

C. S. BRADLEY.
METHOD OF AMPHIDIZING.
APPLICATION FILED AUG. 31, 1909.

1,052,793.

Patented Feb. 11, 1913.

5 SHEETS-SHEET 1.

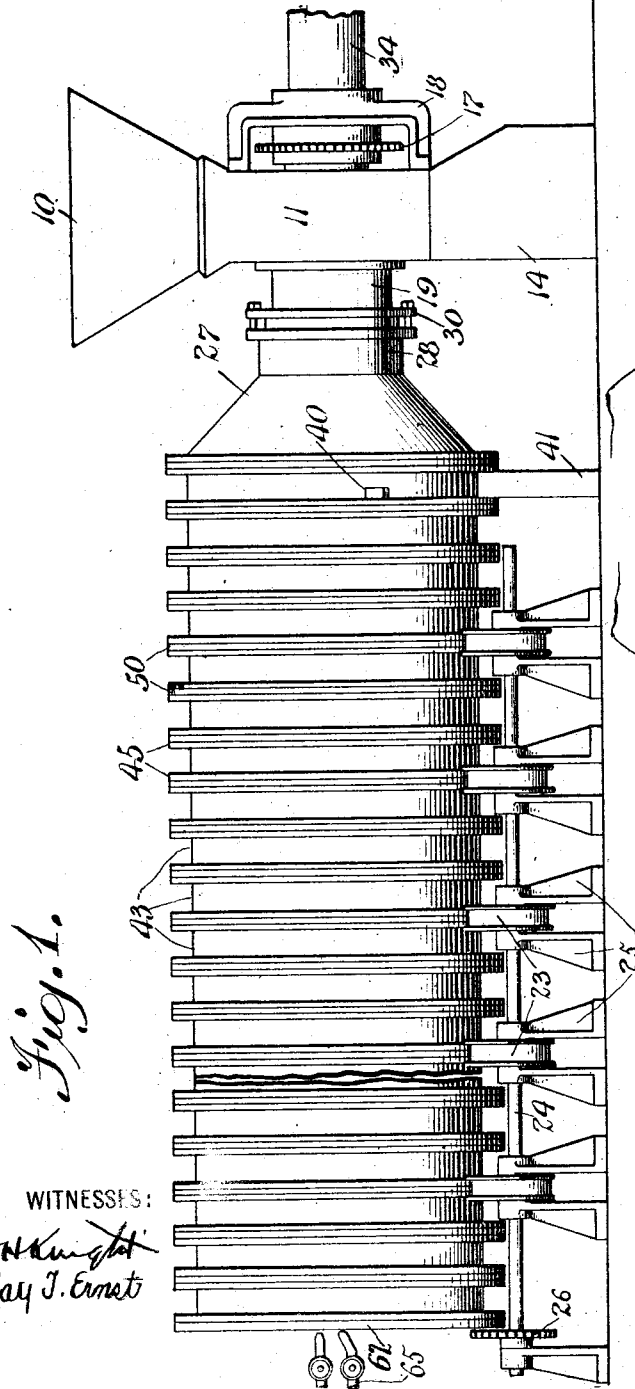


Fig. 1.

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Ray J. Ermet

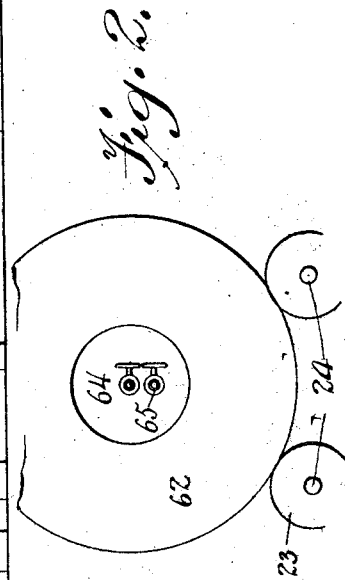


Fig. 2.

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5 SHEETS—SHEET 2.

Fig. 3.

