alternate between the securing bolts; and the track plates preferably rest loosely upon a bed of sand laid upon the combustion chamber arch 5, forming the bottom of the tunnel chamber which permits an expansive movement of the plates without affecting the bottom of the tunnel chamber.

The conveyer chains are preferably provided with a series of pins 29, upon which pins the steel or iron sheets 30 are carried through the tunnel chamber and the forward ends of the track plate flanges 31 and $31^a$ are beveled as at 32 at each joint, so that if the edges of the sheets hang down upon the track flanges, they will be deflected upward by the beveled edges of the flanges without being stopped.

The ends of the tunnel chamber are closed

by the doors 33 which are preferably arranged to slide upward and downward; and the lower edges of the doors, when the same are closed by being dropped downward, are located just far enough above the ends of the chain pins 29, to permit a sheet traveling on the pins to pass underneath said edges. The interval between the lower edges of the doors 33, and the floor of the tunnel chamber are furthermore closed by the swinging shields 34 and 34ª, which are hinged to the lower edge of the doors 33. The middle shield 34, has its lower edge notched to correspond with the transverse contour of the track plates and the conveyer chains with the pins thereon, so that this plate will normally hang downward and close the middle portion of the interval between the lower edge of the door 33 and the bottom of tunnel chamber.

The middle shield 34 is made slightly longer than the width of the sheet ordinarily passing through the tunnel, so that this shield alone will ordinarily be deflected by a sheet in passing into and out of the ends of the tunnel. The swinging shields 34ª, are arranged to normally close the interval on each side of the middle shield 34, but are adapted to swinging on their hinges to permit the passing of a sheet of more than ordinary width. By means of these doors and swinging shields, it is evident that the tunnel chamber is substantially closed except for the temporary opening made by the swinging shield when a sheet is passing into or out of the ends of the tunnel; and when necessary for the purpose of providing a fresh supply of air into the tunnel for properly oxidizing the sheets therein, a series of lateral air ports 35 may be provided in the furnace and walls and the intervening tube 36; and air under pressure may be supplied into these ports, and also into the gas burners, by means of the pipe 37 and 37ª controlled by the valves 38 and 38ª leading from the main air pipe 39 which is connected with a suitable source of supply.

As preliminary steps in the general process of bluing the sheets by the improved method, we prefer to pickle the sheet-bars from which the sheets are rolled to remove all scales or oxidation thereon. After the sheets are rolled and sheared to proper size, they are then pickled to remove all oxidation on their surfaces, washed in water to remove all traces of the pickling acid and then while wet are preferably given one or two passes between cold rolls. This preliminary cold-rolling of the sheets is preferred because the partial finishing of the sheets at this stage of the process renders unnecessary an excessive cold-rolling thereof after the sheets have been blued and avoids the resulting undue hardening of the same. After the wet cold-rolling, they are then annealed in the usual manner, and after being cooled and separated are ready for the bluing furnace.

For bluing the sheets, the tunnel chamber is heated as uniformly as possible throughout its entire length, to or somewhat in excess of the temperature required for oxidizing the sheets to make the desired color on their surfaces, as for instance, to a bright red heat, the doors and swinging shields on the ends being preferably closed to retain the heat in the chamber, and the conveyer chains are placed in operation. The sheets are then entered, one at a time, into the forward end of the tunnel chamber upon the pins of the conveyer chains, the swinging shield being temporarily opened in so doing; and are carried by the conveyer chains in succession through the tunnel chamber, to the rear end thereof, where they emerge by temporarily opening the swinging shields.

The speed of the conveyer chains is so proportioned to the length of the tunnel chamber and the heat therein, that the sheets will be retained within the chamber long enough to bring them to the temperature necessary for oxidizing the surfaces to the desired degree or particular color; and when the sheets emerge from the chamber they may be cooled by any of the well known and ordinary methods without affecting or varying the color.

A mere inspection of the sheets as they emerge from the rear end of the tunnel chamber will show the extent to which they have been oxidized within the chamber, that is to say, the color which has been produced thereon; and, if there is not sufficient oxidation to produce the desired color, the speed of the conveyer chains is first reduced to retain the sheets in the tunnel chamber during a longer period, and the heat in the chamber is then preferably increased so that the faster speed of the chains can be resumed.

The oxidation of the sheets in the tunnel chamber takes up the oxygen of the heated atmospheric air therein and leaves the resultant nitrogen gas in the chamber; and in the event there is not sufficient supply of atmospheric air admitted and a corresponding displacement of the nitrogen gas by the temporary opening of the swinging shields at the end of the tunnel chamber to properly oxidize the sheets therein, additional atmospheric air is introduced into the chamber at such points and in such quantities as may be required through the lateral air ports in the sides of the furnace; the positive introduction of which atmospheric air under pressure serves to positively displace the nitrogen gas in the chamber, and thus replenishes and purifies the air within the chamber to

be in the proper condition for the most perfect oxidation of the steel or iron sheets therein.

