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E. STRAUB.

ART OF PRODUCING AND REFINING METALS, METALLOIDS, AND ALLOYS.

APPLICATION FILED JAN. 14, 1902.

NO MODEL.

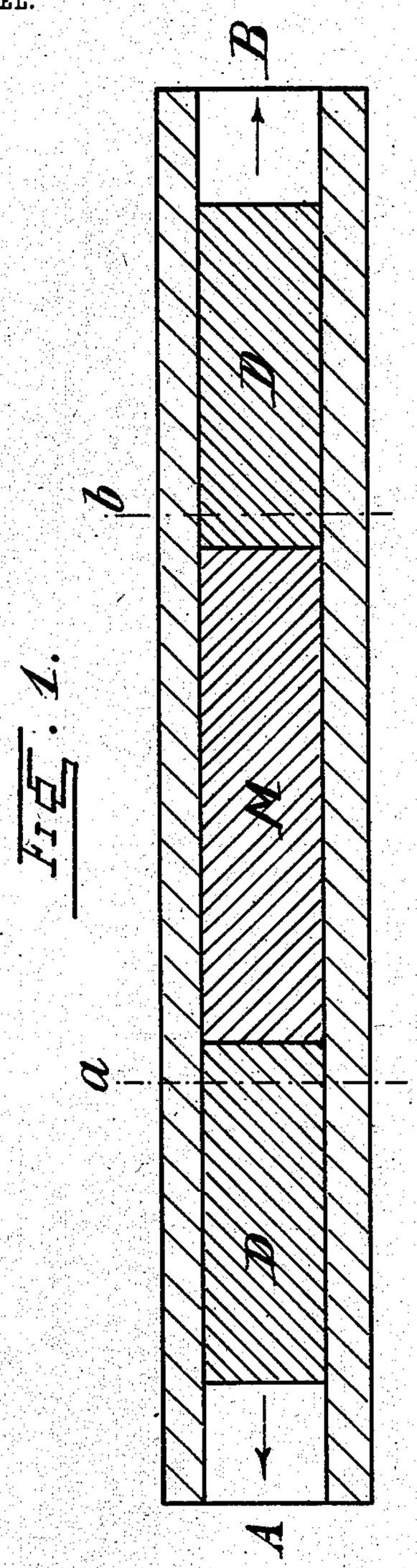

FIG. 1.

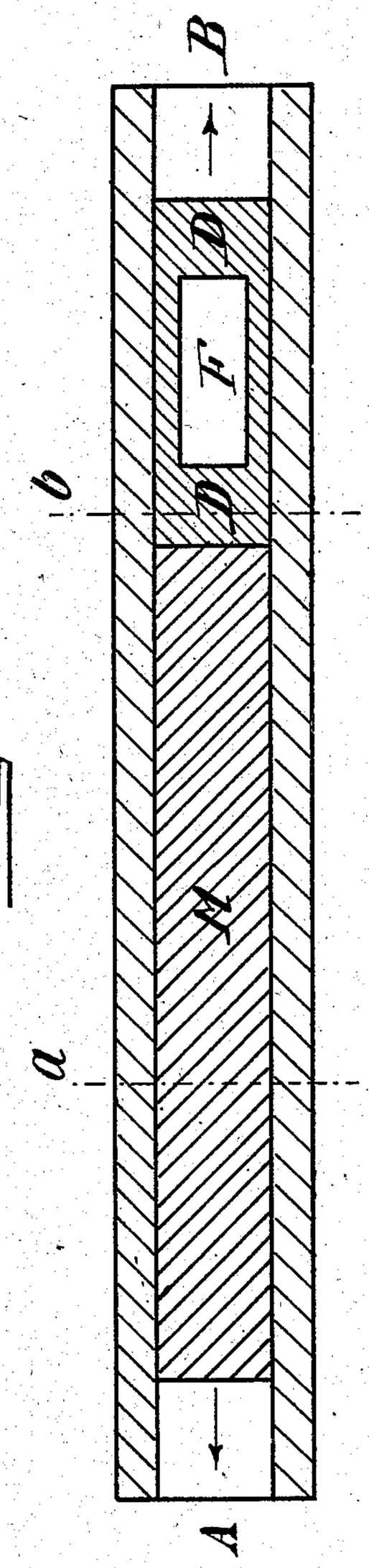

FIG. 2.

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EUGEN STRAUB, OF NUREMBERG, GERMANY.

ART OF PRODUCING AND REFINING METALS, METALLOIDS, AND ALLOYS.

SPECIFICATION forming part of Letters Patent No. 721,638, dated February 24, 1903.

Application filed January 14, 1902. Serial No. 89,747. (No specimens.)

To all whom it may concern:

Be it known that I, EUGEN STRAUB, a subject of the German Emperor, residing at Nuremberg, in the Kingdom of Bavaria, German Empire, have invented a certain new and useful Process of Producing and Refining Metals, Metalloids, and Alloys, of which the following is a description.