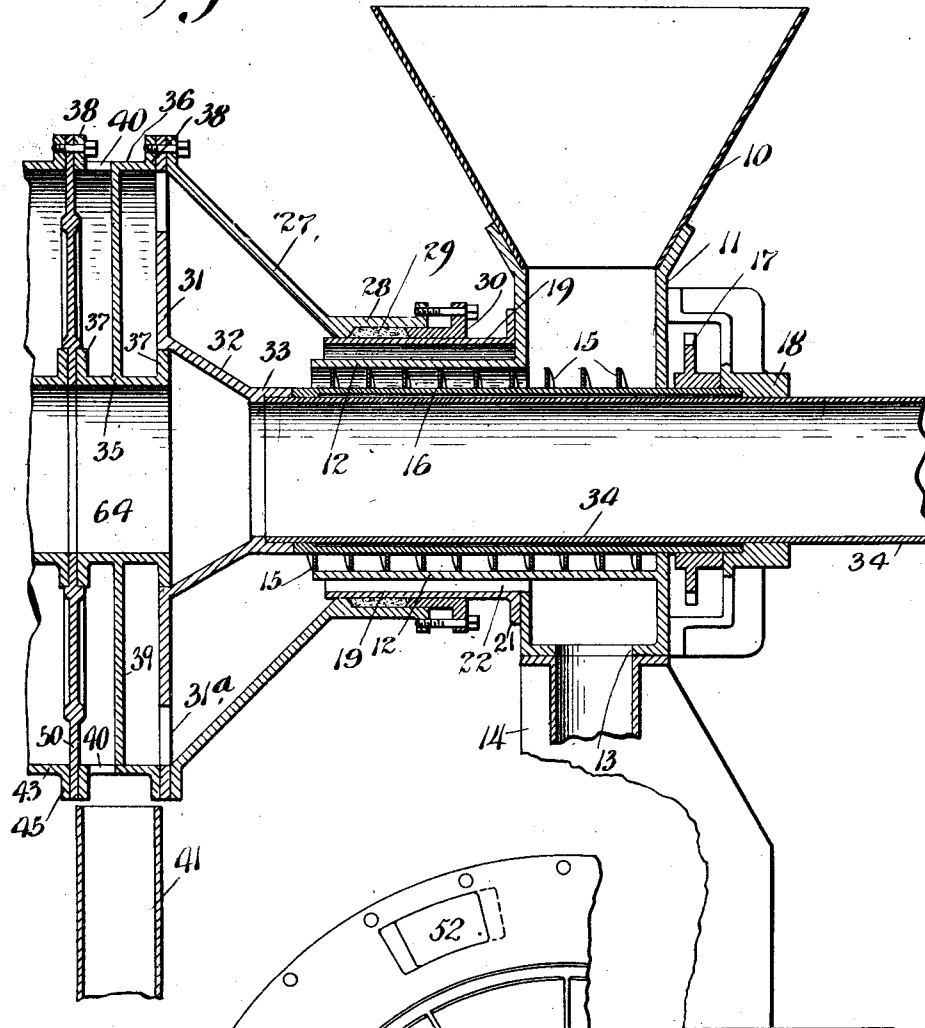
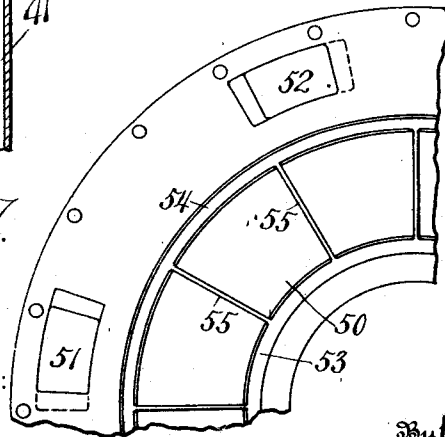


Fig. 7.



