

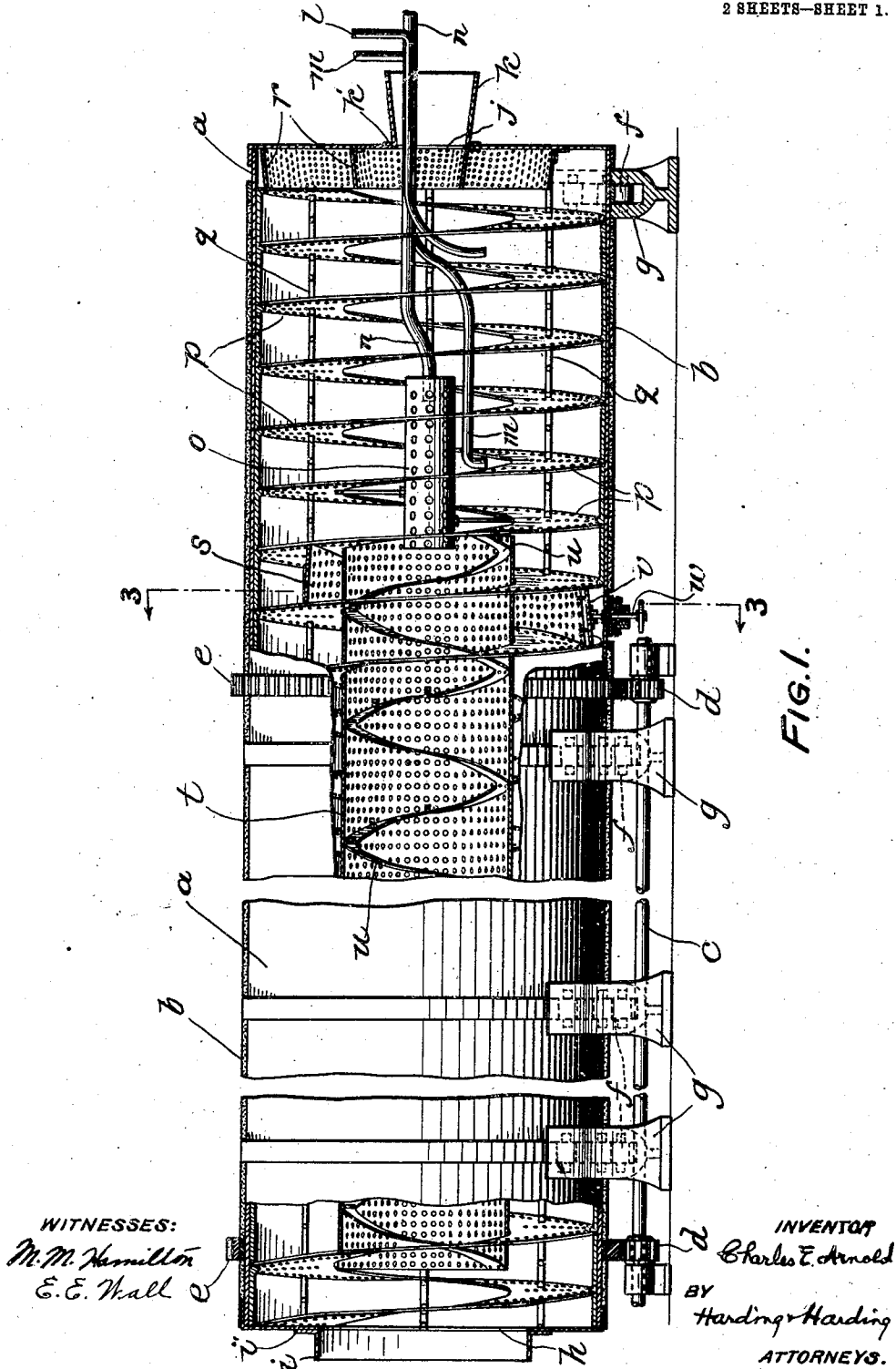
No. 888,685.

