

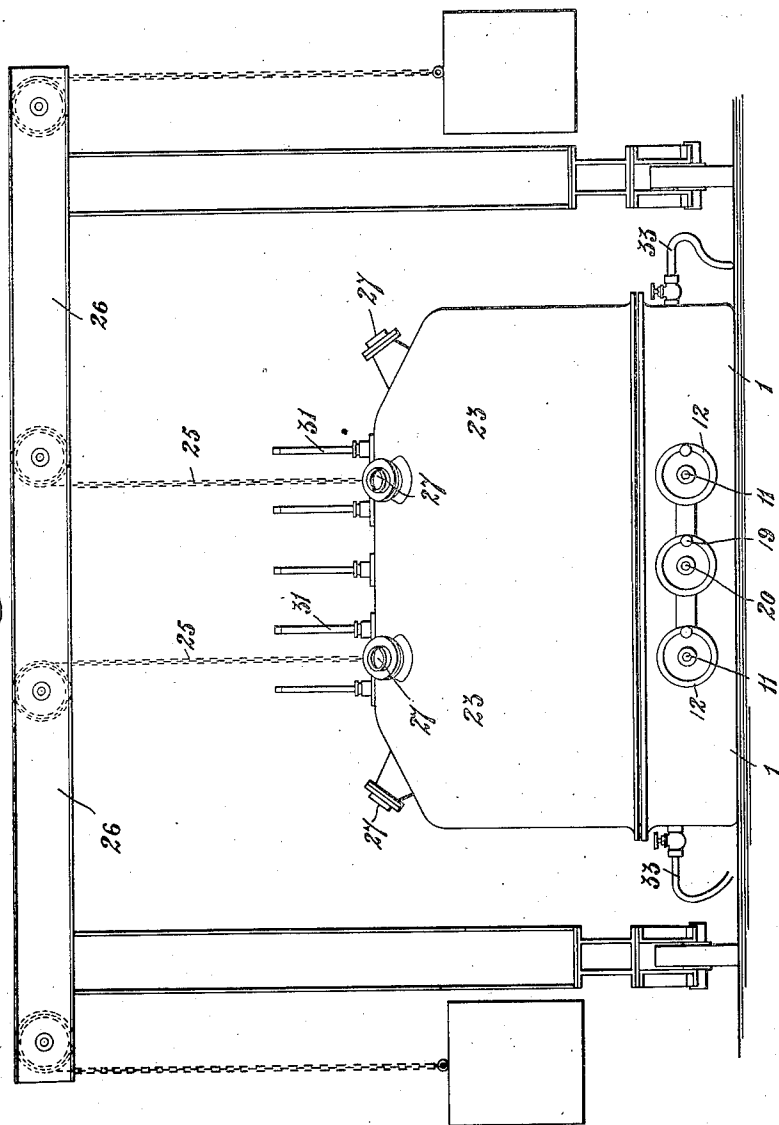
W. S. SIMPSON.
TREATMENT OF STEEL AND IRON SURFACES.
APPLICATION FILED AUG. 17, 1912.

Patented June 10, 1913.

3 SHEETS-SHEET 1.

1,064,671.

Fig. 1.



Witnesses:

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William S. Simpson

by

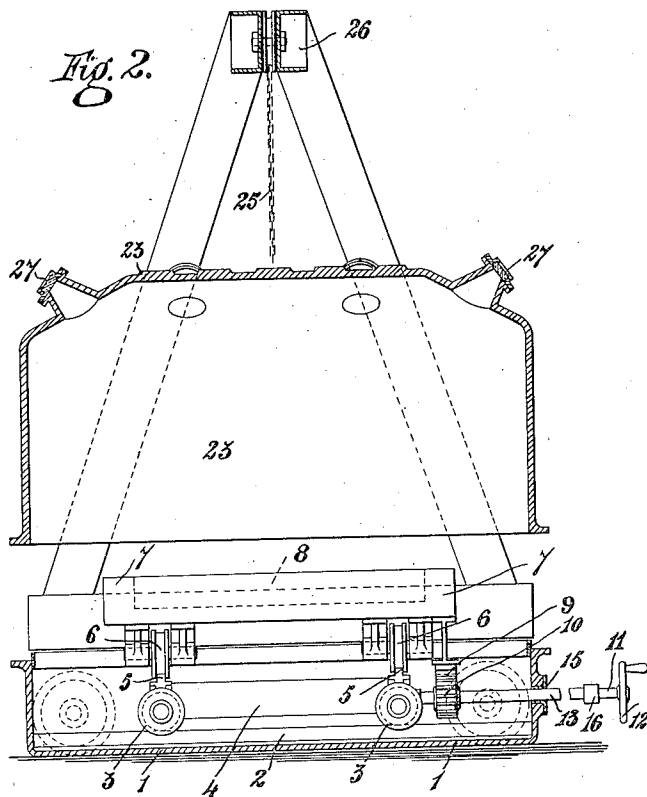
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3 SHEETS—SHEET 2.



