

# UNITED STATES PATENT OFFICE.

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## PROCESS OF EXTRACTING METALS FROM METALLIC OXIDS.

SPECIFICATION forming part of Letters Patent No. 610,014, dated August 30, 1898.

Application filed April 20, 1897. Serial No. 633,061. (No specimens.) Patented in Germany June 30, 1896, No. 93,744, and November 24, 1896, No. 94,405; in England January 12, 1897, No. 859; in Belgium January 30, 1897, No. 125,596, and in France April 20, 1897, No. 262,994.

*To all whom it may concern:*

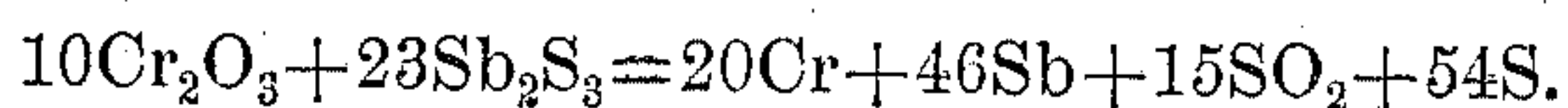
Be it known that I, HEINRICH C. ASCHERMANN, a subject of the German Emperor, residing at Cassel, Germany, have invented certain new and useful Improvements in Extracting Metallic Alloys and Pure Metals by Electric Heat, (patented in Germany November 24, 1896, No. 94,405, and June 30, 1896, No. 93,744; in France April 20, 1897, No. 262,994; in Belgium January 30, 1897, No. 125,596, and in Great Britain January 12, 1897, No. 859;) and I do hereby declare that the following is a full, clear, and exact description of the invention, which will enable others skilled in the art to which it appertains to use the same.

In electric furnaces the extraction of pure metals from their oxids presents considerable difficulties when the metals have great affinity for carbon. There results in that case a carburet or a metal containing a large proportion of carbon, and it becomes necessary, in consequence, to add a very fusible metal as a flux, which combines with the reduced metal in the nascent state and prevents it, accordingly, from absorbing carbon; but that alone is not sufficient. In order to obtain a metal as nearly as possible free from carbon, it is essential that the reduction should be effected rapidly and that it should be produced by the weakest possible currents. That is indispensable, even when no regard is paid to the question of economy. I have never succeeded in obtaining the metal reduced to a state of purity by the prolonged action of the voltaic arc or by the use of more intense currents. The flux volatilizes and is immediately replaced by the carbon of the electrodes. The reduced metal becomes saturated with carbon proportionately to the volatilization of the flux. The flux has little or no influence on the course of the reduction. It serves simply to prevent the entry of carbon into the combination. If, however, a metallic sulfid is taken as a flux, the reduction is effected more rapidly and with less expenditure of thermo-electric energy. It will be seen that it is the sulfur which favors the reaction.

If it is desired to obtain a pure metal, the

sulfid of a very fusible metal is taken as a flux, which can easily be volatilized and driven off from the resulting alloy by reheating. Experiments have shown that the best results are obtainable by the use of sulfid of antimony, ( $\text{Sb}_2\text{S}_3$ .) The mixture of the metallic oxid with the metallic sulfid is produced in simple atomic proportions, the sulfid, however, being slightly in excess. The mixture is interposed in the circuit of an electrical fusion-furnace. The mixture to be reduced forms the negative pole of the arc, because the greatest heat is there developed. A carbon stick or bar may be inserted in the mixture and the positive wire connected with it, while the negative wire will be attached to the base of the furnace. The current employed may have the proportion of seven amperes to one volt or multiples of the same—thus, fourteen amperes to two volts or twenty-eight to four. If large quantities are to be melted, even three hundred and fifty amperes may be required, but fifty volts will not be. The voltage should be kept as low as possible.

By way of example: To extract metallic chromium, chromium oxid and sulfid of antimony are mixed in the proportion of ten to twenty-three. The antimony is driven from the resulting alloy by reheating, and what remains is pure chromium. The reaction may be theoretically expressed as follows:



This, however, is only correct so far as the formation of an indefinite quantity of alloy of the chromium and antimony is concerned, with antimony in excess, for in the upper part of the furnace in which the operation is carried on there may be deposited some crystals of the oxid of antimony, the sulfid of antimony, and chromic oxid, which would greatly modify the above reaction. It is sufficient to know, however, that an alloy of relatively pure chromium and antimony will be formed as a residuum in the lower part of the furnace, and that the more volatile of these elements (the antimony) may be driven off by subsequent heating. For the oxid of aluminium the proportion is ten for thirty-seven of sulfid of antimony. The mixture, being

placed in an iron crucible, is interposed in the electric circuit, and as soon as the fusion commences oxid of aluminium and sulfid of antimony are added in the above proportions.

5 The use of sulfid of antimony as a flux is also recommended for reducing the greater number of metals for the fusion of which a high temperature is necessary, because the reaction is considerably accelerated by the  
10 sulfur, and the amount of energy necessary is very considerably diminished.

Having fully described my invention, what

I claim, and desire to secure by Letters Patent, is—

The process of extracting metals from metallic oxids, which consists in adding to such  
15 oxids the sulfid of antimony in greater proportion than the oxid, and then subjecting the mixture to electric currents, as specified.

HEINRICH C. ASCHERMANN. [L. S.]

Witnesses:

HERMANN MENCHE,

HERMANN AREND.