The essential object of the present invention is to obtain or recover pure, particularly carbon-free, metals, metalloids, as also alloys of the same, on a large scale. Products of this class—such as manganese, chrome, iron, ferromanganese, ferrochrome, tungsten, ferrowolfram, molybdenum, and others—have been obtained or recovered for years; but it has not been possible up till now to obtain or recover the same entirely free from carbon, not even by mixing them with the corresponding oxid and repeatedly remelting them. According to the present invention the pure metals entirely free from carbon may be obtained or recovered on a large scale. The process also enables every metal to be won in reguline form, which has hitherto been impossible in the case of many metals and metalloids. By means of the present process it is also possible to obtain or recover at the same time clear fluxes entirely free from carbon of substances or bodies which it has hitherto been very difficult to fuse, and these fluxes may, if desired, be colored by adding suitable coloring agents.

The process consists, essentially, in allowing the vapors of the metals or metalloids to act upon the corresponding oxid in that the vapors, produced in any suitable manner, are allowed to pass over a molten layer of their oxid and then condensed in a loose layer of the same oxid.

The process, which has proved very advantageous for working on a large scale, is carried out in the following manner:

Reference is had to the accompanying drawings, showing in Figures 1 and 2 two diagrams, according to which the carrying out of the process will be rendered more easily intelligible.

A tube A B, Fig. 1, is charged in the following manner: The space M is charged with the reducing mixture or with pieces of the metal to be produced or refined. The spaces D D are loosely filled with the corresponding oxid. After this has taken place the part of the tube lying between the lines *a b* is heated in a suitable manner and to a sufficient degree to produce vapors of the product to be obtained. According to the height of the temperature employed the ends of the oxid layers D D next to the layer M will fuse to a greater or less thickness, while the remaining part of the said oxid layers will remain in a loose state. The metal vapors pass through the molten oxid layers, during which passage all the carbon they may contain will be given off to the said layers, and the said metal vapors will condense in the loose part of the oxid layers. A metal produced or refined by this process contains no carbon whatever nor any traces of the same. The molten oxid layer becomes perfectly clear during the process, and, what is of essential importance, it is entirely free of carbon impurities, a great advantage in the case of oxids fusing at a very high temperature. It has not been possible hitherto in the furnaces employed in large factories to produce fluxes of such clearness. The metal penetrates far into the oxid layer and will be found in the loose part of the same in the form of irregular reguline pieces of various sizes. When the reaction has been completed, which will be the case when the gases cease to escape from the tube, the latter is allowed to cool down and may then be emptied.

In order to illustrate the invention, I will now describe the process as it is carried out in refining manganese—*i. e.*, in producing manganese entirely free of carbon. The ordinary manganese of commerce, which always contains carbon, is disintegrated and the space M filled with the pieces. The spaces D D are filled with pure oxid of manganese in a loose condition, which is most advantageously effected by making a thick fluid mass of manganic oxid mixed with water. The tube is then heated to a temperature high enough to cause the raw manganese to vaporize. The ends of the manganic oxid layers next to the raw manganese fuse to a flux, while the rest of the said oxid layers remain in a loose state after the water has been vaporized. The vapors of the raw manganese pass through the molten oxid zones, giving off all their carbon and condense in the loose part of the said

oxid layers. By this process the molten manganic oxid zones will become perfectly clear, since these and the manganese vapors exercise a purifying action one upon the other. The manganese obtained in this manner, which is entirely free of carbon, has a considerably higher value than the raw manganese, while the clear manganic oxid flux may be utilized for ceramic purposes.

In the same manner as raw manganese the following products containing carbon have been refined—viz., chromium, iron, ferromanganese, ferrochrome, and chromium copper.

If it is required not merely to refine but to obtain or recover a metal, metalloid, or alloy, the space M—for instance, in obtaining manganese—would be filled with a mixture of manganic oxid and carbon. The other parts of the tube remain unaltered in the case of raw manganese. The whole is then heated to such an extent that the carbon reduces the manganic oxid to manganese, forming carbonic oxid, the manganese being vaporized. In this case the manganese is refined in the same manner as the raw manganese, while the carbonic oxid passes through the raw manganic oxid layers and escapes. The action is exactly the same in obtaining or recovering chromium from a mixture of chromic oxid and carbon, ferrochrome from a mixture of chromic oxid, ferric oxid, and carbon or chromic oxid, iron, and carbon, or boron from boric acid and carbon, or silicon copper from quartz, copper, and carbon or from quartz, copper, and silicon carbid (carborundum) or from quartz, copper oxid, and silicon carbid, and of many other metals, metalloids, and their alloys.