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- 3 SHEETS-SHEET 3.

Fig. 3.

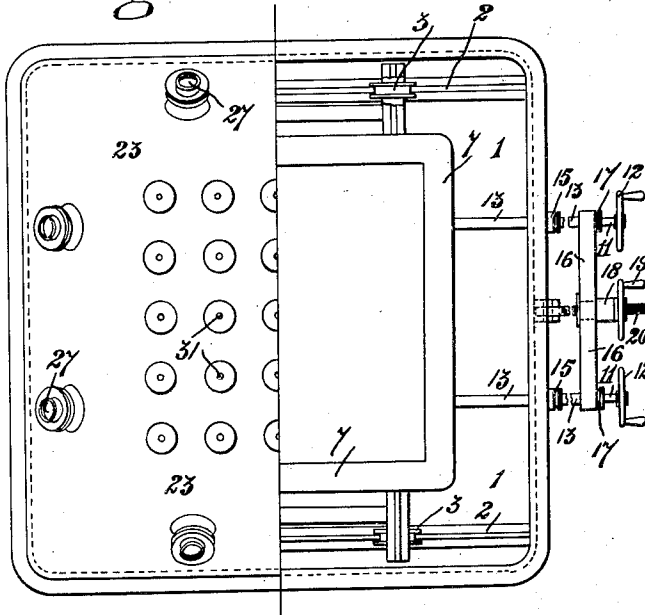
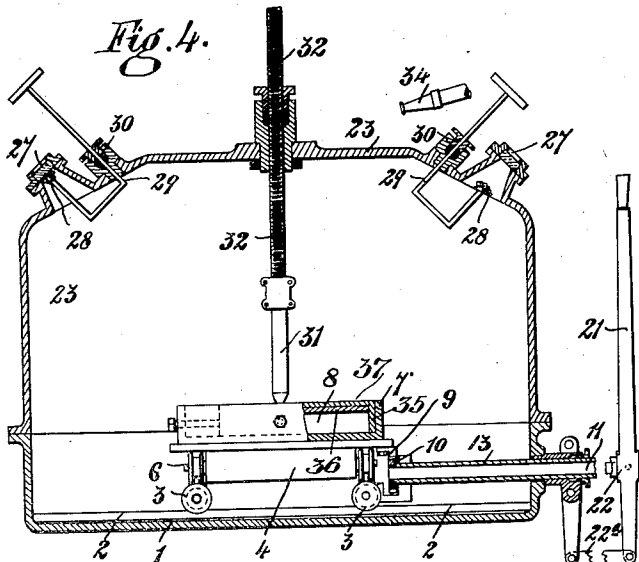


Fig. 4.



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UNITED STATES PATENT OFFICE.

WILLIAM SPEIRS SIMPSON, OF LONDON, ENGLAND.

TREATMENT OF STEEL AND IRON SURFACES.

1,064,671.

Specification of Letters Patent.

Patented June 10, 1913.

Application filed August 17, 1912. Serial No. 715,638.

To all whom it may concern:

Be it known that I, WILLIAM SPEIRS SIMPSON, a subject of the King of Great Britain, residing at London, England, have
5 invented certain new and useful Improvements in the Treatment of Steel and Iron Surfaces, of which the following is a specification.