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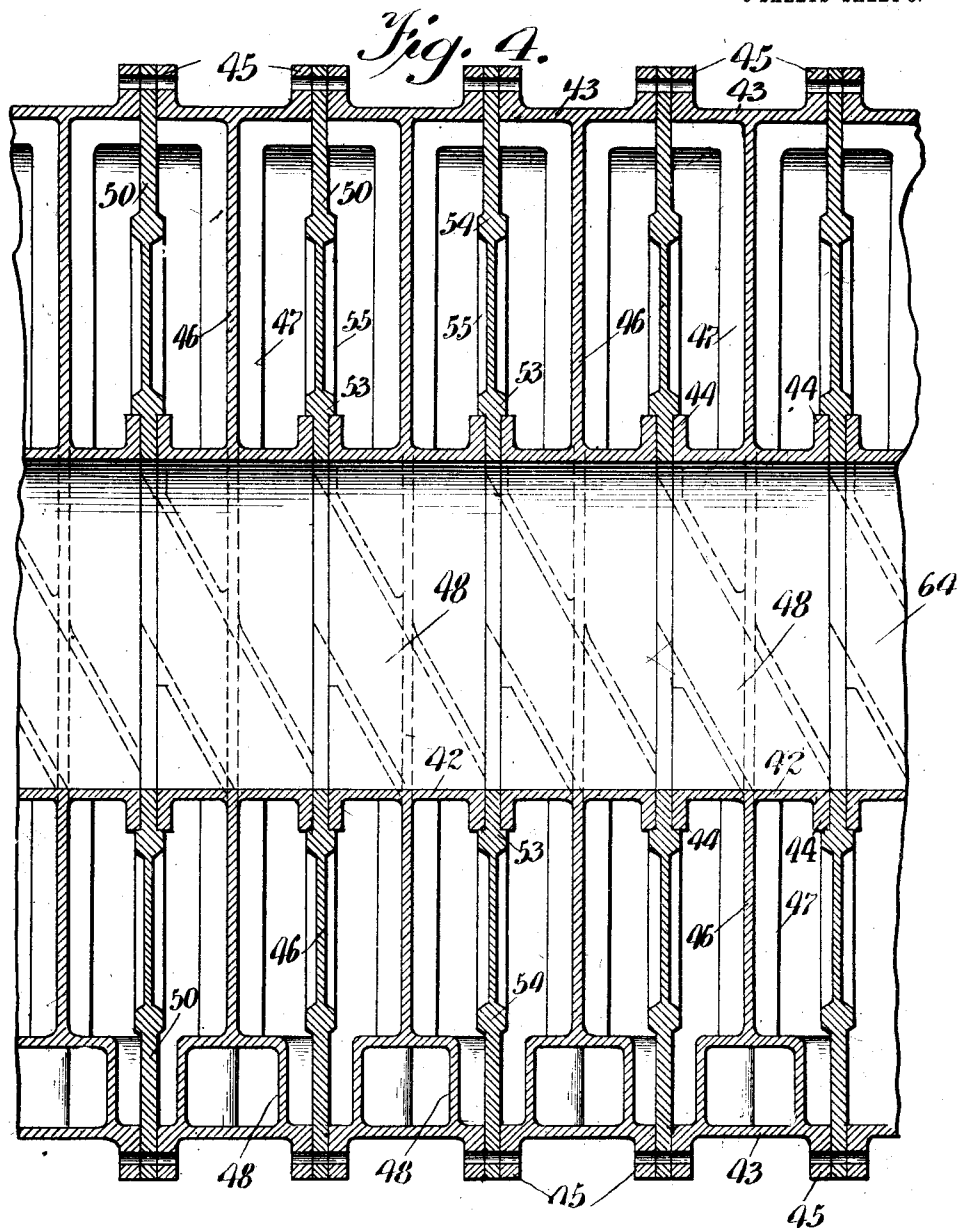
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5 SHEETS—SHEET 3.



