UNITED STATES PATENT OFFICE.

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PROCESS OF DISSOLVING METALS IN AMMONIACAL SOLUTIONS.

SPECIFICATION forming part of Letters Patent No. 298,149, dated May 6, 1884.

Application filed November 7, 1883. (No specimens.) Patented in England February 9, 1883, No. 737; in France August 8, 1883, No. 156,941, and in Belgium October 27, 1883, No. 63,003.

To all whom it may concern:

Be it known that I, CHARLES ROMLEY ALDER WRIGHT, a subject of the Queen of Great Britain, doctor of science, consulting chemist, residing at 3 Castillain Road, Maida Vale, in the county of Middlesex, England, have invented certain new and useful Improvements in the Production of Metallic Solutions, (for which I have received Letters Patent in Great Britain, No. 737, dated February 9, 1883; in France, No. 156,941, dated August 8, 1883, and in Belgium, No. 63,003, dated October 27, 1883;) and I do hereby declare that the following is a full, clear, and exact description of the invention, which will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to improvements in the production of certain compounds of copper and zinc with oxygen and watery solution of ammonia, which form fluids capable of being employed for various useful purposes. It is well known that when metallic copper is moistened with or immersed in watery solution of ammonia and exposed to the air, oxygen is gradually taken up by the copper from the air, and the oxide of copper formed dissolves in the solution of ammonia, forming a blue liquid. This ammoniacal solution is sometimes spoken of as "copperized ammonia," as "cuprammonium," or otherwise as solution of "cuprammonium hydrate."

The object of this invention is to render practicable the manufacture, with facility and speed, of large quantities of this liquid, and also of the analogously-constituted ammoniacal solution containing zinc instead of copper, which may be termed "solution of zinc ammonium hydrate," and also of analogous solutions containing both copper and zinc, simultaneously.

In accordance with my invention I proceed as follows: Metallic copper in suitable fragments, either in small lumps of solid metal in the condition of clippings or cuttings of sheet-copper, or in the form of copper filings or of precipitated copper, is covered with a solution of ammonia in water, or with a weak solution of cuprammonium hydrate containing an amount of free ammonia in solution dependent on the strength of the copper solution ultimately required. A current of air is then caused to pass through the whole by means of any convenient air-pump or blowing-engine in such a fashion that the bubbles of air pass over and among the portions of metallic copper, which, if in powder or in particles or pieces of only minute size, may advantageously be kept more or less in suspension in the liquid by means of any convenient mechanical agitator. In a few hours the liquid becomes saturated with as much copper as it can permanently dissolve, the rate of solution varying with the form of the vessel containing the materials, the strength of the ammoniacal fluid, and the rate of the passage of the stream of air.

As an example of the manner in which the process may be carried out may be given the following: A vertical cylindrical tower is constructed of wrought or cast iron and provided with a perforated false bottom or grating a few inches above its base. The tower may be twenty inches in internal diameter and ten feet in height. Cuttings of sheet-copper are thrown into this tower so as to fill it, the cuttings being loosely piled on one another. The tower is then filled with watery solution of ammonia within a few inches of the top, or less completely, so as to allow for frothing. A stream of air is then injected under the false bottom, either by means of an external pipe communicating with the tower at that level or by means of a pipe passing to the base of the tower down the inside thereof. This stream of air may pass through the tower at a rate of from five thousand to fifteen thousand gallons per hour. If the watery solutions of ammonia be about half saturated—that is to say, if it contains about one hundred and fifty pounds of actual ammonia in one hundred gallons of fluid—a few hours blowing will cause the ammonia solution to take up practically as much copper as it can permanently retain in solution—viz., about twenty pounds of copper in one hundred gallons of fluid.

The progress of the action may conveniently be tested from time to time by drawing a sample of the fluid and determining, by means of well-known simple analytical methods, the actual quantity of copper in solution, so that the blowing may be stopped when the liquid is sufficiently rich in copper for the particular purpose in view.

Instead of a perforated false bottom or grating, the base of the tower may be fitted with an iron pipe bent spirally or constructed star shape, and perforated at intervals with holes in such a way that when this pipe is connected with the air-supply a multitude of little streams of air issue through the holes and rise up in the tower, as they would do through the perforations of the false bottoms or through the interstices of a grating.

