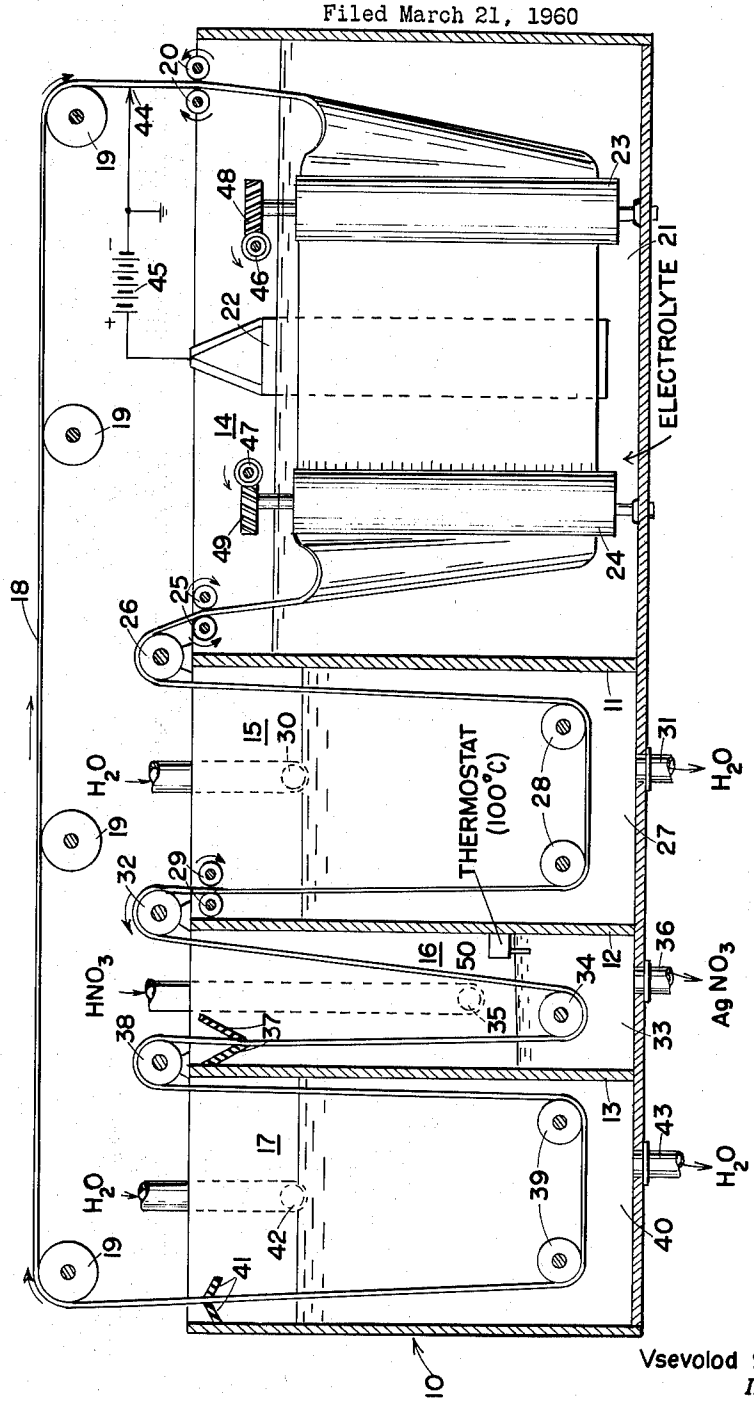
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PROCESS FOR PRODUCING SILVER NITRATE

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PROCESS FOR PRODUCING SILVER NITRATE

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My present invention relates to a process for producing silver nitrate as more generally disclosed in my co-pending application Ser. No. 779,521, filed Dec. 11, 1958, of which the present application is a continuation-in-part, now abandoned.

The aforementioned co-pending application discloses a process wherein crystals of high-purity silver nitrate are produced from metallic silver through the use of a silver-oxide intermediary. The latter is deposited at an inert electrode in an alkaline electrolyte and, after its removal therefrom, contacted with nitric acid to be converted to silver nitrate.

