UNITED STATES PATENT OFFICE.

JULIUS BAUR, OF NEW YORK, N. Y.

IMPROVEMENT IN THE MANUFACTURE OF STEEL.

Specification forming part of Letters Patent No. **49,495**, dated August 22, 1865.

To all whom it may concern:

Be it known that I, JULIUS BAUR, of the State, county, and city of New York, have invented a new and useful Improvement in the Manufacture of Steel; and I hereby declare that the following is a full, clear, and exact description of the same.

No drawings accompany this specification, for the reason that the nature of the case does not admit of drawings.

This invention is applicable both to the making of steel in the ordinary steel-makers' crucibles and to making it in the large way by what is known as the "Bessemer" or "pneumatic" process.

It consists in combining the metal known as "chromium" with the iron which is to be converted into steel, whereby the steel produced is greatly improved and rendered tougher and harder than it would otherwise be.

One leading object of my invention is to dispense with the use of manganese, tungsten, (wolfram,) or other similar or analogous substance, in any form whatever in the making of steel, and at the same time to produce as good or better quality of steel than can be made by the use of any of said last-referred-to substances, whether said substances be used alone or combined together.

It is believed that chromium does not exist in nature in a pure metallic state, but only in the form of an oxide of chromium or chrome ore; and in order to obtain it in the proper condition to be made available by my process it is necessary to reduce the chrome ore to metallic chromium. For this purpose I effect the reduction by taking the requisite quantity of chrome ore and presenting to the oxide contained in it a sufficient amount of carbon to remove the oxygen and leave the chromium in a pure or nearly pure metallic state. I prefer, in doing this, to use a quantity of carbon somewhat in excess of whatever quantity of chrome ore I operate upon, in order that I may be as sure as possible to remove every particle of oxygen from the ore. I prefer that the chrome ore should first be pulverized or granulated as finely as possible—the finer the better—and that the charcoal which furnishes the carbon should be finely powdered. I then prefer to mix them together thoroughly before heating them, and then to put them, thus mixed, into an ordinary crucible; or, if large quantities are required to be reduced, they may be heated, if desired, in a puddling-furnace, blast-furnace, or furnace or vessel of any other suitable description. Upon being heated the carbon will combine with the oxygen and set free the metallic chromium, in the form of shots and small lumps, by a reaction well known to chemists. After the metallic chromium has been thus produced it must by sifting and washing, or other suitable means, be thoroughly separated from the small adhering particles of the coal used in heating the contents of the reducing-vessel, and when thus separated I take the requisite quantity of it, together with the requisite quantity of carbon, and add it in the crucible or other vessel to the iron to be converted into steel. To explain what this requisite quantity will be I will state my respective methods of procedure in making different kinds or qualities of steel:

For tool-steel of superior quality I take about five pounds of the metallic chromium and about five ounces of powdered charcoal to every one hundred pounds (more or less) of puddled iron of proper steel-making quality.

Instead of the powdered charcoal white pig-iron or other suitable carbonaceous matters may be employed; but when I use the white pig-iron I take about eight pounds of it to every one hundred pounds (more or less) of puddled iron, the proportion of chromium remaining the same. If pure graphite be employed as a carbonizer, I use the same quantity as of powdered charcoal—namely, about five ounces. If bone-dust be used, I take about two ounces of it combined with about three ounces of powdered charcoal to every hundred pounds (more or less) of puddled iron and every five pounds of metallic chromium. From these examples it will be evident that when still other suitable carbonaceous matters are desired to be employed the proper proportions and mixtures for each can readily be ascertained by those skilled in the art.

In melting the metallic chromium and puddled iron, as above described, I use about ten ounces of common salt, or fluor-spar, or about six ounces of cryolite, or any other suitable flux. The cryolite is, however, somewhat liable to injure the melting-vessel by reason of the action of the sodium contained in the cryolite; but this injury does not take place to any serious extent.

For a good quality of spring-steel I would

recommend about three pounds of metallic chromium and about four ounces of powdered charcoal to every hundred pounds (more or less) of puddled iron, the flux to be used being the same as above mentioned.

If white pig-iron be employed as a carbonizer for spring-steel in place of powdered charcoal, I take about six pounds of it to every hundred pounds of puddled iron, and if still other carbonizers are desired, the proportions and mixtures for them may be determined from the examples above stated in reference to tool-steel.

For a quite low steel I employ about three pounds of chromium and about one ounce of charcoal to each one hundred pounds (more or less) of puddled iron, the flux remaining the same as specified above. If white pig-iron be used for the carbonizer of this low steel, I take about one pound and a half of it, and for other carbonizers I determine the proportions and mixtures in the manner above directed.