I find it advantageous to close in the tower at the top, providing a suitable man-hole for charging the tower with cuttings of copper from time to time, as required, and a pipe, by means of which the issuing air can be led away to the base of a second similar tower, through which this air is also made to pass. Three, four, or even more such towers may thus be connected, so that the same air-stream traverses all of them in succession. In this way the amount of ammonia-gas which is unavoidably lost through being carried away by the issuing air is materially diminished in proportion to the total quantity of copper dissolved.

If it be desired wholly to avoid weakening of the fluid as regards the amount of ammonia present therein, the air-stream may be mixed with a sufficient quantity of ammonia-gas before passing into the towers, which may be conveniently done by causing the air to pass through a solution of ammonia of suitable strength, or through a mixture of sulphate of ammonia and milk of lime, or other materials which will generate ammonia in ways well known to chemists. By increasing the amount of ammonia relatively to the air with which it is admixed, it is practicable not merely to avoid weakening of the solution ultimately obtained as regards the amount of ammonia present therein, but also to increase the ammoniacal strength of the fluid.

When a large bulk of liquid already containing some copper in solution and enough ammonia to enable it to dissolve additional copper is required to be so treated that more copper is to be dissolved therein, I find it advantageous to proceed in the following way: The total liquid to be treated is collected in a suitable tank, from which it is pumped into the first of a series of closed-in towers, entering at the base at the same level as the air. When the towers are thus sufficiently filled by reason of the liquid overflowing from the first tower when filled into the next, and so on, the air-current is made to pass through the series of towers, the liquor being still pumped in, so that at the far end there issues from the exit-pipe not only air with a little ammonia-gas, but also solution of cuprammonium hydrate in a more or less frothing state. The issuing air, fluid, and froth are led into a sufficiently capacious tank, which may be conveniently covered over and provided with an exit-pipe near the top for the air to escape. In this tank the froth breaks, and solution of cuprammonium hydrate collects at the bottom of the tank, from which it is run by gravitation or pumped either to a store-tank for use or back again to the original tank from which it was pumped to the towers, so as to be pumped again through the towers, and thus further strengthened as regards the amount of copper in solution.

Sometimes, instead of providing the needed ammonia in the form of a watery solution, as first above described, I proceed as follows: Metallic copper in lumps or fragments of convenient size is loosely piled inside a vertical tube or tower or other conveniently-shaped vessel, and water is allowed to trickle from a pipe or cistern over the copper, so as to keep its surface moist. At the base of the tower a current of air, mixed with ammonia-gas, is caused to pass into the tower, so as to ascend upward, meeting the descending water as it trickles over the copper. Under these conditions the copper becomes oxidized, and the water dissolves, first, the ammonia-gas, and, secondly, the oxide of copper formed, so that the liquor which passes out at the base of the tower is a solution of cuprammonium hydrate, the strength of which depends on the proportions subsisting between the bulk of the mass of copper, the quantity of water trickling over it, and the amounts of air and ammonia-gas supplied in a given time. The same result is equally arrived at if, instead of water, a weak solution of ammonia or of cuprammonium hydrate be allowed to trickle over the copper.

As another form of apparatus suitable for carrying out the process may be mentioned the following: A vertical iron tower or tube is provided, which may be ten inches in internal diameter and ten feet in height, and I fill it with fragments consisting of scraps of copper or cuttings of copper-sheet. Onto this mass of copper loosely piled together I allow water to trickle, while at the base of the tower I pass in, by means of a pipe, a mixture of air and ammonia-gas, which, passing upward through the tower, acts on the copper and water present, forming a solution of cuprammonium hydrate, which is allowed to trickle out at the base of the tower into a tank or other convenient receptacle.

