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E. VIEL.

PROCESS OF OBTAINING METALS AND ALLOYS BY REDUCTION.

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Fig. 1.

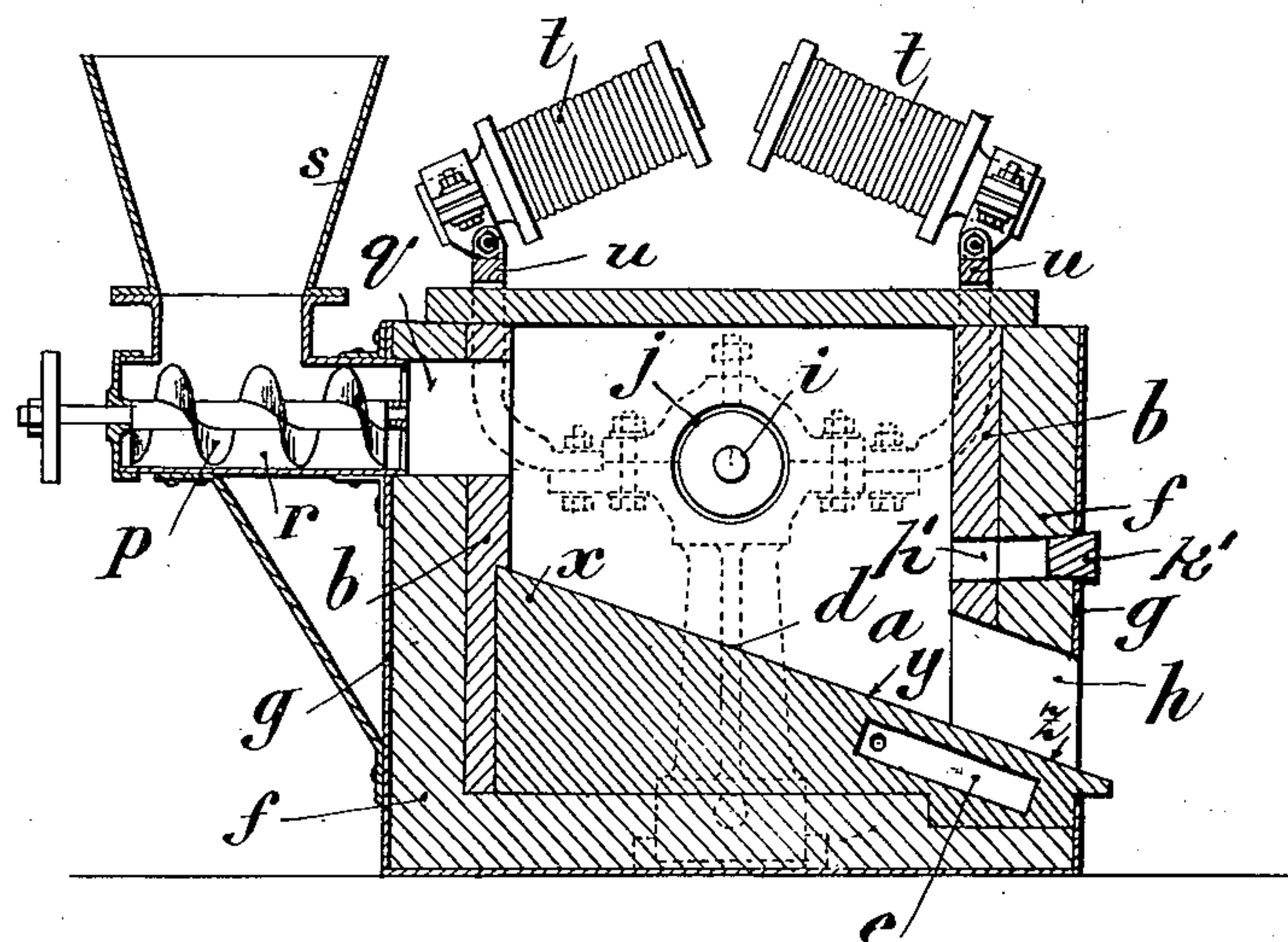
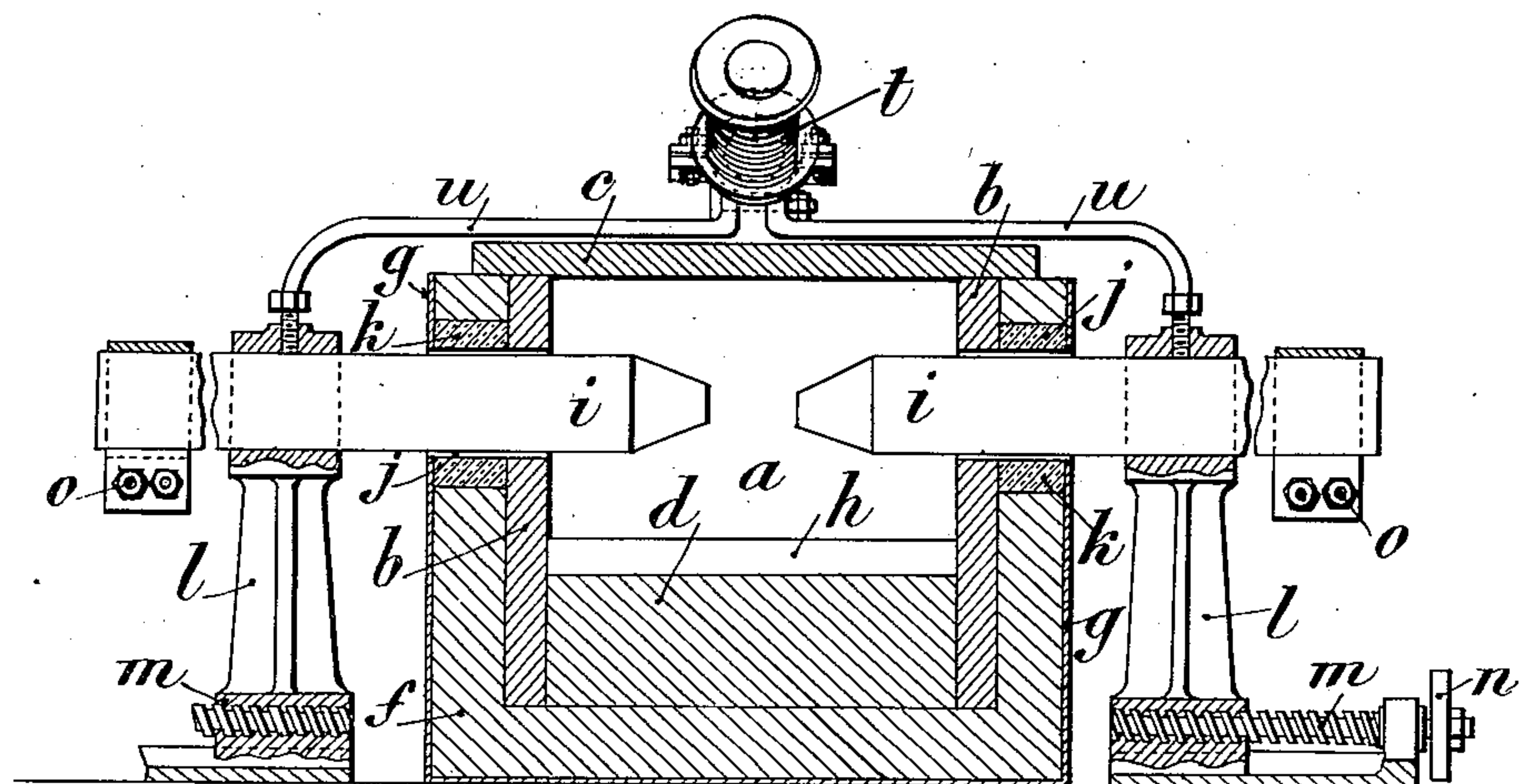