PATENTED MAY 26, 1908.

C. E. ARNOLD.
LIXIVIATING APPARATUS.

APPLICATION FILED MAY 21, 1907.

2 SHEETS—SHEET 1.



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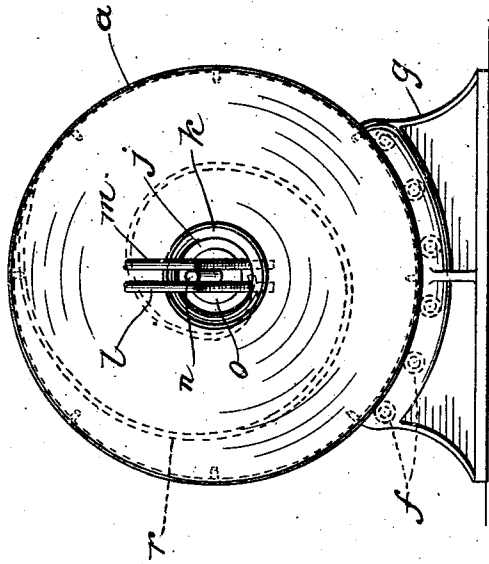


FIG. 2.

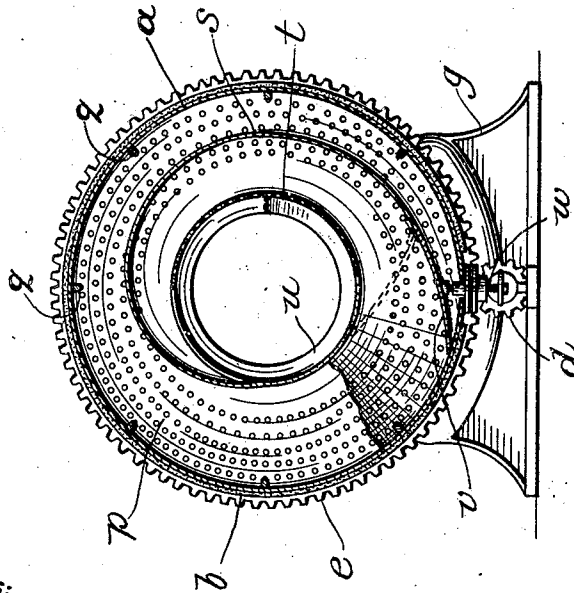


FIG. 3.

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LIXIVIATING APPARATUS.

No. 888,685.

Specification of Letters Patent.

Patented May 26, 1908.

Application filed May 21, 1907. Serial No. 374,834.

To all whom it may concern:

Be it known that I, CHARLES E. ARNOLD, a citizen of the United States, residing at Wilmington, county of Newcastle, and State of Delaware, have invented a new and useful Improvement in Lixivating Apparatus, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, which form a part of this specification.

The object of my invention is to produce an apparatus capable of extracting nitrate of soda from caliche. The known processes are always attended with a loss of a certain portion of the available nitrate, the loss being due partly to the carrying away of nitrate in solution by the "ripios" or waste. The percentage of loss varies with the process or apparatus employed, and amounts to from one-third to one-half of the available nitrate in the methods of extraction most commonly used.

The more specific object of my invention is to produce an apparatus capable of extracting nitrate of soda from caliche without loss of substantially any of the available nitrate and to carry out the extracting process continuously and automatically.

While the apparatus is designed with especial reference to the requirements attending the extraction of nitrate of soda from caliche, it will be understood that it is not intended to imply that the apparatus is not useful for operating upon other substances. It will also be understood that whether applied to the particular use that I have more especially in view, or whether used for other purposes, the detailed construction and arrangement of parts may be modified, it being understood that the specific apparatus hereinafter described is intended to represent a preferred embodiment of my invention for the particular purpose specified.