This invention has for its object the fusing electrically of steel or iron surfaces (and super-heating the same) and the introduction therein of metals or metallic compounds for hardening, toughening or otherwise improving such surfaces and all without oxidation or deterioration during the process which throughout is carried on *in vacuo*. By this method or process the plate, bar or other article may be converted into two or more qualities of steel or iron either at the
10 back or front and by a series of operations may be caused to consist of several layers of metal varying in hardness, ductility or other desirable qualities. In no case are the metals or surfaces burned or oxidized but on the
15 contrary are purified and improved, the ultimate surface when cooled being free from blowholes. For example: in the manufacture of an armor plate my procedure is as follows: I prepare a plate of suitable size and thickness which (preferably) has been rendered of superior quality as regards tensile strength, toughness, ductility, etc., by reason of its carbon contents and by the employment of suitable metallic alloys as well
20 as by known methods of forging, rolling, heat treatment, etc. I then place this plate in a metallic chamber so constructed as to be employed as a vacuum chamber. The plate rests horizontally therein upon a platform or carriage supported on wheels and capable of being moved backward and forward or shifted laterally, without breaking vacuum. In some cases especially in treating thin
25 plates the surface of the platform or carriage upon which the plate is resting may be provided with a water cooling device to prevent too deep a fusion of the upper surface of the plate. The plate while in the vacuum chamber is surrounded as to its
30 edges with a suitable refractory material so placed as to form a metal-tight mold adequate to prevent the escape of any molten metal from the surface of the plate. After the vacuum chamber has been closed and a
35 high vacuum created therein, electrical heat

is applied to the face of the plate in such a manner and with such local intensity that any or all parts of the surface are rendered molten either simultaneously or in sections. The electrodes whereby such effect is produced are under the perfect control of the operator and are sufficient in number to render effective the heating and super-heating of the surface of the plate to any depth desirable for the introduction of metallic alloys or improving the character of the steel composing the surface of the plate for certain definite purposes, and although in the early stages of fusing the iron or steel surface it is convenient to bring the electrode
40 or electrodes into contact with such surface I provide a fusible slag covering therefor which enables the arc to be maintained even if the electrode is raised above the metallic surface and out of actual contact therewith during the final stages of the operation. Means are provided for moving the electrodes or any of them and for changing at will their relative position to the face of the plate while the same is molten or otherwise, without breaking the vacuum. My special
45 treatment of either face of the plate may consist in the introduction of carbon or manganese added in the form of ferro-carbon or ferro-manganese, an increased percentage of some one or more of the various metals already present as alloys, or it may consist in the impregnation of either face of the plate with a suitable alloying metal not already present in the steel (such for instance as nickel, chromium, molybdenum, tungsten or vanadium) which may be added either pure or in combination with iron. A pre-determined quantity of one or more alloying metals or metallic compounds may be placed upon the surface of the plate before the application of the electrical heat, in any convenient form suitable for melting and mixing so that upon being fused they may become a part of the surface of the plate, or (in some cases) the metals or metallic compounds may be separately prepared and melted and then introduced within the vacuum chamber while in a molten condition and added to the fused metal already composing the face of the plate.

In some cases my initial plate may be composed of a pure quality of iron, rolled or otherwise into the requisite shape, which, by my treatment, may be impregnated as

to either of its surfaces with ferro-carbon and suitable alloying metals and thus converted into any desirable quality of steel having differing qualities of ductility, capacity for hardening, etc., upon its upper and lower surfaces. During the entire operation and until the vacuum chamber is opened to allow the metal to cool, a high vacuum should be maintained and the higher the vacuum employed the more perfect is the result obtainable; since under such conditions there is no oxidation of the sensitive metals introduced as alloys and no deterioration of the metals or any of them through super-heating. The best results obtainable at present are effected with a vacuum above 27, under barometric conditions of 30, or if the barometric conditions are different, under about the same ratio. Moreover the extreme fluidity of the metals obtainable *in vacuo* facilitates a perfect diffusion and alloy.

In the manufacture of an armor plate this process renders it possible to impregnate the face of the plate to a depth of two or more inches with any alloying metal, especially such metals as molybdenum or tungsten, in suitable proportions to render the steel self-hardening on exposure to the air, or carbon as contained in the carbids of iron may be added to the steel surfaces to a much greater depth and in a more uniform manner than by cementation in cases where it is desirable to harden by chilling in water or otherwise.

The apparatus I prefer to employ is shown in the annexed drawings whereof:

Figure 1 is a front elevation with the dome closed and showing the appliance for moving the dome. Fig. 2 is a side sectional elevation showing only the dome and the carriage and its actuating gear. Fig. 3 is a part sectional plan of the apparatus showing a number of electrodes. Fig. 4 is a view similar to Fig. 2, with a modified gear for actuating the carriage and with means for cleaning the sight holes and showing only one electrode in position.