Fig. 2.



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Specification of Letters Patent.

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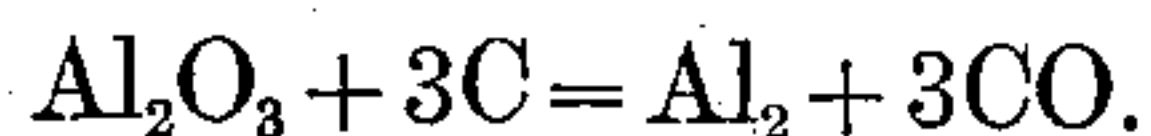
Application filed October 31, 1906. Serial No. 341,494.

To all whom it may concern:

Be it known that I, EMILIE VIEL, a citizen of the Republic of France, and residing at Rennes, France, have invented a new and useful Process of Obtaining Metals and Alloys by Reduction, which is fully set forth in the following specification.

This invention has for its object a process of obtaining all metals and alloys and in particular aluminium, silicon, magnesium, chromium, etc. by reduction of their oxids.

Hitherto numerous attempts have been made by scientists and engineers to reduce in the electric furnace the refractory oxids, such as alumina, silica, magnesia, and chromite etc. for the purpose of obtaining the corresponding metals. These attempts have not been successful because the inventors who have taken up this question have failed to realize the necessary conditions in their processes and their apparatus. The first of these conditions is to raise to the formation temperature, that is to say approximately to the decomposition temperature, all the compounds of the known metals, and at this moment to cause the intervention of a body capable of absorbing the oxygen, if an oxid is being treated, the chlorine, if a chlorine is being treated and so forth. In the most general case where oxids have to be treated, the appropriate reducing agent is carbon. In order to comply with this condition, it is necessary to have an apparatus permitting of obtaining a sufficiently high temperature. The second condition is to form beforehand with the reducing agent, such as carbon, preferably in the form of charcoal, as perfect a mixture as possible, which result may be obtained by employing these bodies in a very finely pulverized condition; the proportions of the mixture should then be such as are indicated by the equations of the chemical reaction, for example:—



In the third place care should be taken that when the mixture has been raised to such a temperature that decomposition has taken place, the metal liberated should immediately be conducted from the excessively hot decomposition zone into another relatively cold zone which is at a temperature lower than the volatilization temperature of the separated metal. For example, in the case of alumina, which is decomposed by carbon at a temperature of about 3,000° and gives

aluminium, the arrangement must be such that immediately after its separation the aluminium is conducted into a zone at a temperature lower than 800°, above which temperature aluminium volatilizes. In this manner, the combination of the volatilized metal with oxygen and the formation of the oxid is avoided. Finally the addition of the mixture of oxid and carbon or other reducing agent should take place progressively, that is to say almost in a continuous manner, and in small quantities, so that it is only necessary immediately to raise to the decomposition temperature of the oxid small quantities of the mixture which is passing into the excessively hot zone and to effect the conduction of the metal into the cold zone very rapidly.

The process in accordance with the present invention therefore consists in subjecting to the decomposition temperature of the oxid or of the compound, and this in a continuous manner, small quantities of the mixture, which is very intimate and appropriately proportioned, of the oxid or the compound with the reducing body, the metal or alloy arising from the decomposition being immediately conducted in an appropriate manner into a sufficiently cold zone, that is to say a zone at a temperature lower than that of volatilization of the metal or of the metals of the separated alloys for the purpose of preventing combination with the oxygen of the air.

In the following description, a working furnace which satisfies the conditions enumerated above is referred to by way of example and illustrated in the accompanying drawing in which:—

Figures 1 and 2 represent the said furnace in cross-section and in longitudinal section respectively.

The furnace consists essentially of a fusion chamber or crucible *a* with carbon walls *b* provided with a cover *c* likewise of carbon, and with a sole *d* having a very steep inclination (say, 25° to 30°) this sole having at its lower extremity a water circulation *e* extending for example over about one-third of the sole. This chamber or crucible is surrounded by refractory walls or coverings *f* of appropriate thickness, which may be confined in a sheet metal jacket *g*. At the lower part of the wall situated at the lowest part of the sole, a tapping hole *h* of appropriate dimensions is formed, to permit of the discharge

of the metal; there may also be provided above this tapping hole h' a second hole which is ordinarily stopped by a plug k' of refractory material having a carbon extremity, which hole may be used for inspection purposes and for cleaning the sole.