In the drawings:—Figure 1 is a side-elevation, partly in section. Fig. 2 is an end view. Fig. 3 is a section on the line 3—3 of Fig. 1.

a is a long tube or cylinder of one-quarter inch iron plate. The diameter of the cylinder may be about six feet, and its length about one hundred feet. The entire tube is covered with heavy insulating material *b* to prevent radiation of heat. The cylinder is rotated from the shaft *c*, on which are gears *d* engaging annular gears *e* encircling the cylinder. The cylinder rests and turns on sets of

rollers *f* journaled in standards *g*. In operation, the cylinder is turned at the rate of not more than two or three revolutions per minute.

One end of the cylinder is provided with a central circular opening *h*, of less diameter than the cylinder; and registering with this opening is the annular throat *i* having flanges *i'* bolted to the end plate of the cylinder. Through the opening *h*, the caliche or other material is introduced and the saturated solution discharged. The opposite end of the cylinder is provided with a central opening *j* of less diameter than the opening *h*; and registering with the opening *j* is a funnel shaped throat *k* having flanges *k'* bolted to the end plate. Through the opening *j* are inserted the pipes *l* and *m*, the pipe *l*, through which fresh water is introduced, opening into the cylinder near the latter's extreme end, while the pipe *m*, through which the mother liquid is introduced, opens into the cylinder at a point more remote from the latter's extreme end.

n is a third pipe extending into the cylinder through the opening *j* and connecting with a perforated cylinder or heater *o*, supported from the helix *p* hereinafter described. The fuel supply, which may be crude oil or coal dust, is introduced through the pipe *n* into the heater *o* and is burned there. The heater *o* always being hot, the ignition of the fuel is insured should the supply be momentarily stopped. The perforated helix *p* extends the entire length of the cylinder *a*, the function of the helix being to propel the caliche, while the perforations permit the solution to flow in the opposite direction to that of the caliche.

q, q, represent ribs extending longitudinally of the cylinder and secured to its inner wall, their function being to increase the rubbing action of the caliche and at the same time serve as supports for the helix *p*.

r is an elevating spiral adjoining the outlet *j*, the spiral extending from the inner wall of the cylinder to the edge of the outlet *j*, its function being to carry the ripios or waste out at *j*.

s is a perforated elevating spiral extending between successive convolutions of the helix *p* and merging into one end of the perforated tube *t*. This tube is provided with a helix *u* whose convolutions extend in the opposite direction to those of the helix *p*. The function of the spiral *s* is to carry any lumps, too large to

pass its (spiral *s*) perforations, up to and into the tube *t*, whence the lumps are conveyed, by the helix *u*, back to the starting point for retreatment.

v is a gate, hinged to and forming part of, the spirals *s*, the gate being operated by means of a screw shaft *w*, extending through the wall of the cylinder *a*.

To put the apparatus into operation, fire is started in the heater *o*, air for the combustion entering through the pipes *l*, *m*, and *n*. The cylinder is revolved at the rate of one or two revolutions per minute. Fresh water is run in at pipe *l* and mother liquor at pipe *m*. At the same time a continuous supply of caliche is fed in through the opening *i*. The water flows gradually along, extracting the nitrate from the caliche during its progress and, becoming saturated therewith, flows out of the cylinder at *h*. At the same time the caliche is carried in the opposite direction by the helix *p*. When it reaches the spiral *s*, if it is finely disintegrated, it will pass through the perforations of the spiral *s* at this point and continue on; but any lumps remaining will be elevated by the spiral *s* and conveyed to the tube *t*, whence the helix *u* conveys them back to the starting point. The finely disintegrated "ripios" is elevated by the spiral *r* and discharged through the outlet *j*. The nitrate is recovered from the saturated solution escaping at *h* by crystallization of the nitrate, as is well known, and the mother liquor, containing more or less nitrate in solution, is fed in through the tube *m* as described. Should a large amount of rock containing no nitrate accumulate in the apparatus, the gate *v* is opened for a time, and the rock passes out with the finer insoluble materials. It will be observed that the extracting process is carried on continuously and automatically. The action of the apparatus is such as to entirely disintegrate the caliche, and the ripios or waste is discharged wet with fresh water and not wet with the nitrate solution. Further, it is impossible for any lumps containing nitrate to be discharged, and it is also impossible for the waste to carry away nitrate in solution. Moreover, maximum efficiency is secured in the utilization of heat, every unit of heat from the fuel being absorbed by the liquid.