In the case of many metals, metalloids, and alloys it is desirable to produce the same in the furnace in the shape or form in which they are subsequently employed or, in other words, to "cast" the same during production in the furnace to the required form. This is of particular importance in the case of metals having a very high fusing temperature or being easily combustible. This object is attained in a very simple manner by forming hollows or recesses in the loosely-packed oxid layer having the shape to which it is desired to mold the metal produced. The diagram in Fig. 2 illustrates this method of carrying out the invention, the mold F being formed in the oxid layer. By this arrangement the furnace is, as it were, double-walled. The metal collects in the mold and gradually fills the same up. By employing this method the furnace may be adapted for working continuously. If the temperature is kept high enough to retain the metal in the mold F in a molten state, the said mold may be tapped through the outer wall of the layer D, the tube being recharged at the end A. In this case the end A of the tube is advantageously provided with a double charging closure of any known construction to prevent the escape of gases while charging.

It will be obvious that the diagrams are merely utilized to render the explanation of the process easily intelligible. They are diagrams only and do not necessarily represent the construction of the furnace. The oxid refining or condensing layer or zone may also be entirely or partially replaced by any suitable combination of the metal to be obtained or recovered with oxygen—for instance, by its hydroxid or carbonate in some cases, by its nitrate, or by any salt of the corresponding metallic acid.

A particular advantage of the process is that compact pieces of any desired size and shape may be produced of such metals, &c., as it has hitherto been impossible to produce in economical manner on a large scale, nor has it been possible to produce the same in the necessary shape and size at all. A most striking example for this fact is the obtaining of pure aluminium. For instance, if a mixture of aluminium oxid and carbon is heated no aluminium will be obtained, but at the best only aluminium carbid. I carry the heat to such a degree that the aluminium carbid is vaporized, and the vapors produced are forced through a layer of alumina or aluminium oxid. In this manner the aluminium carbid loses its contents of carbon and pure aluminium is condensed. Another striking example of the process is the obtaining of pure or practically carbon-free silicon. Hitherto it has been only possible to obtain silicon in small crystals by means of a difficult and expensive process. I obtain it easily in the form of compact pieces of any desired size and shape by heating a mixture of quartz and carbon to a very high temperature and forcing the vapors obtained into a layer of quartz. The production of boron is similar. It is obtained by heating a mixture of boric acid and carbon and forcing the vapors of the same through a layer of boric acid. An alloy of aluminium and magnesium is produced by heating a mixture of alumina, magnesia, and carbon and forcing the vapors of the same into alumina or magnesia or into a mixture of both oxids, and the production of an alloy of aluminium and calcium is effected by heating a mixture of alumina and burnt lime and carbon and forcing the vapors into a layer of alumina.

I claim as my invention—

1. A process for treating metals, metalloids and alloys which consists in passing the vapor of the metal, metalloid or alloy under treatment through a fused zone of a combination of the said metal, metalloid or alloy with oxygen, and condensing, in the manner and for the purpose substantially as described.

2. A process for treating metals, metalloids and alloys which consists in passing the vapor of the metal, metalloid or alloy through a fused zone of a combination of the said metal, metalloid or alloy with oxygen and condensing the said vapor on the farther side of the said zone in the loose mass of the said

combination in the manner and for the purpose substantially as described.

3. A process for treating metals, metalloids and alloys, which consists in passing the vapor of the metal, metalloid or alloy through a fused zone of a combination of the said metal, metalloid or alloy with oxygen and condensing the same in a mold or recess formed in the non-fused mass of the said combination at the farther side of the said zone in the manner and for the purpose substantially as described.

4. A process for treating metals, metalloids and alloys which consists in passing the vapor of the said metal, metalloid or alloys through a fused zone of the said metal, metalloid or alloy, condensing the same at the farther side of the said zone in a mold or recess formed in the non-fused mass of the said combination and in drawing off the metal condensed in the said mold or recess in the manner and for the purpose substantially as described.

5. A process for treating metals, metalloids and alloys, which consists in passing the vapor of the said metal, metalloid or alloy through a fused zone of the corresponding oxid of the said metal, metalloid or alloy and condensing at the farther side of the said zone in the manner and for the purpose substantially as described.

6. A process for treating metals, metalloids or alloys which consists in passing the vapor of the said metal through a fused zone of the corresponding oxid of the said metal, metalloid or alloy, forming a mold or recess in the non-fused mass of the said oxid and condensing the said metal, metalloid or alloy vapors in the said recess in the manner and for the purpose substantially as described.

7. A process for obtaining or recovering metals, metalloids and alloys and for refining the same, which consists in passing the vapor of the said metal, metalloid or alloy through a fused zone of its oxid, forming a mold or recess in the non-fused mass of the said oxid, retaining the metal in the said mold or recess in a molten state and drawing off from the said mold or recess in the manner and for the purpose substantially as described.

8. A process for treating metals, metalloids and alloys, which consists in arranging in a furnace a zone of the raw metal, metalloid or alloy to be treated, and adjacent zone of a suitable combination of the said metal, metalloid or alloy with oxygen, heating the raw metal zone until the metal, metalloid or alloy vaporizes and a fused zone of the oxygen combination of the same has been produced and passing the said vapor through the said fused zone and again condensing in the manner and for the purpose substantially as described.

In witness whereof I have hereunto set my hand in presence of two witnesses.

EUGEN STRAUB.

Witnesses:
ALOIS GOBANZ,
OSCAR BOCK.