It will be understood that the temperature to which the furnace is held for oxidizing the sheets to produce any desired color, will depend upon the length of time required for the sheets to pass through the tunnel chamber, that is to say, the length of time to which the sheets are subjected to the heat of the furnace; and accordingly a lower heat may be employed in a longer tunnel chamber or when the sheets travel with less speed, than is required in a shorter tunnel chamber or when the sheets pass through the same more rapidly; the essence of this step of the process consisting in heating the sheets to, but not beyond, the particular temperature required for oxidizing them to produce the desired color and then withdrawing the sheets from the furnace or the action of the heat, irrespective of the particular apparatus employed or the character of the heat to which the sheets are subjected. After the sheets are thus blued, they are passed once or twice between the cold rolls to give them the desired polish or finish, without unduly hardening them; and for making certain higher grade sheets for special purposes the sheets may then be re-blued by passing them again through the tunnel chamber of the furnace, although such re-bluing is not essential for producing a uniform color to the surfaces of the several sheets and the different parts of the same sheet, which is accomplished by once passing the sheets through the improved bluing furnace.

The apparatus which is illustrated and described, but not claimed herein, is made the subject-matter of a separate application filed herewith.

We claim:

1. The process of oxidizing steel or iron sheets which consists in subjecting the sheets to the action of heat in the presence of an oxidizing agent until they are heated to but not beyond the temperature required for oxidizing the surfaces to the desired color, and then withdrawing them from the action of the heat.

2. The process of oxidizing steel or iron sheets which consists in subjecting separate sheets to the action of heat in the presence of an oxidizing agent until they are heated to but not beyond the temperature required for oxidizing the surfaces to the desired color, and then withdrawing them from the action of the heat.

3. The process of oxidizing steel or iron sheets which consists in subjecting the sheets to the action of an indirect heat in the presence of an oxidizing agent until they are heated to but not beyond the temperature required for oxidizing the surfaces to the desired color, and then withdrawing them from the action of the heat.

4. The process of oxidizing steel or iron sheets which consists in subjecting separate sheets to the action of an indirect heat in the presence of an oxidizing agent until they are heated to but not beyond the temperature required for oxidizing the surfaces to the desired color, and then withdrawing them from the action of the heat.

5. The process of oxidizing steel or iron sheets which consists in subjecting the sheets to the action of heat in the presence of an oxidizing agent in a substantially closed chamber until they are heated to but not beyond the temperature required for oxidizing the surfaces to the desired color, and then withdrawing them from the action of the heat.

6. The process of oxidizing steel or iron sheets which consists in subjecting separate sheets to the action of heat in the presence of an oxidizing agent in a substantially closed chamber until they are heated to but not beyond the temperature required for oxidizing the surfaces to the desired color, and then withdrawing them from the action of the heat.

7. The process of oxidizing steel or iron sheets which consists in subjecting the sheets to the action of an indirect heat in the presence of an oxidizing agent in a substantially closed chamber until they are heated to but not beyond the temperature required for oxidizing the surfaces to the desired color, and then withdrawing them from the action of the heat.

8. The process of oxidizing steel or iron sheets which consists in subjecting separate sheets to the action of an indirect heat in the presence of an oxidizing agent in a substantially closed chamber until they are heated to but not beyond the temperature required for oxidizing the surfaces to the desired color, and then withdrawing them from the action of the heat.

9. The process of oxidizing steel or iron sheets which consists in heating the sheets in the presence of a controlled supply of an oxidizing agent until they are heated to but not beyond the temperature required for oxidizing the surfaces to the desired color, and then withdrawing them from the action of the heat.

10. The process of oxidizing steel or iron sheets which consists in heating separate sheets in the presence of a controlled supply of an oxidizing agent until they are heated to but not beyond the temperature required for oxidizing the surfaces to the desired color, and then withdrawing them from the action of the heat.

11. The process of oxidizing steel or iron

sheets which consists in subjecting the sheets to an indirect heat in the presence of a controlled supply of an oxidizing agent until they are heated to but not beyond the temperature required for oxidizing the surfaces to the desired color, and then withdrawing them from the action of the heat.

12. The process of oxidizing steel or iron sheets which consists in subjecting separate sheets to an indirect heat in the presence of a controlled supply of an oxidizing agent until they are heated to but not beyond the temperature required for oxidizing the surfaces to the desired color, and then withdrawing them from the action of the heat.

JOHN E. CARNAHAN.
ARTHUR J. MASKREY.

Witnesses:
PHILIP A. H. TERRELL,
CHAS. M. BALL.