

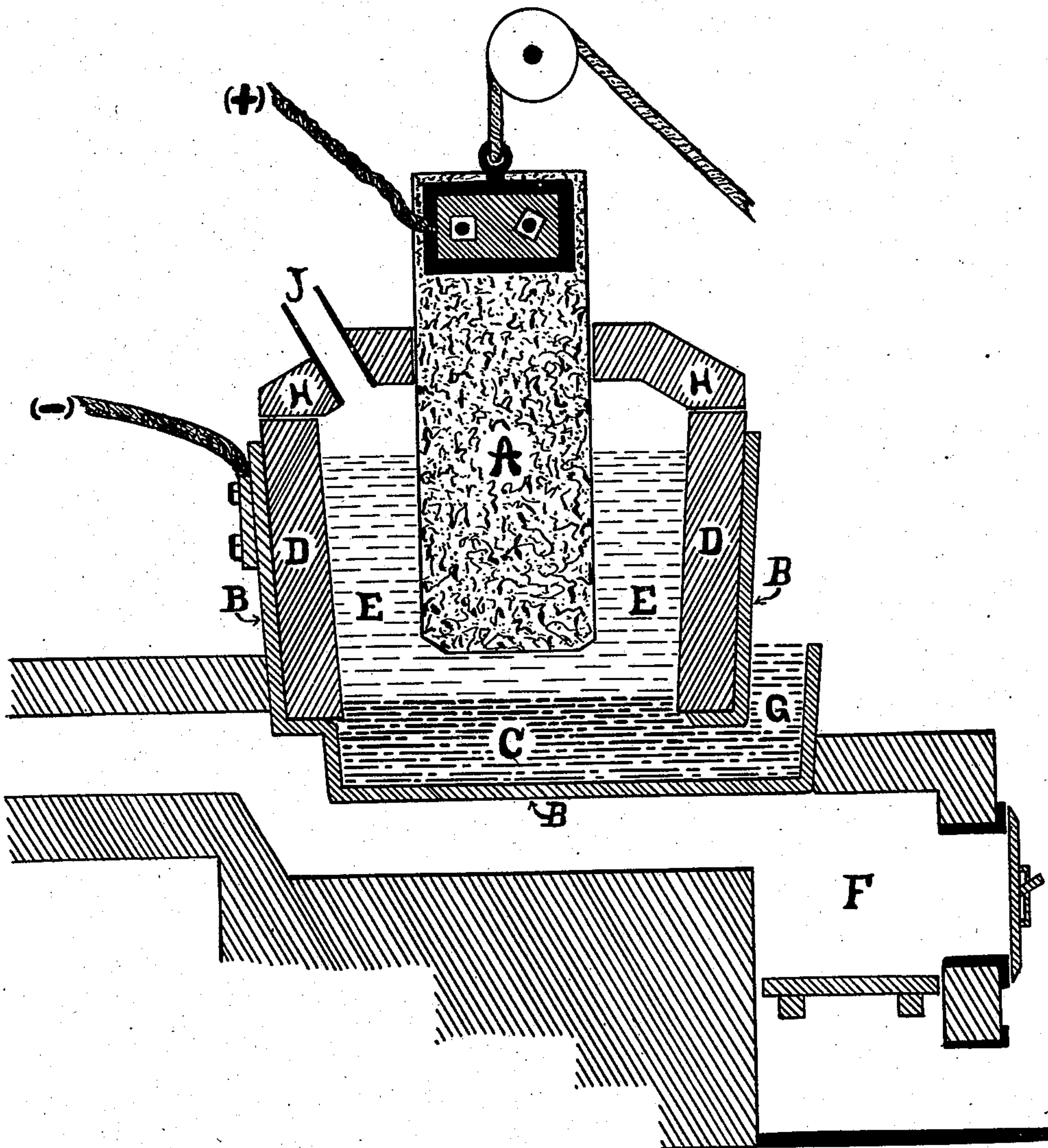
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E. F. KERN.

PROCESS OF RECOVERING METALS FROM THEIR SULFID ORES.

APPLICATION FILED SEPT. 1, 1906.



Witnesses:

William Campbell.  
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Inventor:

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# UNITED STATES PATENT OFFICE.

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## PROCESS OF RECOVERING METALS FROM THEIR SULFID ORES.

No. 885,761.

Specification of Letters Patent.

Patented April 28, 1908.

Application filed September 1, 1906. Serial No. 333,018.

*To all whom it may concern:*

Be it known that I, EDWARD FRANK KERN, a citizen of the United States, residing at Knoxville, county of Knox, and State of Tennessee, have invented certain new and useful Improvements in Processes of Recovering Metals from their Sulfid Ores, of which the following is a specification, accompanied by drawing.

10 My invention relates to processes for the electrolytic recovery of metals from their sulfid ores by means of electrolysis, with the ore as anode in a fused electrolyte.