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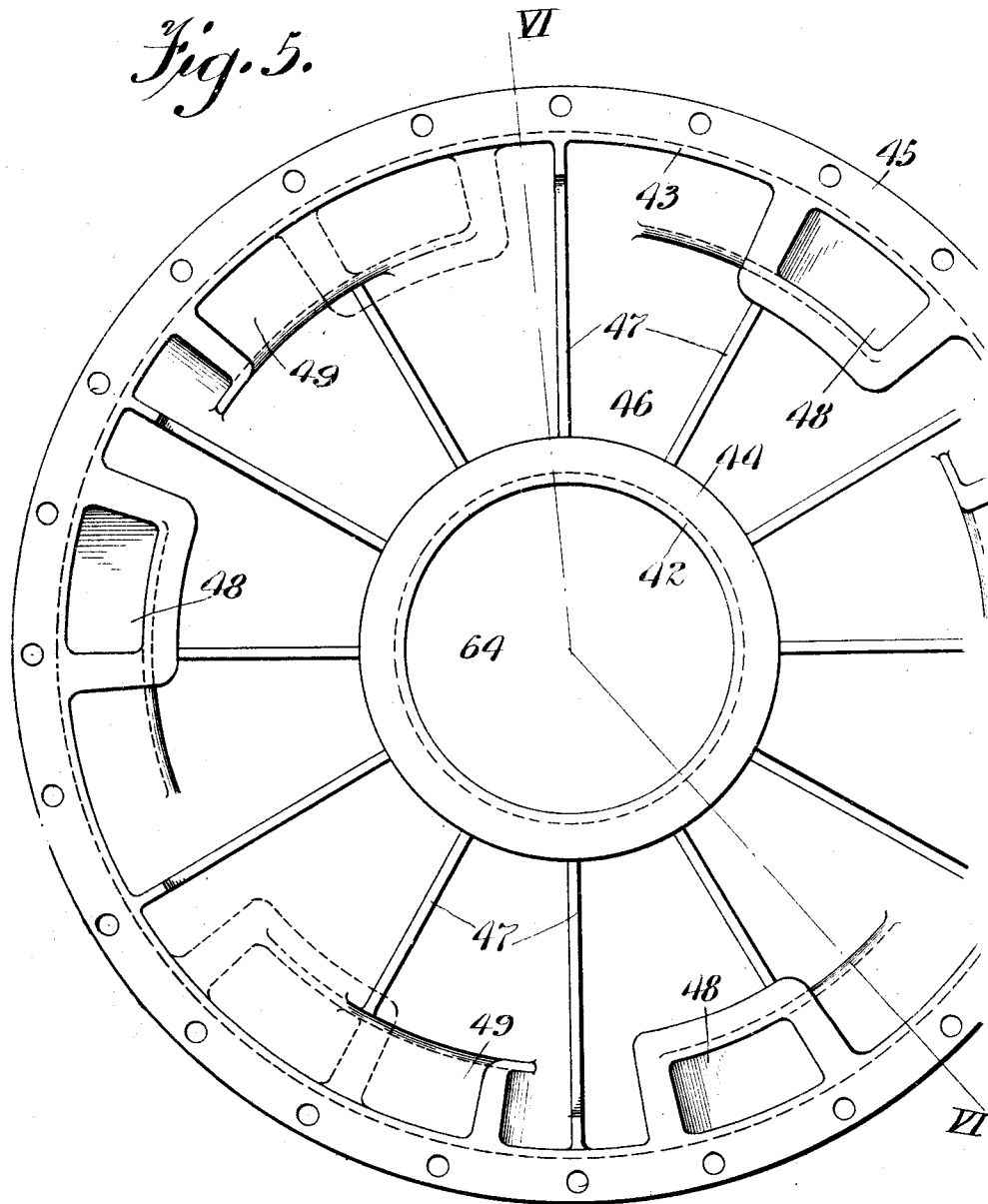
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5 SHEETS—SHEET 4.

Fig. 5.



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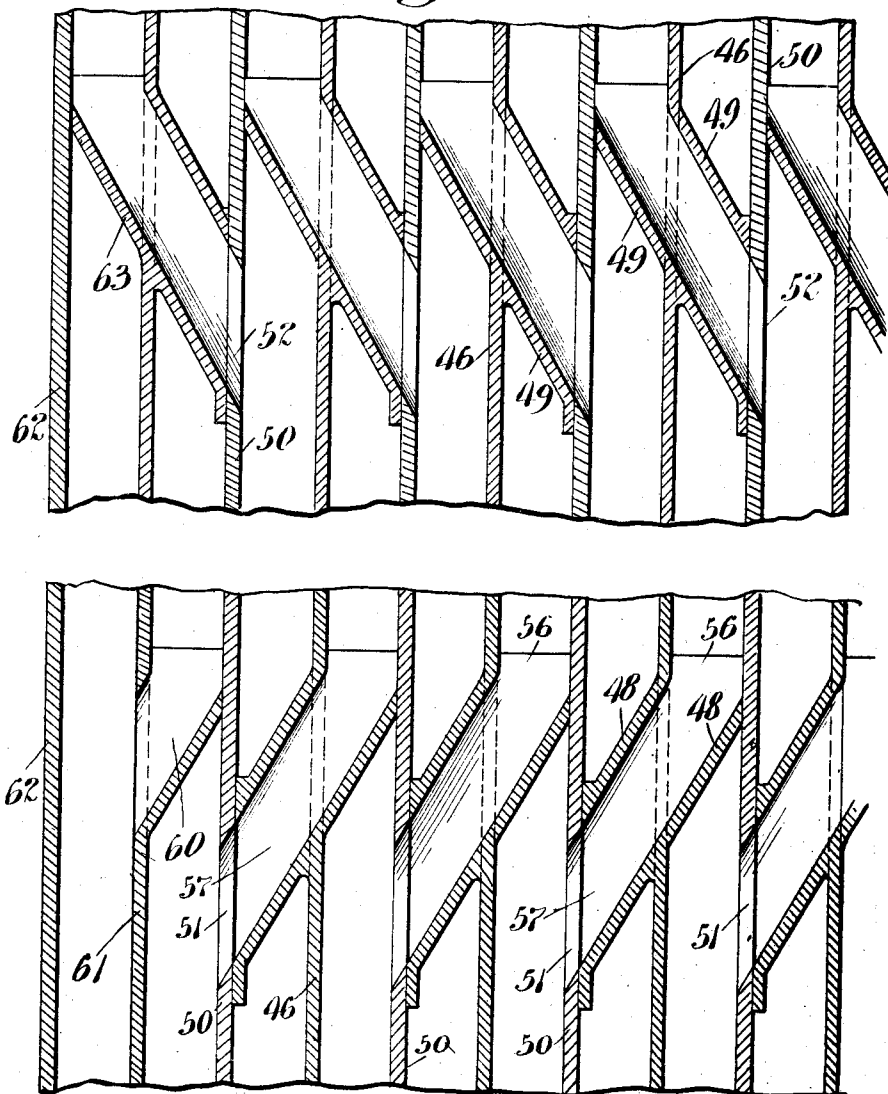
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6 SHEETS—SHEET 5.