Having now fully described my invention, what I claim and desire to protect by Letters Patent is:

1. In a lixiviating apparatus, the combination with a cylinder and means for rotating the same, of a perforated helix therein and rotating therewith for conveying the material from one end to the other, an outlet at the latter end for the solid residue, means to introduce liquid at the end of the cylinder at which the solid residue is discharged, and means to allow the saturated solution to escape at the opposite end of the cylinder.

2. In a lixiviating apparatus, the combination with a cylinder and means for rotating the same, of means at one end permitting the material to be introduced and the saturated solution to be discharged, means at the opposite end permitting liquid to be introduced and the solid residue to be discharged, and a helix within and rotating with the cylinder for conveying the material from one end to the other.

3. In a lixiviating apparatus, the combination with a cylinder, of a perforated helix therein for conveying the material from one end to the other, an outlet at the latter end for the solid residue, means to introduce liquid at the end of the cylinder at which the solid residue is discharged, means to allow the saturated solution to escape at the opposite end of the cylinder, a heater within the cylinder, and means to introduce fuel to the heater.

4. In a lixiviating apparatus, the combination with a cylinder, of a perforated helix therein for conveying the material from one end to the other, an outlet at the latter end for the solid residue, means to introduce liquid at the end of the cylinder at which the solid residue is discharged, means to allow the saturated solution to escape at the opposite end of the cylinder, a heater near the end of the cylinder at which the water is introduced and the solid residue discharged, and a fuel-supply pipe extending through the discharge opening and connected with the heater.

5. In a lixiviating apparatus, the combination with a cylinder, of a perforated helix therein for conveying the material toward the end at which the solid residue is discharged, a centrally disposed outlet at said end to permit the solid residue to escape, and an elevating spiral to convey the solid residue from the bottom of the cylinder to said outlet.

6. In a lixiviating apparatus, the combination with a cylinder, of a perforated helix therein for conveying the material toward the end at which the solid residue is discharged, a tube within the cylinder, a helix within the tube conveying material in the opposite direction, and an elevating spiral to arrest lumps of material and convey them from the bottom of the cylinder to the tube.

7. In a lixiviating apparatus, the combination with a cylinder, of a perforated helix therein for conveying the material toward the end at which the solid residue is discharged, a waste outlet at said end at which the solid residue is discharged, means at said end to introduce liquid into the cylinder, means at the opposite end permitting the saturated solution to escape and the material to be introduced, a tube within the cylinder, a helix within the tube conveying material in the opposite direction, an elevating spiral extending between successive convolutions of the first named helix, from the inner wall

of the cylinder to the end of the tube nearest said outlet, the opposite end of the tube terminating near the end of the cylinder at which the solid material is introduced and the saturated solution escapes.

8. In a lixiviating apparatus, the combination with a cylinder, of a perforated helix therein for conveying the material toward the end at which the solid residue is discharged, a tube within the cylinder, a helix within the tube conveying material in the opposite direction, and an elevating spiral to arrest lumps of material and convey them from the bottom of the cylinder to the tube, a gate closing an opening in the elevating spiral, and means to open said gate and permit lumps of material to be fed by the helix into that part of the cylinder beyond the elevating spiral.

9. In a lixiviating apparatus, the combination with a cylinder having a relatively large central opening at one end and a relatively small central opening at the other end, of a perforated helix therein for conveying the material from the first opening to the second opening, and means to introduce liquid near the end of the cylinder containing the second opening.