15 The principal object of my invention is to treat sulfid ores, and recovering therefrom the metals and the sulfur, with good metallurgical recovery, and at low cost.

Other objects will appear in connection with the following description of my method:  
20 I have discovered by experiment that if lead sulfid ore, which is a conductor of electricity, is made the anode in a suitable fused electrolyte, which has a melting point below that of the ore, the lead and associated metals of the  
25 ore may be deposited at, or in, the cathode, while the sulfur, with which the metals are combined, is liberated from the bath, provided the temperature be above the boiling point of sulfur, which is 445° C. Frequently  
30 the naturally occurring galena is too fine, being in the form of concentrates, or is associated with too much gangue material, to be directly suitable for the electrolysis; so I accordingly first melt the ore under a suitable  
35 flux, thus collecting its metal content as a fused matte, which may be cast into suitable blocks or cylinders, and a slag, which contains most of the gangue material. Such blocks or cylinders of cast ore or matte, being  
40 good conductors of electricity, are made the anodes, and also serve the purpose of carrying the current from an exterior conductor to the working surface of the anode. The cast matte consists practically of the sulfids of  
45 lead, zinc, copper, iron, etc., and carries the gold, silver and other values of the ore.

As electrolytes, I prefer to use baths, containing lead chlorid. Fused lead chlorid has considerable dissolving power for lead sulfid,  
50 so the bath is nearly or quite saturated with lead sulfid, giving an electrolyte which is fluid at 500° C.

Other salts may be mixed with the lead chlorid, for example the haloid salts of the  
55 alkalies and alkaline-earths, and zinc chlorid.

I am not restricted to the use of chlorids

for the electrolyte, as the process will evidently succeed also with, for example, the fluorids, and mixtures of haloid salts with alkali hydroxids: the main object being to se- 60  
cure a bath which will melt at the proper temperature, not be too volatile, and conduct the current well.

Regarding the use of mixtures of salts, I have used:—2 parts NaCl + 1 part CaCl<sub>2</sub> + 1 65  
part PbCl<sub>2</sub>; and 1 part NaCl + 2 parts CaCl<sub>2</sub> + 1 part PbCl<sub>2</sub>; and 3 parts NaCl + 1 part PbCl<sub>2</sub>. In all cases the mixtures were saturated, in their molten condition, with lead sulfid. These mixtures were fluid between 70  
500° C. and 650° C.

The electrolysis, and the results, are similar with different suitable baths, or electrolytes; the main difference resulting from the differ- 75  
ent temperatures of working, which depend upon the melting point of the bath, or electrolyte, used.

It is necessary that the melting point of the bath, or electrolyte, be below that of the sulfid ore, in order that the anode remains 80  
solid. It is advantageous to use a bath, or electrolyte, which will melt and remain fluid in the region of 500° C., as a saving in the cost of keeping it molten is thus effected. A bath having a melting point below 450° C. 85  
would be no great advantage, as a temperature of at least 50° above the boiling point of sulfur, which is 445° C., should be maintained in order to effect the rapid removal of the sulfur from the cell by volatilization. 90

The electric current efficiency, I have found in a number of experiments, to vary from 88% to 94%, the electromotive-force usually being about 2.5 volts with an anode current density of about 500 amperes per 95  
square foot. With a current density of about 1200 amperes per square foot, the electromotive-force varied from 4.5 to 6.0 volts. In either case, the distance from anode to cathode was from 1½ to 3 inches. 100

The lead which was reduced at the cathode was malleable, and free from sulfur, at least for all practical purposes, and the sulfur liberated at the anode was free from chlorin and sulfur chlorids. 105

I am enabled by my process to also recover the zinc occurring in lead ores. The zinc accumulates in the electrolyte, from which it may be recovered by any suitable method. 110

Having reference to the accompanying drawing, I have shown a view in vertical



cross-section of an apparatus in which I may carry out my invention. The apparatus consists of an iron vessel B, its inside walls lined with a refractory and non-conducting material D. This constitutes the electrolyzing cell, which contains the fused electrolyte E. The ore, or sulfid containing material, made into suitable form for electrolysis by fusing with a flux and the resulting matte cast into blocks or a cylinder A, is placed in the electrolyte E, and brought into electrical contact with the (+) source of the current. The cathode C, is a bath of molten metal in the bottom of the cell B, which is in electrical contact with the (-) source of the current. The molten metal cathode C, is maintained at a constant height by having a well G on the side of cell B, and as rapidly as the metal accumulates, it may be either ladled out or else "tapped" from the apparatus. In order to recover the sulfur which is liberated at the anode during electrolysis, the apparatus may be provided with a cover H of refractory material, and the volatilized sulfur, or its oxidized products, such as SO<sub>2</sub>, removed from the cell through the opening J.