Two electrodes $i i$ of circular or rectangular or other cross-section enter the chamber or crucible horizontally in line one with the other, or inclined, these electrodes passing through appropriate apertures j formed in the walls f , considerable play being left between the walls of these apertures and the electrodes, the said apertures being covered with a protecting layer k of magnesia. These electrodes $i i$ are supported by appropriate bearings or supports l , mounted in slideways in such a manner that the electrodes may be caused to advance or recede by appropriately rotating the endless screws m by means of hand wheels n . The object of this arrangement is to permit of a general regulation of the arc, and in particular in accordance with the wear of the electrodes to which the current is conducted and which it leaves at the terminals $o o$. In the wall opposite the wall in which the tapping hole is formed, a charging orifice q is provided, and in continuation of it a conduit r surmounted by a hopper s in which an Archimedean screw p rotates; this screw is operated by hand, or controlled mechanically in any appropriate manner when the furnace acts with a continuous feed. In the median plane perpendicular to the vertical plane passing through the electrodes and above the carbon cover c , two inclined and symmetrical electro-magnets t are jointed on legs u which rest upon projecting bearings on the supports l . These two electro-magnets which may be fed with current in parallel with that of the electrodes, or from an independent source, are wound in such a manner that both of them exert a repelling effect upon the arc, so as to blow it and bring it nearer to the sole. As will be understood, the two effects of these electro-magnets combine themselves in such a manner as to exert a resultant effect, the direction of which may be varied either by acting upon the inclination of one of the electro-magnets or of both at once, or by placing a greater or smaller number of ampere turns in circuit in one of the electro-magnets by means of an appropriate commutator. In this manner it is possible to direct the blown arc for the purpose of locating it in a predetermined zone of the sole, which zone should always be comprised between the points $x y$ marked on the drawing, that is to say outside the cold zone, which is situated above the water circulation e . The reduction process in accordance with this invention is then carried out with this special furnace in the following manner:—

The hopper g is charged with the appropriately proportioned and pulverized mixture

of carbon and oxids or compounds to be reduced, and the said mixture is charged continuously or in small quantities on to the sole by rotating the screw p . The mixture falls upon the inclined sole at its upper extremity and at once reaches the zone of the blown arc the temperature of which may be taken as about 3000° . Under the influence of this high temperature, the oxid fuses and decomposes, and its oxygen combines with the carbon and forms carbonic oxid, which is able to escape freely owing to the play left between the electrodes $i i$ and their entrance apertures, or through apertures which may be formed in the cover. The liberated metal flows off at once and reaches the cold zone $y z$ from which it may be collected in the ingot molds or other appropriate receptacles.

As in all electro-metallurgic operations, it is advisable to preliminarily heat the furnace until the desired temperature is obtained. During the first operation the liberated metal may combine with the carbon of the sole in such a manner as to form a refractory carbide sole.

It will be understood that by means of the furnace which has been described, it is possible to realize the conditions of the process because a continuous or almost continuous admission of the mixture may be obtained, and owing to the very vigorous blowing of the arc by means of exceedingly powerful electro-magnets, it may be concentrated in a given zone as close to the sole as desired and a very high temperature obtained, and further that owing to the inclination of the sole the metal when once it has been separated immediately passes away from the exceedingly hot zone and reaches another relatively cold zone which is obtained as has been indicated by cooling by a water circulation. As stated above this process and this apparatus permit of reducing not only alumina, but also chromite, magnesia and silica. In this latter case, the operation takes place more readily because the volatilization temperature of silicon is 1650° , that is to say much higher than that of aluminium, and the difference between the volatilization temperature and the decomposition temperature (2500°) is much less. With this process, it is also possible to treat silicates or analogous compounds in order to obtain compounds of alloys, such as silico-aluminium, ferro-chromium etc. In order to obtain pure aluminium and silicon from silico-aluminium, it is necessary to heat the silico-aluminium to 700° upon the sole of a reverberatory furnace; the aluminium separates and the silicon remains as residue. The aluminium thus formed still contains 3% of silicon; in order to obtain it pure, the silicon is burned like carbon in a Bessemer retort.

The apparatus herein described forms the subject of the description and claims of my

copending application, Serial No. 399,696, filed October 29th, 1907, and is not herein claimed.

What I claim, is:

5 1. The process of reducing refractory metallic compounds consisting in subjecting a mixture of said compounds and a reducing agent in a continuous stream to the heat of an electric arc directed thereon within a furnace chamber to effect reduction of the com-
10 pound to the metallic state, and then passing the metal so reduced immediately into a cooling zone before it leaves the furnace.

2. The process of reducing alumina to alu-
15 minium consisting in subjecting a mixture of

alumina and carbon in equivalent proportions in a continuous stream to the heat of an electric arc directed thereon within a furnace chamber to effect reduction of the alumina to aluminium, and then passing the metal so reduced into a cooling zone before it leaves the furnace.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

EMILIEN VIEL.

Witnesses:

F. PERRET,
R. HIER.