UNITED STATES PATENT OFFICE.

JOHN STEVENSON, JR., OF SHARON, PENNSYLVANIA.

METALLURGICAL PRODUCT OR ALLOY.

SPECIFICATION forming part of Letters Patent No. 714,618, dated November 25, 1902.

Application filed September 30, 1902. Serial No. 125,432. (No specimens.)

To all whom it may concern:

Be it known that I, JOHN STEVENSON, Jr., a citizen of the United States, residing at Sharon, Pennsylvania, have invented certain new and useful Improvements in Metallurgical Products or Alloys, of which the following is a specification.

In the metallurgy of iron and steel it is a common practice, if not a necessity, to introduce into the molten metal before it is cast certain elements which have been removed from the molten bath during the course of the operations having for their object the production of what is known by the usual term "steel" from pig metal, scrap, ore, or similar materials. The presence of these elements in the steel is necessary and desirable on account of the useful properties they induce in it and without which properties the metal would be useless for the particular purpose intended. Prominent among the elements are manganese, carbon, and phosphorus. Manganese is desirable on account of the property it confers on the steel of rolling without cracking. This is really due to the fact that manganese removes from the steel the occluded oxids formed during the operations, which oxids cause redshortness or cracking under mechanical treatment. Furthermore, the presence of oxids will cause the formation of blow-holes or cavities during the setting or chilling of the molten steel. Steel at high temperature will occlude a large amount of various gases, nearly all of which contain oxygen in combination. On solidifying or chilling the steel is no longer able to hold in suspension or combination a large part of these gases, and then expulsion within the rapidly-solidifying metal leads to the cavities mentioned. The affinity which manganese has for oxygen causes a decomposition of these occluded gases to take place, resulting in the formation of oxid of manganese and certain simple gases. These simple gases are not held in solution so readily by the steel and if released when the steel is at a high temperature and still fluid they are able to escape without causing any deleterious influence. The oxid of manganese formed is a thin cinder at the temperature of the molten steel and rises rapidly to the surface, leaving the steel clean and free. Thus manganese also confers solidity upon steel.

The presence of carbon in steel is desirable on account of the hardness and strength it produces and also the density. Phosphorus is desirable for the same reasons. Hitherto it has been regarded as a very deleterious element in steel, but its real properties are lately becoming recognized. Formerly rails containing a high percentage of phosphorus were looked upon with great disfavor; but the production of phosphorated steel rails at Terre Noire which gave excellent service and the contemporaneous discovery that steel rails in England, noted for their long life, contained upward of 0.30 to 0.40 phosphorus has modified this opinion considerably. It has thus been found that under certain conditions carbon and phosphorus may replace each other within certain limits with most desirable results, as was noted by Bell and other authorities. It has been found that by lowering the carbon and raising the phosphorus the steel is less brittle, gives greater service, and rolls with a better finish. Thus steel containing a considerable proportion of phosphorus when rolled—as, for example, into rails—possesses a desirable surface or "skin," which is not found in lower phosphorus and higher carbon steel. The same effect is noted in the softer grades of steel used, for example, in the manufacture of plates or sheets. Phosphorus produces to a greater extent than carbon a closer and more finished texture and surface in steel, provided the percentage is not excessive. This is found extremely desirable in the manufacture of sheets or tin-plate, where trouble is sometimes encountered due to the sticking of the sheets one to another in the doubled and rerolled packs. The addition of these elements to the steel is made in various ways. The manganese is added in the condition of spiegeleisen or ferromanganese, alloys of iron, and manganese. Manganiferous alloys have a great affinity for carbon. For example, spiegeleisen and ferromanganese contain between five and six per cent. carbon. The addition then of manganese to the molten bath of metal