Fig. 6.



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UNITED STATES PATENT OFFICE.

CHARLES S. BRADLEY, OF NEW YORK, N. Y., ASSIGNOR TO BRADLEY COPPER PROCESS COMPANY, OF JERSEY CITY, NEW JERSEY, A CORPORATION OF NEW JERSEY.

METHOD OF AMPHIDIZING.

1,052,793.

Specification of Letters Patent.

Patented Feb. 11, 1913.

Application filed August 31, 1909. Serial No. 515,538.

To all whom it may concern:

Be it known that I, CHARLES S. BRADLEY, a citizen of the United States, residing in New York, borough of Manhattan, State of New York, have invented new and useful Improvements in Methods of Amphidizing; and in order that those skilled in the art may understand and practise my invention I give the following specification, reference being had to the accompanying drawings.

My invention relates to the treatment of ores and more particularly to the treatment of copper ores to convert the copper into soluble form so that it may be dissolved and thus readily separated from the gangue. In the preferred embodiment of my invention the copper contents are converted into copper sulfate. An amphigen being an element which combines with metals to form either an acid or a base, as for example oxygen, and an amphid being a salt of an acid and a base each of which contains an amphigen, as for example copper sulfate ($\text{CuO} + \text{SO}_3$), I designate the apparatus which forms the amphid as the "amphidizer" and the act of producing the amphid as "amphidizing."

As an example of the kind of ore to which my invention can be advantageously applied, I may refer to the following samples which show analyses of ore from prominent mines in this country.

A.		B.		C.	
35	Cu..... 2.58%	Moisture .. 1.97	Moisture .. 2.31	Moisture .. 2.31	
	SiO_2 59.70	SiO_2 59.07	SiO_2 58.02	SiO_2 58.02	
	Al_2O_3 18.05	Cu..... 2.58	Fe..... 4.50	Fe..... 4.50	
	Fe_2O_3 10.76	Fe_2O_3 5.20	Al_2O_3 17.82	Al_2O_3 17.82	
	CaO..... .20	FeO 4.41	TiO_284	TiO_284	
	MgO..... .14	Ter_2S_404	Fe_2O_305	Fe_2O_305	
	P_2O_581	Al_2O_3 18.05	CaO..... .59	CaO..... .59	
	TiO_282	CaO..... .20	MgO..... .08	MgO..... .08	
40	S..... 2.12	MgO..... .14	K and NaO 2.12	K and NaO 2.12	
	K_2O 2.81	Fe_2O_381	Lead..... .22	Lead..... .22	
	Na_2O18	TiO_232	Arsenic..... .54	Arsenic..... .54	
	Ag..... Trace.	Na_2O13	Zinc..... .66	Zinc..... .66	
	Cl..... Trace.	K_2O 2.81	Sb..... Trace.	Sb..... Trace.	
	Pb..... None.	F..... .01	Cu..... 2.68	Cu..... 2.68	
		CO_218	S..... 5.32	S..... 5.32	
45		Cl..... Trace.			
		SnO_2 Trace.			
		Sulfur..... 2.12			