Instead of using puddled iron cast-iron may be employed; but this, of course, will produce a poorer steel. When cast-iron is employed it will be necessary to use oxide of iron with it in order to remove the excess of carbon in the cast-iron over what is required for steel. This oxide of iron I employ either by itself or in the form of a hematite or magnetite iron ore; but if ore be used it must be very pure. I prefer to remove, by the oxide of iron, so much of the carbon in the cast-iron that there shall be only about one and one-half per cent. of carbon remaining in it when tool-steel is to be made, and only about one per cent. when spring-steel is to be made, and only about one-quarter to half of one per cent. when low steel is to be made.

It will of course be understood that when cast-iron is used no charcoal or other additional carbonizer is required. It will also be understood that the same fluxes are to be used with cast-iron as with puddled iron.

My method has been thus far described as applicable to the making of steel in crucibles; but when it is desired to make steel in large quantities or masses substantitally the same mode of procedure may be advantageously employed in reverberating furnaces, or in any other kind of furnace or vessel in which the fuel does not come in contact with the charge to be converted into steel.

When thus making steel in large quantities I employ the same proportions of the metallic chromium and of fluxes as I have already specified for use in crucibles; but I employ the chromium in a different form, and, instead of puddled iron, I take cast-iron, which, in the process of making the steel, should be decarbonized by the now well-known Bessemer or pneumatic process, the chromium uniting with the iron in the course of the operation, and having the effect of greatly improving the quality of steel which could be made by the pneumatic process alone without such union, and thus constituting a highly beneficial substitute for spiegeleisen, franklinite, or a triple compound of iron, carbon, and manganese, which have heretofore been deemed essential to be used in connection with the pneumatic process.

To carry out this part of my improvement I prefer, previous to uniting the chromium with the charge of melted iron in the pneumatic converter, to prepare it in the form of pigs, which shall consist of a triple compound of iron, carbon, and metallic chromium. For this purpose I prefer to take about four hundred pounds of chrome ore to about six hundred pounds of a good hematite or magnetic iron ore, free, or nearly free, from sulphur and phosphorus, and, after finely powdering or granulating these ores, to mix them thoroughly together and smelt them in an ordinary blast or cupola furnace in the manner usually practiced in smelting iron ores, and after the smelting has been performed I run the melted metal into pigs in the common way. I prefer that the composition of these "chromium pigs," as they may be termed, shall be such that they shall consist of, say, from fourteen to eighteen per cent. of metallic chromium, about seventy per cent. of iron, and from about four to about six per cent. of carbon. The proportions of four hundred pounds of chrome ore to six hundred pounds of the hematite or magnetite ore will usually yield about the above-stated percentages of metallic chromium and iron in the pigs; but in order to secure the above-stated percentage of carbon in the pigs it is necessary to observe the nature of the hematite or magnetite ores operated upon and how much carbon the particular ore used contains, and when this is known sufficient carbon can be removed or introduced during the operation of smelting, as well known to iron masters, to make the resulting amount of carbon in the pigs the percentage above specified. After these chromium pigs or triple compound of iron, carbon, and chromium have been thus prepared, I introduce the requisite quantity of them into the pneumatic converter in the manner and at that stage of the process at which spiegeleisen or franklinite are now usually added. The proportions of this triple compound which I prefer are from six to ten or twelve per cent., or thereabout, of the said triple compound to the charge of metallic iron in the converter. These proportions may, of course, be varied according to the quality of steel required. For instance, about six per cent. of the triple compound will produce a good low steel, and about ten per cent. will produce a good high steel, and intermediate grades of soft and hard steel may be produced between these extremes by varying the percentage of the triple compound, according to the option of the operator.

It will, of course, be understood that in using my invention in making steel in crucibles other grades and qualities of steel of different de-

grees of hardness can be made by varying the proportions of the chromium and carbon employed with the iron; but the examples I have given will answer a good purpose, and will serve to illustrate my improvement.

The use of my invention in connection with the pneumatic process will be found to entirely obviate the difficulties heretofore met with in making steel by that process on account of such steel proving more or less incapable of extension by hammering or rolling at any temperature, or on account of the bars formed from it having cracks or flaws in them, or being sometimes "hot short" and sometimes "cold short," or possessing other defects.

I do not confine myself to the above-described method of producing the chromium pigs or triple compound of iron, carbon, and chromium, as the same may be produced in other modes; but the one which I have specified will be found successful and will exemplify my improvement.

It will be observed that in this process of making or improving steel I dispense entirely with manganese, tungsten, (wolfram,) titanium, or other analagous substances, and I believe that I am the first to establish the fact that metallic chromium can be used practically in making steel for all purposes, and also the first to show that it can be successfully used alone and without being combined with any of the other substances named for producing steel of a superior excellence.

Having thus described my improvements, what I claim as new, and desire to secure by Letters Patent, is—

1. Combining metallic chromium with iron for the purpose of producing or improving steel in crucibles, substantially in the manner set forth.

2. Combining metallic chromium with iron for the purpose of producing or improving steel made by the pneumatic process, substantially in the manner set forth.

3. A triple compound of iron, carbon, and chromium, substantially such as and for the purposes set forth.

JULIUS BAUR.

Witnesses:
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