incidentally and necessarily implies the addition of carbon, so that recarburizing and remanganizing are carried out in one operation. Occasion sometimes requires that the carbon added be excessive in amount, in which case the addition is made by putting carbon in the bath in the form of coke, anthracite, and even bituminous coal. This method of recarburizing, while practicable, is attended with certain disadvantages, as the introduction of carbon in this shape generally causes violent reactions in the molten steel that result in unfavorable conditions in the final product. It has been found that the addition of carbon in the condition of an alloy or in combination with metal is the simplest and most satisfactory method. The addition of phosphorus is likewise attended with disadvantages unless added in the form of an alloy. The natural mineral apatite or calcium phosphate has been used; but the results are not uniform, and the influences on the steel are bad. In the shape of an alloy—as, for instance, ferrophosphorus—the addition is much simplified and the results much more satisfactory. Hence up to the present time recarburizing, remanganizing, and rephosphorizing have been obtained by adding to the bath at least two different materials and ordinarily three. This is disadvantageous, because the operations are complicated and the amount of material added is excessive on account of the low percentage of concentration of the desirable elements in the medium through which they are added. This means that a great deal of inert material is introduced to no purpose but the chilling of the metal and the production of disturbing influences that tend to destroy uniformity.

By the use of the metallurgical product—an alloy which I have discovered—I combine the three desirable elements—manganese, carbon, and phosphorus—in one in a highly-concentrated condition. I exclude as far as possible the inert material usually present in such products—as, for instance, the iron in ferromanganese and ferrophosphorus—and make use of the manganese itself as a medium for the introduction of the other two elements—phosphorus and carbon. I concentrate the phosphorus and carbon in the manganese almost to the point of saturation.

It is well known that manganese and phosphorus separately will combine with iron in any and all proportions. Thus ferromanganese consists, roughly, of eighty per cent. manganese, six per cent. carbon, and fourteen per cent. iron, including impurities. Spiegeleisen contains twenty per cent. manganese, five per cent. carbon, and seventy-five per cent. iron, including impurities. Both of these alloys contain phosphorus in very small proportions only—for example, less than one per cent. Ordinary pig-irons contain both manganese and phosphorus in relatively small proportions with iron, the upper limit for phosphorus being about four per cent. and the manganese two to three per cent. The carbon in pig-iron runs about four and one-half per cent. Phosphorus and iron will readily combine in many proportions. For example, the commercial product ferrophosphorus is known, containing upward of twenty-five per cent. phosphorus and seventy-two per cent. iron, including impurities. The carbon is two to three per cent.; but the manganese is about one per cent. only. These examples are cited to show that there is in use no combination of the three elements—manganese, phosphorus, and carbon—such as I propose. The alloy of these three elements which I have discovered and made consists of about sixty-eight per cent. manganese, twenty-five per cent. phosphorus, five per cent. carbon, and two per cent. impurities, including iron. The manganese is sometimes replaced to the extent of upward of five per cent. by iron; but this is dependent on the purity of the raw material used. This alloy is made by the use of highly-phosphoric manganese ores and can be produced by smelting in the blast-furnace, reverberatory, or electric furnace in connection with carbon and a flux. If the ores are not phosphoric enough to give the desired state of concentration of the phosphorus, various phosphoric substances, such as calcium phosphate or apatite, can be introduced as a flux. The metal so produced and having the above-described composition resembles ferromanganese, but has a more columnar or acicular structure, is much more brittle, and more readily fusible. Hence its introduction into a bath of metal abstracts less heat, and in addition it confers on the molten steel fluidity and "quietness," due to the phosphorus. By the use of this alloy I thus simplify the process of remanganizing, recarburizing, and rephosporizing considerably, reduce the amount of the addition required, obtain more satisfactory and uniform results, and obviate the addition of a large quantity of inert material, the necessity for which is neither warranted nor desirable.

I do not wish it to be understood as limiting myself to the exact proportions as above stated, as these can be varied at will. I have found, however, that the proportions given produce the best results and are to be preferred over other combinations.

Having thus clearly set forth the object of my invention and described the nature thereof, what I claim is—

1. A metallurgical product or alloy containing the elements manganese, phosphorus and carbon in relatively large proportions, substantially as described and for the purpose set forth.

2. A metallurgical product or alloy containing manganese, phosphorus and carbon in a highly-concentrated state in combination with a relatively small proportion of iron and impurities, substantially as described.

3. The metallurgical product or alloy containing about sixty-eight per cent. manganese, twenty-five per cent. phosphorus, five per cent. carbon and two per cent. impurities including iron, substantially as described.

In testimony whereof I affix my signature in presence of two witnesses.

JOHN STEVENSON, JR.

Witnesses:
W. H. LEWIS,
K. J. STEINER.