F. GIOLITTI.

ARMOR PLATE AND OTHER STEEL ARTICLE.

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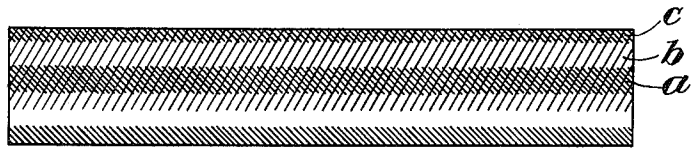
1,043,416. Patented Nov. 5, 1912.



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UNITED STATES PATENT OFFICE.

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ARMOR-PLATE AND OTHER STEEL ARTICLE.

1,043,416. Specification of Letters Patent. Patented Nov. 5, 1912.

Original application filed September 6, 1906, Serial No. 333,409. Divided and this application filed October 10, 1907. Serial No. 396,863.

To all whom it may concern:

Be it known that I, FEDERICO GIOLITTI, a subject of the King of Italy, residing in Rome, Italy, have invented certain new and useful Improvements in Armor-Plates and other Steel Articles, of which the following is a specification.

This application has been divided out of an application filed in the United States Patent Office September 6, 1906, Serial No. 333,409.

This invention refers to the manufacture of armor plates or any other objects of ordinary carbon steel as well as of any other special ternary, quaternary and like steel, formed of successive layers alternately more or less hard, tenacious and elastic.

This invention consists in submitting the plates or other objects of homogeneous steel possessing a small or large proportion of carbon, to a series of successive carbonizations or decarbonizations, or both, regulated as regards their duration, and as regards the temperature at which they are produced, so as to obtain at the interior and on one or more surfaces two or more layers strongly carbonized, tenacious, having a clearly crystalline structure and capable of being strongly tempered, the said layers being alternated with two or more layers having a slight proportion of carbon which consequently, even after the tempering, are less hard and more plastic.

The figure of the drawing indicates a steel plate made according to the present invention in which there is a zone *b* containing less carbon than the inner portion *a* of the article, and an outer zone *c* containing a greater proportion of carbon than the adjacent inner zone *b*.

In order to obtain this result advantage is taken of the laws that govern the velocity of diffusion of the carbon in iron and in steel, at the various temperatures, at the time of the carbonization, or of the de-carbonization, as well as of the laws which govern the limit of saturation of the iron as regards the carbon, which varies also with the variations of temperature. The operation is effected in the following manner:—The ordinary ternary, quaternary or like steel ingot, before, or after, it has been submitted to the ordinary mechanical manipulations (pressing, rolling, hammering and the like) that transforms it into the plate or other object of the desired shape or form, is submitted first to a treatment which varies according to the proportion of carbon contained by the ingot; and then to ulterior treatments, described hereafter; and which treatments constitute the essential part of the present invention, and impart to the plate or other object special resisting and other advantageous qualities.

In the case where the plate has only a small proportion of carbon the preliminary operation consists in strongly carbonizing it on one of these surfaces by proceeding with the carbonization to the depth necessary so as to obtain, by means of the tempering, the hard deeper layer in the desired position and presenting the desired degree of carbonization. This carbonization can easily be obtained by the ordinary method used by maintaining the plate for a sufficiently long period, and at a suitable temperature below the highest critical point, in contact with granular carbonaceous substances compressed against one of its surfaces, or in an atmosphere of carbureted gas, limiting also in this case the contact of these latter to only one surface of the plate.

In the case where, on the contrary, it refers to an ingot and consequently a plate having a high proportion of carbon, the first operation to which the plate has to be submitted is inverse as regards that of the preceding case. In this second case the plate is submitted to a de-carbonization on the one or both of its surfaces. This de-carbonization is effected by heating the said plate for a given time and at a given temperature below the highest critical point with suitable mixtures of metallic oxids reduced to a suitable degree of sub-division and firmly compressed against the surface or surfaces from which it is desired that the de-carbonization may extend to the interior of the plate.

The de-carbonization will be carried to a different degree, and to a different depth, on the two surfaces by suitably regulating the temperature and the duration of the operation for each of them. This latter can at a certain moment be interrupted on one of the surfaces by substituting for the mixture of oxids, a granular compact inert substance.

In any case, it is always possible, by carefully applying the law of diffusion of the carbonization and the de-carbonization as regards the temperatures, and the times, to continue the operation until a layer of given carbonization and thickness and situated at a determined position at the interior of the plate is obtained.

