

S. S. WALES.
ARMOR AND SAFE PLATE.
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1,097,573.

Patented May 19, 1914.

Fig. 1.

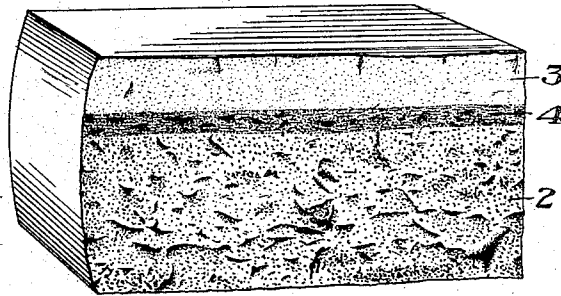
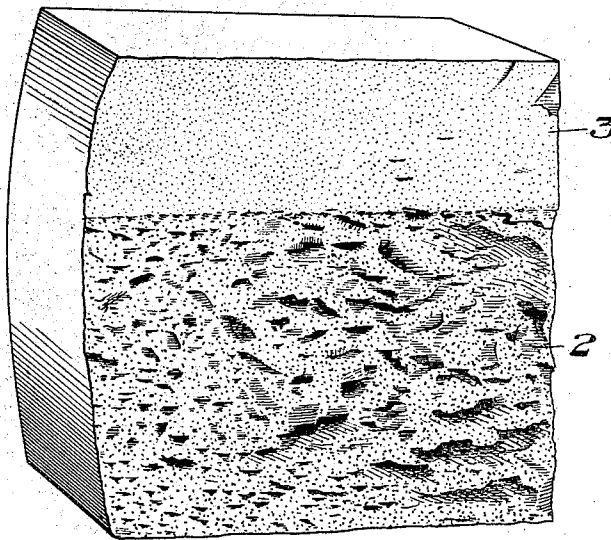


Fig. 2.



WITNESSES

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UNITED STATES PATENT OFFICE.

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ARMOR AND SAFE PLATE.

1,097,573.

Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, SAMUEL S. WALES, of Munhall, Allegheny county, Pennsylvania, have invented a new and useful Improvement in Armor and Safe Plates, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, in which—

Figure 1 is a section illustrating the fracture of armor plate embodying my invention, and Fig. 2 is a similar view showing another form.

My invention relates to face-hardened armor plates, and vault or safe plates, and is designed to provide an improved plate which will afford higher ballistic resistance, and in which the face-hardened portion is of more uniform chill or hardness than in previous plates of this character.

To that end my invention consists in a face-hardened plate having its face-hardened layer of substantially uniform hardness, the body or back of the plate having substantially uniform characteristics, and the plate also having a third intermediate layer between the face-hardened portion and the back, said intermediate layer being in a soft annealed condition. My improved plate, therefore, while made integral possesses the characteristics of a compound plate, in that it consists of three different layers having different characteristics, each layer being substantially uniform throughout its depth or thickness, and all three layers being in molecular contact with each other, thus avoiding the disadvantages of compound plates.

In obtaining my improved plate, my process departs from prior methods or processes, particularly in the step of heating prior to quenching for water-hardening. Heretofore in this step of the process as used in practice, the plate has been bedded in loam or similar material, which covers the back and all the edges of the plate, leaving the face to be hardened exposed. The face of the plate is exposed to the heat of the furnace, while the other parts of the plate are protected by the loam, and this face is raised to about 850° to 950° centigrade. During this heating, the body of the plate is heated by conduction from the face to successively lesser degree from the face to the back, the back being usually about 550° to 600° centigrade. The plate is then removed from

the furnace and water sprays directed against both faces. This gives the final hardness to the face of the plate, and at the same time, the body of the plate is softened or annealed by reason of its temperature being in the range in which water annealing takes place. The strength of the body of the plate is decreased by this treatment, and this can not be remedied, it being the final treatment. This prior method of heating and quenching produces a plate having a face-hardened portion with the maximum hardness at or near the surface thereof, this hardness decreasing gradually through the chilled portion. From the lower part of the chilled portion, the metal changes gradually in its characteristics through the body portion of the plate to its back. This body portion merges into the face-hardened or chilled portion through a crystalline structure, which gradually becomes mixed with the chilled fiber, or soft annealed portion, the latter increasing successively toward the back until at the back there is no crystalline structure. In other words, starting at the back of the plate, there is a soft annealed portion or fibrous structure which merges into the face-hardened portion by a gradual increase in hardness until the chilled or undrillable portion of the plate is reached. In these previous plates, there were no separate layers each having substantial uniform characteristics throughout the layer and each differing from the other layers as to such characteristics. In other words, these plates varied continuously from back to front as to the degree of hardness and tensile strength, though not necessarily uniformly. This character of plate is the result of the ordinary heating for face-hardening, in which the entire plate is heated to a greater or less degree, this heat decreasing from the front to the back of the plate continuously. Owing to this heating of the entire body of the plate, the main body portion is water-annealed at the same time that the face is hardened by the quenching, and consequently, the water-annealed portion at the back merges gradually into the water-hardened portion through successive portions. This treatment will obviously remove or largely modify the effect of any former heat treatment which may have been beneficial to the body of the plate, by raising its tensile strength or toughening it, as it will

reduce the back portion of the plate to the softest condition which it can contain due to the water annealing, or to a mixed condition which is neither water-hardened nor annealed, which will give neither the best condition as to tensile strength nor resistance to impact.