10. In a lixiviating apparatus, the combination with a cylinder, of a perforated helix therein for conveying the material from one end to the other, means to introduce liquid at the end of the cylinder toward which the solid material is conveyed, means allowing the saturated solution to escape at the opposite end, and ribs on the inner wall of the cylinder.

11. In a lixiviating apparatus, the combination with a cylinder, of a perforated helix therein for conveying the material from one end to the other, means to introduce liquid at the end of the cylinder toward which the solid material is conveyed, means allowing the saturated solution to escape at the opposite end, and longitudinally extending ribs on the inner wall of the cylinder.

12. In a lixiviating apparatus, the combination with a cylinder, of means allowing the introduction of the solid material and the escape of the saturated solution at one end of the cylinder, a discharge opening for the solid residue at the other end of the cylinder, means to introduce liquid at the last named end of the cylinder, a perforated helix in the cylinder to convey the material from one end to the other, an elevating spiral at the last named end of the cylinder to convey the solid residue to the discharge opening, an inner tube within the cylinder, a helix therein to convey material in the opposite direction from that in which it is conveyed by the helix in the cylinder, an elevating spiral to convey the solid material from the cylinder to the inlet end of the tube, and a heater within the cylinder.

13. In a lixiviating apparatus, the combination with a cylinder, of means allowing the introduction of the solid material and the escape of the saturated solution at one end of the cylinder, a discharge opening for the solid residue at the other end of the cylinder, means to introduce liquid at the last named end of the cylinder, a perforated helix in the cylinder to convey the material from one end to the other, an elevating spiral at the last named end of the cylinder to convey the solid residue to the discharge opening, a perforated inner tube within the cylinder, a helix therein to convey material in the opposite direction from that in which it is conveyed by the helix in the cylinder, a perforated elevating spiral to convey the solid material from the cylinder to the inlet end of the tube, a heater within the cylinder, a gate forming part of, and hinged to, the last named elevating spiral, and longitudinally extending ribs on the inner wall of the cylinder.

14. In a lixiviating apparatus, the combination with a cylinder, of a feeding device therein to carry the same in one direction, and means to introduce a liquid therein and cause it to flow in the opposite direction in contact with the solid material.

15. In a lixiviating apparatus, the combination with a cylinder, of a feeding device therein to carry the same in one direction, means to introduce a liquid therein and cause it to flow in the opposite direction in contact with the solid material, and a second feeding device in the cylinder to carry partly disintegrated solid material in the direction of the flow of the body of liquid but out of contact therewith.

16. In a lixiviating apparatus, the combination with a cylinder, of a feeding device therein to carry the same in one direction, and means to introduce a liquid therein and cause it to flow in the opposite direction in contact with the solid material, and devices to arrest the feed of partly disintegrated solid material and convey it in the direction of the flow of the liquid and reintroduce it into the cylinder.

17. In a lixiviating apparatus, the combination with the cylinder, of a perforated helix therein for conveying the material from one end to the other, an outlet at the latter end for the solid residue, a pipe, opening into the interior of the cylinder near the last named end, for introducing water into the cylinder, a second pipe, opening into the interior of the cylinder more remote from the last named end, for introducing mother liquor into the cylinder, and means allowing the saturated solution to escape at the opposite end of the cylinder.

18. In a lixiviating apparatus, the combination with a feeding device to carry the material in one direction, means to cause a flow of liquid in the opposite direction in contact

with said material, and a second feeding device to carry partly disintegrated solid material in the direction of the flow of the liquid.

19. In a lixiviating apparatus, the combination with a feeding device to carry the material in one direction, means to cause a flow of liquid in the opposite direction in contact with said material, a second feeding device to carry partly disintegrated solid material in the direction of the flow of the liquid, and means

to arrest the feed of partly disintegrated solid material and convey it to the second feeding device.

In testimony of which invention, I have hereunto set my hand, at Wilmington, Del., 15 on this eleventh day of May, 1907.

CHARLES E. ARNOLD.

Witnesses:

HENRY E. MEAD,
S. W. NEWELL.