It will be observed that each of these ores has a content of sulfur which under proper treatment will be sufficient for amphidizing all of the copper, as in the formation of copper sulfate, 64 lbs. of copper are united with 32 lbs. of sulfur plus the required amount of oxygen. It thus appears that such ores contain all the material necessary for their own amphidizing, with the exception of oxygen which may be obtained from

the air, and as air is always present this need not be considered. To illustrate my invention I shall describe the same with reference to the treatment of these ores, it being understood, however, that it may just as well be applied to ores which require the addition of outside acid to effect the amphidizing.

It has already been proposed to convert the copper contents into soluble form such as the sulfate and subsequently dissolve the sulfate and separate the solution from the gangue, but so far as I am aware this treatment has met with little or no success in commercial practice. The ore to be treated frequently has such a low copper content that great quantities of ore relatively to the copper obtained must be worked. It is therefore obvious that the commercial success of the plant, especially in such cases, demands the ability to handle large quantities of ore in a given time. With this end in view I have designed the apparatus and method so that there need be no idle period between separate charges and discharges but the action is a continuous one, the crushed ore passing continuously into the apparatus where the copper is continuously amphidized and the amphidized copper and remaining parts of the ore are continuously discharged. Such an apparatus is illustrated in the accompanying drawings in which—

Figure 1 is a side elevation of the amphidizer. Fig. 2 is a diagram of its rotary support. Fig. 3 is a vertical longitudinal section of the feed and discharge portions thereof. Fig. 4 is a fragmentary vertical longitudinal section through the reaction portion of the amphidizer. Fig. 5 is an elevation of one of the units employed, and Fig. 6 is a sectional view of the reaction portion of the amphidizer taken on the line VI—VI of Fig. 5. Fig. 7 is a view in elevation showing the face of a portion of a header unit hereinafter described.

Referring now more specifically to said drawings, 10 indicates a hopper into which the suitably crushed ore may be fed. The hopper 10 delivers the ore through the intake 11 of a stationary ore duct 12 which is suitably secured as by underneath inturned flanges 13 upon a support 14. A worm 15, secured upon tubular shaft 16 driven by sprocket wheel 17 or other suitable means and having its outer end disposed in thrust

bearing 18, operates within the ore duct 12 to advance the crushed ore to the discharge end thereof. Surrounding the ore duct 12 is an air duct 19 which is secured at its outer end by annular flange 21 to the inner face of intake 11 of the ore duct 12 and receives air through air inlet 22 and leads it toward the reaction portion of the apparatus which will now be described.

The reaction portion of the amphidizer, as shown in Figs. 1, 2 and 3, is in the form of a drum rotatably mounted upon rollers 23 mounted suitably upon shafts 24 journaled in bearing blocks 25, one or both of which shafts may be driven as by sprocket wheel 26. The rotary or reaction portion is connected with the feed portion by a flaring union 27 which fits over the inner end of the feed portion of the apparatus and has an annular flange 28 between which and the air duct 19 a packing 29 is confined by a gland 30. It is thus apparent that the union provides the support for the inner end of the air duct 19 and has gas tight connection therewith. When the crushed ore reaches the rotary reaction portion of the amphidizer it advances through one system of passages and returns through another. This is accomplished by subdividing the reaction space transversely into a number of reaction chambers, the alternate reaction chambers being connected by bridging passages inclined so that the crushed ore advances by the action of gravity as the drum rotates, whereas the intermediate reaction chambers are connected by bridging passages inclined the other way so that the crushed ore returns by the action of gravity as the drum rotates. I prefer to provide this arrangement by a unit construction. These units are of two types, one type comprising the ore conducting passages and hereinafter referred to as conducting units, and the other forming headers between adjacent conducting units and hereinafter referred to as header units.

