

# UNITED STATES PATENT OFFICE.

SAMUEL S. WALES, OF MUNHALL, PENNSYLVANIA, ASSIGNOR TO CARNEGIE STEEL COMPANY,  
OF PITTSBURG, PENNSYLVANIA, A CORPORATION OF NEW JERSEY.

## BALLISTIC PLATE.

No. 928,348.

Specification of Letters Patent.

Patented July 20, 1909.

Application filed December 23, 1907. Serial No. 407,792.

*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 Ballistic Plates, of which the following is a full, clear, and exact description.

My invention relates to ballistic plates either with or without a carburized face.

The object of the invention is to provide a new alloy which will give a plate of high ballistic resistance and great resistance and toughness in the body of the plate.

In my application Serial No. 383,687, filed July 13th, 1907, I have disclosed an armor plate alloy which contains nickel, chromium, and vanadium below one per cent. I have now found that a nickel armor plate can be greatly improved by the use of tungsten and vanadium, both below one per cent. where the chromium is omitted entirely.

In carrying out my process in the manufacture of either face-hardened armor plate or protected deck plates, I use an alloy, of which I have found the following to be best suited for the purpose, although other elements may be added to those specified, or the proportions varied within certain limits:—carbon, .10 to .50 per cent.; manganese, .25 to .40 per cent.; nickel, 3 to 10 per cent.; tungsten, .50 to 1 per cent.; vanadium, .15 to .50 per cent.

The steel which I employ is preferably open hearth steel, and I prefer to add the nickel as a part of the charge of the furnace in a cold condition. The tungsten and vanadium are preferably added in a molten condition, preferably as ferro-alloys, to the open hearth ladle as the heat is tapped thereinto. The proportion of carbon may be produced by recarburizing in the usual manner. The silicon contents of the steel should be low, preferably less than .15 per cent. The sulfur should be as low as possible, preferably less than .04 per cent. It is important in this vanadium alloy that the phosphorus should be extremely low because the vanadium is found to intensify the action of this element. The phosphorus should, therefore, not exceed .04 per cent.

In some cases I may substitute molybdenum as an equivalent for the tungsten or a part thereof, in varying amounts up to one per cent., or I may add molybdenum to the present alloy as recited, in amounts below one per cent. The method of introducing

the nickel and making the additions may remain the same as above stated.

The ballistic armor or vault plate produced from this alloy may be subjected to any well-known armor plate treatment, and may be face-hardened or not as desired.

The advantages of my invention result from the use of the elements, nickel, tungsten, and vanadium. The combination of the tungsten and vanadium in the armor plate appear to increase the toughness and strength without materially decreasing the elongation. By the word "tungsten" I intend to cover either tungsten or an equivalent thereof, for performing the same functions as referred to herein.

Many variations may be made in the proportions of the elements, in the heat treatments, &c., without departing from my invention.

By the term "tungsten" in my claims, I intend to cover tungsten or its functional equivalents for the purpose.

I claim:—

1. As a new article of manufacture, a ballistic, armor, or vault steel plate free from chromium, and containing tungsten, and below one per cent. of vanadium; substantially as described.

2. As a new article of manufacture, a ballistic, armor, or vault steel plate free from chromium, and containing tungsten, nickel, and below one per cent. of vanadium; substantially as described.

3. As a new article of manufacture, a ballistic, armor, or vault steel plate free from chromium, and containing tungsten below one per cent., nickel, and below one per cent. of vanadium; substantially as described.

4. As a new article of manufacture, a ballistic, armor, or vault steel plate free from chromium, and containing tungsten, nickel above two per cent., and below one per cent. of vanadium; substantially as described.

5. As a new article of manufacture, a ballistic, armor, or vault steel plate free from chromium, and containing tungsten below one per cent., nickel from three to ten per cent., and below one per cent. of vanadium; substantially as described.

6. As a new article of manufacture, a ballistic, armor, or vault steel plate free from chromium, and containing tungsten, nickel, molybdenum, and vanadium below one per cent.; substantially as described.



7. As a new article of manufacture, a ballistic, armor, or vault steel plate free from chromium, and containing tungsten, nickel, and molybdenum below one per cent., and  
5 vanadium below one per cent.; substantially as described.

8. As a new article of manufacture, a ballistic, armor, or vault steel plate free from chromium, and containing tungsten below  
10 one per cent., molybdenum below one per

cent., three to ten per cent. of nickel and below one per cent. of vanadium; substantially as described.

In testimony whereof, I have hereunto set my hand.

S. S. WALES.

Witnesses:

JOHN MILLER,

H. M. CORWIN.