It is an object of the present invention to provide an efficient process for the large-scale production of high-purity nitric acid in the manner described above.

In accordance with a feature of the invention, silver oxide is electrolytically deposited upon a continuous inert but flexible band which passes from the alkaline electrolyte through a water bath to remove traces of alkalinity and thence into a bath of nitric acid in which the silver oxide is stripped from the band and crystals of silver nitrate are precipitated. The band then passes into another water bath wherein excess nitric acid is washed from the band which is thereupon returned to the electrolyte.

According to another feature of the invention, the bath of preferably concentrated nitric acid (48.5° Bé) is maintained at a temperature in excess of 100° C. to drive off the water resulting from the reaction between the nitric acid and the silver oxide. Only a small proportion of the length of the continuous band is permitted to enter the nitric-acid bath whose volume is kept at a minimum in order to facilitate recovery of the silver-nitrate crystals from the liquor and to limit the erosive action of the acid upon the band.

I have found that the silver-oxide mass electrodeposited upon the cathodized flexible band tends to adhere thereto as it passes out of the electrolyte, especially if the mass is compressed against the band as, for example, by a pair of rollers. The latter may also serve to free the oxide mass from electrolyte via a squeegee action. The silver-oxide mass may, therefore, be carried along an extended transport path by the band.

The above and other objects, features and advantages of the present invention will become more fully apparent from the following description, reference being made to the accompanying drawing in which the sole figure is a schematic, cross-sectional view of a plant for producing silver nitrate by a process according to the invention.

In the figure I show a processing tank **10** divided by partition walls **11**, **12** and **13** into a first compartment **14** containing an alkaline electrolyte, a second compartment **15**, adjacent thereto, containing a water bath, a third compartment **16** containing a nitric-acid bath, and a fourth compartment **17** containing another water bath. An inert, flexible and conductive band **18**, preferably formed from a stainless steel resistant to attack by both the alkaline electrolyte and the nitric-acid bath, passes over guide rollers **19** and between a pair of drive rollers **20**, bearing thereupon, into the electrolyte **21** of compartment **14**. The electrolyte **21** is, preferably, an aqueous solution of an alkali, such as potassium hydroxide, in which a salt having an ion capable of forming soluble silver compounds is dissolved. An example of such salt is potassium (or sodium) acetate which may be readily dissolved

in the electrolyte and which may be present in a proportion up to the point of saturation. Advantageously, the concentration of alkali in the solution is maintained at the value corresponding to maximum conductivity of the electrolyte. Therefore, a 27%-to-30% solution of potassium hydroxide, having a specific gravity between 1.270 and 1.305 at room temperature, will be found to be satisfactory.

A pair of silver electrodes **22** (only one of which is shown) are suspended at opposite sides of the band **18** which is brought into an upright position in the compartment **14**, as it passes between a pair of vertical rollers **23**, so that electrodeposition of silver oxide may occur on both surfaces of the band. A second pair of vertical rollers **24** then serve to compress the silver-oxide mass against the band to limit the flaking off of the mass as the band **18** leaves the compartment **14**. As the band leaves this compartment, it passes between a pair of horizontal rollers **25** which further compress the mass and squeeze adherent electrolyte therefrom.

From the compartment **14**, the band is guided over an idler roller **26** and into the water bath **27** contained within the compartment **15**. The band **18** is led under two rollers **28** immersed in the water bath **27** and, upon emerging therefrom, between another pair of squeegee rollers **29**, similar to rollers **25**, which serve to extract the water from the mass carried by the band. The compartment **15** is provided with a water inlet **30** and an outlet **31** to permit the water bath **27** to be changed continuously or intermittently as required.