In the manufacture of my improved plate, the face to be hardened is exposed in a furnace, directly to the heat, while the edges are protected by any convenient refractory material so as to force the heat to penetrate from the front surface only. At the same time the back is exposed to a positive cooling effect such as a spray of water, steam, or other cooling fluid, which is forced against it. The surface to be hardened is thereby raised to a temperature where water-hardening takes place in the next or water-quenching operation, while the main body of the plate is maintained at such a temperature that no changes take place over the condition in which the material was left by its immediately preceding metallurgical treatment.

Between the portion to be water-hardened and the main body or back of the plate there will be a thin layer where the temperature changes from the water-hardening range to the temperature where no action takes place in quenching. This thin layer of the plate will consist of soft metal, since its temperature at the time of quenching has been such that it is annealed during this step. This soft intermediate layer is connected with the face and the back or body by very thin laminae, wherein the metal is changing in characteristics to that of the face and back.

My improved plate comprises a face-hardened portion, in which the hardness is substantially uniform by reason of the uniformity of temperature therein, and by reason of the heating being practically limited to this portion of the plate, so that the total heat to be extracted is relatively small and because the inner surface of the heated portion is in molecular contact with the cooled back, which will extract the heat therefrom very rapidly, so that when this plate is finally quenched the heat is extracted from the hot surface by direct contact with the water or cooling fluid, and also from the back portion of the heated layer by conduction through the cooled back, which is also in contact with the cooling fluid. If this face-hardened portion is four inches thick, the hardening operation amounts to the quenching of a four-inch plate, instead of a plate of the full thickness of the plate treated, which in this case would be eight or ten inches.

My plate comprises a strong back portion, which maintains the characteristics imparted thereto by the last metallurgical treatment previous to heating for hardening, owing

to the fact that the cooling of the back of the plate has prevented its temperature being raised to a point where any annealing can take place, either during the heating process or during the subsequent quenching. These two portions of the plate are connected by a comparatively thin layer wherein the heat is changing from the temperature at which water-hardening takes place to that of the main body or back of the plate. This portion will obviously be annealed to a soft condition.

The above described product will thus furnish a plate consisting of three principal layers or strata, as seen in Fig. 1, which shows a section broken through the plate, the main body or back of the plate 2 being in substantially the same condition that it was before this treatment, the face or water-hardened portion 3 being chilled to the desired hardness, and an intermediate layer 4 consisting of a soft or annealed metal between and connecting the two above mentioned layers. The division line between the middle layer and the main body or back of the plate may not be distinctly visible to the eye where the main body or back of the plate was annealed to the same condition before heating for water-hardening as this strip will be after process of heating for water-hardening, but this will in no way interfere with the invention.

In case the body or back of the plate has been annealed to a soft condition, but still harder than this soft strip mentioned, the line of demarcation may not be visible to the eye, as is the case of Fig. 2 showing a section broken through the plate, but can be detected by physical tests taken successively from the back to the face of the plate. If the main body or back of the plate in its immediately preceding metallurgical treatment has been left in a condition whose structure differs radically from that of the soft annealed strip, both division lines will be visible to the eye, as in Fig. 1. My plate, therefore, contains all the advantages claimed for compound plates made up of several layers of distinct metal, while avoiding their disadvantages, as the laminations are induced in a homogeneous metal by definite heat treatment, and not by being built up and welded together, nor by being cast in successive layers. The body of the plate is kept in its condition prior to heating for hardening, thus retaining the resistance of the plate as a whole.

Changes may be made in the steps of the process, the plate alloy &c., without departing from my invention.

I claim:—

1. An integrally formed compound armor or vault plate having three layers, namely: a face hardened layer or finely crystalline structure, an intermediate softer annealed

- layer of fibrous structure, and an unannealed back or body in the unannealed condition imparted thereto prior to heating the plate for hardening its face, and forming the major portion of the thickness of the plate; substantially as described. 20
2. A compound face-hardened armor or vault plate integrally formed, having three layers, namely, a face-hardened layer, an unannealed back portion constituting the greater thickness of the plate and a thin intermediate layer of annealed softer material; substantially as described. 25
3. A compound face-hardened armor or vault plate integrally formed, having three layers, namely, a face-hardened layer, an unannealed back portion constituting the greater thickness of the plate and a thin intermediate layer of annealed softer metal having less tensile strength than the unannealed back portion; substantially as described. 30
4. A compound face-hardened armor or vault plate formed integrally and having three distinct layers constituting a face-hardened layer, an unannealed layer forming the back or body portion of the plate and a thin layer of soft annealed material of less tensile strength than the unannealed back layer; substantially as described.
- In testimony whereof, I have hereunto set my hand.
- S. S. WALES.
- Witnesses:
HOWARD L. CAMPBELL,
W. H. CORBETT.