The rate at which water should be admitted to the tower depends on the proportion subsisting between the ammonia-gas and the air also admitted, and on the absolute quantity of ammonia passed through the tower in a given time. If the mixture of air and ammonia-gas be such as that contained in the spent air passing out from a series of towers, such as those first-above described, the water must be admitted only in a comparatively small quantity; otherwise the issuing cuprammonium-hydrate solution will be too weak to be of practical value. More water may be admitted when larger quantities of ammonia-gas are present, such as are obtained by connecting with the base of the tower a pipe into which is led not merely air driven by a blowing-engine, but also ammonia-gas generated by well-known chemical processes, such as heating together sulphate of ammonia and lime. In this case, if it be required to make a solution of great ammoniacal strength, it is desirable to apply some well-known means of cooling to the tower—such as a water-jacket—in order to avoid the heating of the liquid owing to the heat developed during the condensation of the ammonia in the water.

In certain cases I find that it is advantageous to use a series of towers, so that the stream of air mixed with ammonia-gas shall pass through each in succession, the weak solution of cuprammonium hydrate obtained in the later towers of such a series being employed instead of water to trickle over the copper contained in the towers arranged earlier in the series.

In certain cases I find that it is advantageous to proceed in the following way: By means of a series of suitable towers, a solution of cuprammonium hydrate is prepared containing a certain amount of copper in solution and a considerable quantity of ammonia, so that the fluid is capable of permanently dissolving more copper than is actually present therein. This solution is readily regulated as regards the quantities of ammonia and copper dissolved therein by suitably regulating the proportions between the ammonia-gas and the air led through the towers and the rate of passage of the mixture of air and ammonia relatively to the water used. The solution thus obtained is then pumped, together with air or with a mixture of air and ammonia-gas, through a second series of towers, either once or repeatedly, until it is of sufficient richness in copper. The air which issues during this part of the operation from this second series of towers is led through a final or exhaust tower, and the weak solution of cuprammonium hydrate thus obtained is employed instead of water in the first series of towers. In this way the ammonia that would otherwise be carried away from the second set of towers by the issuing air is practically wholly recovered.

This invention also relates to the production of solutions containing zinc ammonium hydrate, either alone or admixed with cuprammonium hydrate.

It is well known to chemists that zinc possesses the power of displacing copper from various of its compounds. To the general rule cuprammonium hydrate is no exception, so that if cuprammonium hydrate be digested with metallic zinc, copper is deposited and zinc ammonium hydrate formed.

If in working, as hereinbefore described, a mixture of metallic copper and metallic zinc in pieces or fragments be employed instead of copper alone, the result is that a solution of cuprammonium hydrate is first formed from the copper present, and is then more or less completely decomposed again by the zinc, forming a solution containing zinc ammonium hydrate, together with such an amount of cuprammonium hydrate as has escaped decomposition.

Instead of using a mixture of separate fragments of copper and zinc, I have found that the two metals, alloyed together in the form of brass, or of other similar mixtures of metals essentially consisting of copper and zinc, with but small amounts of other metals, may be employed with the same result—that is to say, of producing ultimately a solution containing both zinc ammonium and cuprammonium hydrates simultaneously.

If it be desired to produce a solution containing simultaneously both copper and zinc, the former being present in greater quantity relatively to the latter than can be obtained by the solution of brass alone, a mixture of metallic copper and of copper-zinc alloy is to be employed, the quantity of the former being proportioned to the extra amount of copper that it is desired that the solution should contain.

When it is desired to produce a solution of zinc ammonium hydrate free from copper, this may be obtained by making either a solution of cuprammonium hydrate or one containing both cuprammonium and zinc ammonium hydrates by any of the above-described ways, and then digesting the liquor for a sufficient time in closed vessels with fragments of metallic zinc.

Having now described the nature of my said invention and the manner in which the same may be carried into effect, I wish it to be understood that I do not confine myself to the exact details as above described in the examples given, inasmuch as the shape and dimensions of the towers, vessels, and other appliances employed and their material mode of construction and arrangement, and the velocity and amount of air-current used, and the amount of ammonia-gas and of water employed, may be varied to a large extent, and must be so varied to suit particular cases; but

What I claim as my invention is—

The hereinbefore-described process of treating metals to produce solutions, which consists in subjecting fragments of copper, &c., to the action of water, ammonia, and a stream or streams of air, substantially as set forth.

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Witnesses:
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