The band **18**, carrying the silver-oxide mass which has been washed substantially free from all traces of the alkaline electrolyte in the water bath **27**, is then directed over an idler roller **32** between compartments **15** and **16** and down into a nitric-acid bath **33** and around a roller **34** immersed therein. Since the reaction between the silver-oxide mass and the nitric acid is rapid, it is not necessary to provide more than a rather shallow bath. The temperature of the bath **33** is maintained, with the aid of suitable heating means (not shown) and a thermostat **50**, at or slightly above 100° C. to evaporate, as rapidly as it is formed the water resulting from the reaction

$$Ag_2O+2HNO_3=2AgNO_3+H_2O$$

occurring therein. Additional nitric acid may be added through inlet **35**, while the silver-nitrate crystals may be drawn off in the liquor via outlet **36**. Upon leaving the nitric-acid bath **33**, band **18** travels between a pair of scraper blades **37**, bearing thereupon, which strip adherent silver-nitrate crystals from the band and also wipe off nitric-acid droplets.

The band **18** is washed free of acid in the water bath **40** of compartment **17** into which it passes over an idler roller **38**. Two rollers **39** immersed in the bath **40** entrain the band **18** beneath the wash liquid. This liquid may be changed through an inlet **42** and an outlet **43** provided in the wall of compartment **17**. From the bath **40**, the band passes between two strippers **41** which remove water droplets adhering thereto to prevent dilution of the electrolyte **21** to which the band is guided over rollers **19**.

The silver electrodes **22** are connected to a direct-current source **45** to form the anodes, while the band **18** is contacted by a wiper **44** connected to the negative pole of the source **45** and thus forms the cathode. Band **18** is driven by worms **46** and **47** which mesh with worm gears **48** and **49** secured to the vertical rollers **23** and **24** respectively. Rollers **20** and **25** are driven through suitable transmission means (not shown) in synchronism with the rollers **23** and **24** to prevent the band **18** from

binding during the transitions from the horizontal lay to the vertical and vice versa. The band is driven sufficiently rapidly to prevent the nitric-acid bath **33** from eroding the exposed electrodeposition surfaces thereof.

In operation, silver metal goes into solution at the anodes **22** while silver oxide is deposited upon the flexible cathod **18** therebetween. After compression by rollers **24** and **25**, the silver-oxide mass is washed in the water bath **27** and converted to silver nitrate in compartment **16**, while the band, after a subsequent washing, is returned in a continuous process to the alkaline electrolyte **21**.

Example

A stainless-steel band **18**, 1 meter in width, is advanced through the compartment **14** at a speed of **3** meters per minute. Silver oxide is deposited upon the band with a current density of 0.45 ampere per square centimeter from a 28.8% solution of potassium hydroxide saturated with potassium acetate and having a specific gravity of approximately 1.295 at room temperature. The anodes **22** are positioned 40 centimeters from the band **18** so that a deposition voltage of only about 12 volts is required. After a run of about 25 minutes, 10 kg. of silver nitrate may be removed from compartment **16**.

The invention as described and illustrated is believed to admit of many modifications and variations which are within the ability of persons skilled in the art and are intended to be included with the spirit and scope of the invention, except as further limited by the appended claims.

I claim:

1. A process for producing silver nitrate, comprising the steps of depositing a loosely adherent mass of silver oxide on a conductive endless band by passing said band through an electrolyte containing the ions of a soluble silver salt while maintaining said band at a negative potential with respect to a silver anode in said electrolyte,

compressing said mass against said band, passing the band carrying said mass through a heated nitric-acid bath whereby said silver oxide is converted to silver nitrate, and stripping said silver nitrate off said band.

2. A process according to claim **1**, further comprising the steps of washing said band in water before and after its passage through said nitric-acid bath.

3. Process according to claim **1** wherein said band is moved through said electrolyte in a substantially vertical position whereby said coating is deposited on both of its sides.

4. A process according to claim **1** wherein said band is made of a material which is substantially inert in said electrolyte and in said bath.

5. A process according to claim **4** wherein said material is stainless steel.

6. A process according to claim **1** wherein said band is advanced continuously through said electrolyte and said bath.

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