The same results can be obtained in the first case, for example, when starting with a plate having a slight proportion of carbon and which has subsequently been carbonized on one of its surfaces to a suitable depth as has been described above. In this instance, the same result as indicated above is obtained by submitting the plate to a suitable de-carbonization on the surface which has previously been carbonized by the ordinary method. By suitably regulating this de-carbonization, it can be easily terminated so that there will result at the interior of the plate, a more or less strongly carbonized layer of the desired thickness and situated at the desired depth. This depth is only regulated by the position of the limit of the first carbonization and by that of the extreme limit of the subsequent de-carbonization. Obviously, the said successive and alternative operations of carbonization and de-carbonization, can be repeated one or more times. There can thus be obtained in the mass of steel, a series of layers more or less strongly carbonized, alternating with layers weak in carbon, so that the proportion of carbon varies gradually and without discontinuity when passing from one layer to the contiguous layer. The said operations can ordinarily be effected simultaneously on both surfaces of the plate.

If it is desired to give to one or to both surfaces a large proportion of carbon in order for example to be able to subsequently harden them to a high degree by the tempering, the steel body should always be submitted to a final superficial and more intense or rapid carbonization on one of the surfaces, or on both.

On subsequently applying the various methods used for the simple or multiple homogeneous tempering of ordinary steels and special steels, a body of steel will be obtained varying gradually from one layer to the other as regards hardness, tenacity and elasticity.

By varying the relative position, the thickness and the composition of the various layers (that is to say their quality as regards the tempering) this permits the employment of the body of steel for a great number of applications in which the heterogeneousness of the body may be very advantageous.

This process of manufacture for example could be largely employed in the manufacture of armor plates for ships. In these plates the plastic and tenacious mass which forms the base and the support of the layer, strongly hardened by the carbonizing and by the tempering under given conditions, will be substituted by the mass itself supported by one or several very hard and tenacious layers. These layers will considerably assist, owing to the great hardness and tenacity of the mass with which they form a homogeneous whole, in stopping the projectile which has already lost much of its kinetic energy in perforating the very hard and very tenacious exterior surface. This will permit considerable decrease in the thickness of the plates for equal resistance, and for equal thickness, will considerably increase the resistance.

For example, to treat a piece of mild steel showing the following composition: carbon 0.7%, manganese 0.60%, silicon 0.12%, sulfur 0.03%, phosphorus 0.02%, with the intention of obtaining two carbureted zones separated from each other by a decarbureted zone, so that, for instance, on proceeding inwardly from the outer face of the piece the percentage of carbon decreases from 0.3% at the surface to 0.1% at 3 mm. depth, then remains unchanged up to 6 mm. depth and increases again to .8% at 9 mm. depth, and again decreases to .2% at 12mm. depth. It will be necessary to adopt the following courses to obtain this result: 1st step, heating the steel piece up to 1000 degrees C. during 90 hours in contact with a mixture consisting of three parts of silicious sand and one part of ferric oxid (F_2O_3). 2nd step, heating the steel piece up to 1100 degrees C. during 20 hours in contact with a granular mixture consisting of two parts of charcoal and one part of barium carbonate. 3rd step, heating up to 1000 degrees C. during 6 hours in contact with the same mixture of silicious sand and ferric oxid used during the first step of the treatment.

Having thus described my invention, I claim:

1. A steel plate or other article of unitary structure having on one or more surfaces a zone formed by diffusion of carbon in such zone whereby the proportion of the carbon is less than in the other part of such article, and one or more sub-zones formed in the said zone by diffusion of carbon whereby the proportion of carbon in such sub-zones is greater than in the other parts of the zone.

2. A steel plate or other article of unitary structure having on one or more surfaces a zone formed by diffusion of carbon whereby the proportion of the carbon in such zone is less than in the other part of such article, and one or more sub-zones formed in the said zone by diffusion of carbon whereby the proportion of carbon in such sub-zones is different than in the other parts of the zone.

3. A steel plate or other article of unitary structure having on one or more surfaces a

zone formed by diffusion of carbon whereby the proportion of the carbon in such zone is less than in the other part of such article, and one or more sub-zones formed in the said zone by diffusion of carbon whereby the proportion of carbon in such sub-zones is greater than in the other parts of the plate.

4. A steel plate or other article of unitary structure having on one or more surfaces a zone formed by diffusion of carbon whereby the proportion of the carbon in such zone is different from the other part of such article, and one or more sub-zones formed in the said zone by diffusion of carbon whereby the proportion of carbon in such sub-zones varies from the other part of the zone and also from the other part of the article, one of the said zones having the proportion of carbon less than in the inner portion of the article.

5. A steel plate or other article of unitary structure, having on one or more surfaces a series of three zones formed by diffusion of carbon in which the proportion of carbon varies in the adjacent zones.

6. A steel plate or other article of unitary structure, having on one or more surfaces a series of three zones formed by diffusion of carbon in which the proportion of carbon varies in the adjacent zones, the second zone having less proportion of carbon than the outer zone, and the third zone having a greater proportion of carbon than in the second zone.

Signed at Nos. 9–15 Murray street, New York, N. Y., October 1st, 1907.

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