Referring now to Fig. 3 of the drawings, it will be seen that a special unit or section having a header portion 31 provided with an annular series of perforations 31^a, a conical wall 32 and a shouldered annular flange 33 is provided. The annular flange 33 supports the inner end of a discharge flue 34 from the heating passage hereinafter described. The inner end of discharge flue 34 in turn supports the inner end of tubular worm shaft 16 and has its outer end supported in the thrust bearing 18 already referred to. The space between the conical wall 32 and the union 27 constitutes an ore chamber which receives the crushed ore from the feed device and from which the ore passes through perforations 31^a into a special conducting and discharge unit. This special unit comprises inner and outer cy-

lindrical walls 35 and 36, respectively, with rim flanges 37 and 38 respectively, and a partition wall 39. The ore to be amphidized enters through perforations 31^a into the space at one side of partition 39, and the amphidized ore is discharged through a peripheral series of perforations 40 from the space at the other side of the partition 39 into a chute 41. The special unit just described has also the function of a conducting unit with respect to advancing the ore and is provided with the advancing passages but lacks the return conducting passages. The advancing passages do not appear in the sectional view shown in Fig. 3 but will be seen in Figs. 4, 5 and 6, and understood from the description with reference to these figures.

In Figs. 4, 5 and 6 it will be seen that the conducting units comprise inner and outer cylindrical walls 42 and 43 respectively with rim flanges 44 and 45 respectively, partition wall 46, radial agitating and heat distributing ribs 47, conducting passages 48 for advancing the ore and conducting passages 49 for returning the ore. The header units are disposed between the conducting units and each comprises the annular header portion 50, a series of ports 51 for the advancing ore, ports 52 for the returning ore, annular shoulders 53 and 54 and radial agitating and heat distributing ribs 55. The effect of the ribs 55 is to turn the ore over and over and thoroughly agitate it during the rotation of the drum, and by reason of their exposure to the heated ore in one side, to conduct the heat therefrom into the ore at the other side which is at a slightly lower temperature, whereby the equalizing or regeneration of the heat is aided. The chambers in which the ore is advancing are to the left of the headers and those in which the ore is returning are to the right of the headers. The conducting passages are inclined accordingly. Those for advancing the ore are shown in the lower portion of Fig. 6, and those for returning the ore are shown in the upper portion of this figure. The advance conducting passages 48 have their intake ports 56 open to one advance chamber, extend through the return chamber to the left (to which they are closed) and discharge through their discharge ports 57 and the advance ports 51 of the header into the next advance chamber to the left. The return conducting passages 49 have their intake ports 58 open to one return chamber, extend through the advance chamber to the right (to which they are closed) and discharge through their discharge ports 59 and the return ports 52 of the header unit into the next return space at the right. The ore thus advances from right to left and returns from left to right. At the end of the series of units described, I provide a spe-

cial unit for reversing the direction of travel of the ore. This ore reversal unit is shown at the left hand portion of Fig. 6, and is similar in principle to the conducting units, but has advance passages 60 which open into the space to the left of its partition wall 61 instead of passing through it as in the other conducting units. An end header 62 closes this chamber, and the return passages 63 similar to those already described start the ore upon its return through the amphidizer. In assembling the units, the outer rim flanges 45 of the conducting units and the outer peripheries of the header units are bolted together, or otherwise suitably united, the inner rim flanges 44 of the conducting units engaging within the annular shoulders 53 of the header units, and the agitating ribs in staggered relation in each chamber. In this condition the inner cylindrical walls 42 of the conducting units and the inner edges of the header units provide a continuous passageway 64 for supplying heat to the ore. Any suitable source of heat may be employed, as represented by the burner 65, the heat passing through the heating passage 64 supplies heat to the surrounding crushed ore, and the outlet of the passage is through the discharge flue 34 hereinbefore referred to.

In operation, the crushed ore is placed into the hopper 10, from which it is fed by worm 15 and ore duct 11 into the union 27, from which it is conducted from right to left through the rotary drum composed of the units described and returned from left to right to be discharged through discharge point 40 into the chute 41. By having the agitating ribs in staggered relation the passage of the ore is less obstructed and at the same time the ore is tumbled back and forth from one side to the other. Heat being supplied when needed through the heating passage 64, the ore coming in is heated continuously and in a regenerative manner due to the fact that the returning amphidized ore passes the incoming ore and transfers a portion of its heat thereto. This regenerative feature results not only in retaining to a large extent the heat in the amphidizer, as the incoming ore is at a much lower temperature and extracts the heat which is present in the amphidized ore before the latter is discharged, but at the same time keeps the heat evenly distributed throughout the entire mass of ore so that sudden rises in temperature are avoided.