The apparatus shown is designed for the electrical fusion of the surface of comparatively small plates or bars of iron or steel and the introduction of some hardening material such as carbon, tungsten or other suitable material.

The apparatus consists of a base or foundation 1, of trough shape and containing a pair of rails 2 on which are placed wheels 3 carrying a frame 4, two opposite members of which are provided with rails 5 positioned at right angles to the rails 2. On these rails 5, are mounted wheels 6 carrying the platform or carriage 7, which latter receives or contains the article 8 to be treated.

According to Figs. 1, 2 and 3, the car-

riage 7 is provided with a rack 9 into which gear toothed wheels 10 on rods 11 provided with hand wheels 12. These rods are positioned in tubes 13 secured at one end to the frame 4, and said tubes, after passing through stuffing boxes 15 in the foundation 1, are connected by a bar 16 having stuffing boxes 17 for the rods 11. In the bar 16 and between the two tubes 13, is positioned a collar 18 having a handle 19, this collar fitting on a screw rod 20 secured to the foundation 1. The object of the rods 11 is to move the carriage along the rails 5 in one direction, and the screw 20 is to move the frame 4 and carriage 7 at a right angle movement, so that the article can be moved to any position for treatment.

The same movements may be effected according to Fig. 4 by a single rod 11 and tube 13, and in this case a lever 21 is employed which engages by a collar 22, the tube 13, and is connected to the foundation by links 22^a so that by operating the lever 21 the carriage 7 and the frame 4 can be moved in the direction as moved by the screw 20. On this carriage I affix the article 8 to be treated, such article being positioned in a recess in the carriage and packed in powdered chromite or carbon 35 to prevent the fused metal from flowing off the surface over the edge. Upon the surface of the said article to be treated are then applied the metals or metallic compounds 36 to be alloyed therewith, and upon these, in turn, is placed the covering of fusible slag 37.

On the foundation is positioned a dome 23 which, when off the foundation is carried by chains 25 running over pulleys on a derrick 26, said derrick running on a track or on the ground to move the dome 23 completely away from the foundation 1.

The dome is provided with sight holes 27 which can be cleaned by the cleaner 28 carried by a rod 29 through a stuffing box 30 to the outside.

The electrodes 31 depend from the dome 23 and are of any desired number and connected up with the source of electric supply by flexible wires through switches for establishing the current to any or all of them, and such electrodes are each carried by a screw 32 operable from outside the dome to position the points of the electrodes at the desired position over the article being treated.

33 are pipes connected with a suction pump for creating the vacuum when the dome 23 is secured to the foundation 1.

The article to be treated is introduced and suitably packed while the dome is off the foundation, and after that the dome is placed on the foundation and the electrodes suitably positioned; then a vacuum is created and the electric current switched on to the desired electrodes, and as the operation

proceeds, the carriage is moved to expose every part of the article to the action of the electric current.

The water for cooling the under surface of the article may be applied before the dome is secured on the foundation, and such dome may be sprayed with water from a pipe 34 while the operation is in progress to keep the dome cool.

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

1. The method of impregnating steel or iron surfaces with metals or metallic compounds for hardening, toughening or improving the same, to any desired depth, which consists in fusing electrically and alloying such surfaces while in a substantial vacuum.

2. The method of impregnating steel or iron surfaces with metals or metallic compounds for hardening, toughening or improving the same, to any desired depth, which consists in fusing electrically, alloying and carburizing such surfaces while in a substantial vacuum.

3. The method of impregnating steel or iron surfaces with foreign matter for hardening, toughening or improving the same, to any desired depth, which consists in applying said matter to said surfaces, covering said matter with fusible slag, and thereafter

melting said surfaces and matter by means of an electric arc while in a substantial vacuum.

4. The method of impregnating steel or iron surfaces with foreign matter for hardening, toughening or improving the same, to any desired depth, which consists in applying said matter to said surfaces, covering said matter with fusible slag, and thereafter springing an electric arc through the stratum of slag to melt said surfaces and matter, while in a substantial vacuum, without the electrodes coming into actual contact with the molten metal.

5. The herein described method of hardening, toughening and improving metallic surfaces which involves fusing the same electrically while in a substantial vacuum and superheating such molten surfaces, whereby perfect diffusion of the alloys is effected and occluded gases are liberated from the molten metal and withdrawn as liberated.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

WILLIAM SPEIRS SIMPSON.

Witnesses:

O. J. WORTH,

H. CRIATT.