UNITED STATES PATENT OFFICE.

CHARLES Y. WHEELER, OF ALLEGHENY, AND FRANK L. SLOCUM, OF PITTSBURG, PENNSYLVANIA.

MANUFACTURE OF CHROME-STEEL ALLOY.

SPECIFICATION forming part of Letters Patent No. 597,869, dated January 25, 1898.

Application filed September 30, 1895. Serial No. 564,238. (No specimens.)

To all whom it may concern:

Be it known that we, CHARLES Y. WHEELER, a resident of Allegheny, and FRANK L. SLOCUM, a resident of Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in the Manufacture of Chrome-Steel Alloy; and we do hereby declare the following to be a full, clear, and exact description thereof.

Our invention relates to steel containing chromium, its special object being to provide a peculiarly high chrome-steel having such a small percentage of carbon as will not injuriously affect the steel or steel alloy produced, the steel so produced having peculiar advantages for projectile or armor-plate purposes, combining the advantages of great hardness to resist impact, high tensile strength, high elongation, and high reduction of area, such qualities giving it high elasticity.

The chrome-steel produced by the methods heretofore in use has had the peculiarity that the carbon was necessarily increased therein in proportion to the increased quantity of chromium present, while the proportion of chromium was largely a matter of chance where it was introduced by the two principal methods in use—namely, the use of chrome-pig or of green oxid of chromium. In the former case it was difficult to ascertain the proportion of chromium in the pig-metal and that metal was also necessarily high in carbon, and in the latter case a large proportion of the green oxid was found to enter the slag, while it was necessary to have a large proportion of carbon present to assist in the reduction of the oxid, and this made the resultant steel high in proportion of carbon. Such carbon in the steel renders it brittle and liable to fracture when tempered, so detracting from the improvement in quality obtained by the introduction of chromium. The steel alloy embodying the present invention has the desirable qualities above pointed out, while it is practically free from the injurious qualities caused by the presence of a high proportion of carbon.

The invention consists, generally stated, in a steel alloy composed of steel and chromium and having three and one-half ($3\frac{1}{2}$) per cent. or more of chromium and having a proportion of chromium at least five (5) times greater than the carbon present, said alloy having the qualities above enumerated.

The steel embodying the invention is preferably produced by dissolving in the molten steel practically pure metallic chromium in amount corresponding to the proportion desired in the resultant steel alloy, it being found that though the metallic chromium melts only at an exceedingly high temperature, much above the practicable working temperature for the steel, the metallic chromium will gradually dissolve in the molten steel and alloy therewith without fear of oxidation or slagging, so that the exact proportion of chromium in the resultant steel can be fixed by the amount of pure metallic chromium so dissolved therein.

In forming the steel the course followed depends upon the class of steel to be produced. For the making of projectile-steel we prefer to employ the crucible process, and for that purpose introduce into the crucible either the steel to be melted having the desired proportion of carbon therein or the iron or lower grade of steel to be melted and add thereto the necessary carbon, and for that purpose only such proportion of carbon as will cause the steel to melt at practicable temperatures need be employed, so that a steel with a very low percentage of carbon, down to three-tenths ($\frac{3}{10}$) of one (1) per cent. or even lower, may be produced. In the same crucible we introduce a piece of the metallic chromium accurately weighed according to the weight of steel to be produced in the crucible, this metallic chromium being either introduced before the melting of the steel or after the primary melting thereof, as desired. In either case the metallic chromium is gradually dissolved in the steel and alloyed therewith, so that practically all the metallic chromium unites with the steel and unites therewith in even proportion throughout, and it is found that a perfect alloy without loss of chromium can be obtained. The steel is then cast and may be rolled or forged to shape, as desired.

In forming the steel in the open-hearth process or the Bessemer process practically the same course is followed, care being of

course taken to ascertain the proportion of carbon in the steel and to add metallic chromium in proper proportion to the molten steel and maintain it in molten condition until the chromium is dissolved therein and thoroughly alloyed therewith.

We find that we are able to produce this steel alloy having any proportion of chromium desired in the steel, the steel having been produced with as high as seven (7) per cent. of chromium, and we also find that we are enabled to reduce the proportion of carbon, employing only such as will cause the melting of the steel at practicable temperatures, and at such temperatures the proportion of chromium in the resultant steel is to all intents and purposes in exact accordance with the amount introduced into the steel, so that there is no loss of chromium in the formation of the steel, and we are therefore enabled to produce the steel alloy in exact proportion of ingredients desired. The steel alloy can therefore be produced with the chromium as high as desired and the carbon as low as desired. We have found that the steel alloy possesses the peculiar qualities desirable for projectile-steel and armor-plate where the chromium is as high as three and one-half ($3\frac{1}{2}$) per cent., while the carbon is not over seven-tenths ($\frac{7}{10}$) of one (1) per cent., though for projectile-steel we prefer to considerably increase the proportion of chromium. The steel alloy so produced has the peculiar physical qualities, above referred to, of great hardness to resist impact, high tensile strength, high elongation, and high reduction of area, and when tempered, as the proportion of carbon is low, it is not brittle or liable to fracture, but can be bent or twisted under bending or torsional strains. As a consequence the projectiles produced from it are found to be exceedingly powerful and not liable to fracture. It has practically the same qualities when employed in armor-plate to resist impact from a projectile, and it has also the other quality that it is not liable to oxidation, so that the steel can be employed for many purposes in the arts, and has advantages over the ordinary steel liable to oxidation. As we have been able to obtain a practically pure metallic chromium at a reasonable cost the steel can also be produced more cheaply than the ordinary chrome-steel.

What we claim as our invention, and desire to secure by Letters Patent, is—

As a new article of manufacture, a steel alloy composed of steel and chromium and having three and one-half ($3\frac{1}{2}$) per cent. or more of chromium, and having a proportion of chromium at least five (5) times greater than the carbon present, said alloy having the qualities of great hardness, high tensile strength, high elongation and high reduction of area, substantially as set forth.

In testimony whereof we, the said CHARLES Y. WHEELER and FRANK L. SLOCUM, have hereunto set our hands.

CHARLES Y. WHEELER.
FRANK L. SLOCUM.

Witnesses:
ROBERT C. TOTTEN,
JAMES I. KAY.