The regenerative feature of the system is important, not only in the saving of fuel and attendance, but for the greater reason that the distribution of the heat of reaction to the continually incoming mass of ore, restrains the reaction to the sulfating temperature. In a furnace for the treatment of substances requiring defi-

nite temperatures for chemical reactions it is very important, in order to reduce the attendance, that the furnace and contents should be slow to depart from the definite temperature. If the ratio of added heat necessary to maintain the reaction is small relatively to the contained heat of the apparatus, it is evident that fluctuations of temperature will be slow. If we heat a body of ore to 1000 degrees without regeneration, it is evident that the heat units added are five times the amount that would be necessary where regeneration was so effective that the ore was discharged within 200 degrees of the temperature at which it entered the apparatus, and in the former case changes of temperature would occur, roughly speaking, with five times the rapidity of the latter condition. In actual practice with the amphidizer herein described, it has been found that with the addition only of heat units necessary to make up for loss in radiation, and in the discharged ore, the heat of reaction is kept steadily at the sulfating temperature, the treated ore discharged at a temperature about 200 degrees above that of the entering ore and the operation is so nearly self governing as to require only occasional inspection by an attendant.

In the apparatus described, it is apparent that great quantities of ore can be handled efficiently due to the continuous operation and the thorough agitation of the ore insured by the tumbling motion.

The chemical action which goes on within the amphidizer will vary according to the ore treated. In the case of forming the sulfate of copper from ores containing sufficient sulfur for this purpose, air is drawn into the apparatus through the air duct described and the copper which is oxidized unites with the oxidized sulfur, the temperature being maintained between that at which the iron sulfate dissociates and the dissociation temperature of the copper sulfate, or preferably at about 550° C. Those skilled in this art are acquainted with numerous ways of maintaining the temperature at the desired degree and hence such means does not require explanation herein. It should be stated, however, that in many cases the heat due to the reaction will be sufficient or more than sufficient in which cases the outside source of heat referred to will be necessary only in starting, and artificial cooling means such as air blasts may be employed where necessary to keep the temperature from rising to the point where sulfate of copper would be dissociated.

I claim:

1. The method of amphidizing ore which comprises advancing the ore through positions of successively higher temperatures until the maximum temperature is attained and the ore amphidized, continuously with-

drawing the amphidized ore from the position of maximum temperature in heat conductive relation to the advancing ore, so that the amphidized ore transfers successive portions of its contained heat to successively colder portions of the advancing ore until it approximates the initial temperature of the ore, and the greater portion of its heat has been regenerated in the advancing ore, and then discharging the amphidized ore.

2. The method of amphidizing ore which comprises advancing the ore and an oxygen supplying atmosphere through positions of successively higher temperatures until the maximum temperature is attained and the ore amphidized, continuously withdrawing the amphidized ore and the resultant and remaining gases from the position of maximum temperature in heat conductive relation with the advancing ore and oxygen supplying atmosphere so that the amphidized ore and the resultant and remaining gases transfer successive portions of their contained heat to successively colder portions of the advancing ore and oxygen supplying atmosphere until they approximate the initial temperature and the greater portion of their heat has been regenerated in the advancing ore and oxygen supplying atmosphere, and then discharging the amphidized ore.

3. The method of amphidizing ore which comprises advancing the ore through positions of successively higher temperatures until the maximum temperature is attained and the ore amphidized, the quantity of the

ore at the position of maximum temperature at any one time being only a small portion of the total quantity of ore under treatment, continuously withdrawing the amphidized ore from the position of maximum temperature in heat conductive relation with the advancing ore, so that the amphidized ore transfers successive portions of its contained heat to successively colder portions of the advancing ore until it approximates the initial temperature of the ore, and the greater portion of its heat has been regenerated in the advancing ore, and then discharging the amphidized ore.

4. The method of amphidizing ore which comprises advancing the ore through positions of successively higher temperatures until the maximum temperature is attained and the ore amphidized, applying heat from an external source at the point of maximum temperature, continuously withdrawing the amphidized ore from the position of maximum temperature in heat conductive relation to the advancing ore, so that the amphidized ore transfers successive portions of its contained heat to successively colder portions of the advancing ore until it approximates the initial temperature of the ore, and the greater portion of its heat has been regenerated in the advancing ore and then discharging the amphidized ore.

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