The apparatus may be arranged above a suitable furnace F for the purpose of fusing the metal-cathode and the electrolyte, preparatory to the electrolysis, and for keeping the temperature constant during the operation.

What I claim as new and desire to secure by Letters Patent, is:

1. The process of recovering lead and associated metals from lead sulfid-containing ore which consists in treating the same to increase its electrical conductivity and then electrolyzing a suitable fused electrolyte comprising a metal haloid compound, with said treated material as anode.

2. The process of recovering lead and associated metals from lead sulfid-containing ore which consists in treating the same to increase its conductivity and then electrolyzing a suitable fused electrolyte comprising a metal haloid compound and a metal sulfid, with said treated material as anode.

3. The process of recovering lead and associated metals from lead sulfid-containing ore which consists in fusing the same to remove impurities and increase its electrical conductivity, and in electrolyzing a suitable fused electrolyte comprising a metal haloid compound, with said fused sulfid-containing material as anode.

4. The process of recovering lead and associated metals from lead sulfid-containing ore which consists in fusing the same to form a matte and then electrolyzing a suitable fused electrolyte comprising a metal haloid compound and metal sulfid, with said matte as anode.

5. The process of recovering lead and associated metals from lead sulfid-containing ore

which consists in fusing the same to form a matte and then electrolyzing a suitable fused electrolyte comprising lead chlorid, with said matte as anode.

6. The process of recovering lead and associated metals from lead sulfid-containing ore which consists in fusing the same to form a matte and then in electrolyzing a suitable fused electrolyte comprising a metal chlorid and a metal sulfid, with said matte as anode.

7. The process of recovering lead and associated metals from lead sulfid-containing ore which consists in fusing the same to form a matte, and then in electrolyzing a suitable fused electrolyte comprising lead chlorid and lead sulfid, with said matte as anode.

8. The process of recovering lead and associated metals from lead sulfid-containing ore which consists in fusing the same to form a matte, and then in electrolyzing a suitable fused electrolyte comprising haloid compounds of lead and zinc having a metal sulfid dissolved therein, with said matte as anode.

9. The process of recovering lead and associated metals from lead sulfid-containing ore which consists in fusing the same to form a matte, and then electrolyzing a suitable fused electrolyte comprising a haloid metal compound, at a temperature below the melting point of said material and above 445° C., with said matte as anode.

10. The process of recovering lead and associated metals from lead sulfid-containing ore which consists in fusing the same to form a matte, and then electrolyzing a suitable fused electrolyte at a temperature of about 500° C., said electrolyte comprising a metal haloid compound with said matte as anode.

11. A process of recovering lead and associated metals from lead sulfid-containing ore, which consists in first fusing said ore with a suitable flux to form a matte and electrolyzing a suitable fused electrolyte, with the said matte as anode.

12. A process of recovering lead and associated metals from lead sulfid-containing ore, which consists in first fusing said ores with a suitable flux to form a matte and electrolyzing a suitable fused electrolyte, comprising a metal haloid compound, at a temperature below the melting point of the matte, with said matte as anode.

13. A process of recovering lead and associated metals from lead sulfid-containing ore, which consists in first fusing said ores with a suitable flux to form a matte and electrolyzing a suitable fused electrolyte, comprising a metal haloid compound, at a temperature above 445° C. and below the melting point of the matte with said matte as anode.

14. A process of recovering lead and associated metals from lead sulfid-containing ore, which consists in first fusing said ores with a suitable flux to form a matte and electrolyzing a suitable fused electrolyte, comprising a



haloid compound of lead and a haloid compound of an alkali or alkaline earth metal, at a temperature above 445° C. and below the melting point of the matte, with said matte  
5 as anode.

15 15. A process of recovering lead and associated metals from lead sulfid-containing ore, which consists in first fusing said ores with a suitable flux to form a matte and electrolyz-  
10 ing a suitable fused electrolyte, comprising haloid salts of lead, zinc and of an alkali or alkaline earth metal, at a temperature above 445° C. and below the melting point of the matte, with said matte as anode.

15 16. A process of recovering lead and associated metals from lead sulfid-containing ore, which consists in first fusing said ore with a suitable flux to form a matte and electrolyz-  
ing a suitable fused electrolyte, comprising

lead chlorid, at a temperature of about 500° 20 C., with said matte as anode.

17. A process of recovering lead and associated metals from lead sulfid-containing ore, which consists in first fusing said ores with a  
25 suitable flux to form a matte and electrolyzing a suitable fused electrolyte, comprising lead chlorid, zinc chlorid and an alkali or alkaline earth haloid compound, having zinc sulfid dissolved therein, at a temperature of  
30 about 500° C., with said matte as anode.

In testimony whereof, I hereunto set my hand this thirtieth day of August 1906, in the presence of two subscribed witnesses.

EDWARD FRANK KERN.

Witnesses:

WM. S. AUSTIN,  
R. B. SHERIDAN.