weights of sulphur corresponding to the several atomic weights of silver.

ATOMIC WEIGHT OF SULPHUR.
If Ag=107.930 and Cl=35.473, S=32.113
If Ag=107.890 and Cl=35.460, S=32.078
If Ag=107.880 and Cl=35.457, S=32.069

The lowest value in this case, as well as in the case of nitrogen, is the one supported by the recent work on the densities of gases. The unanimous verdict of these very different results is interesting, and possibly significant.

In conclusion, it is a pleasure to acknowledge the generous assistance of the Carnegie Institution of Washington, without which the present work could not have been performed.

Summary

The most important results of the research may be briefly summed up as follows:

(1) A method for the preparation of pure silver sulphate was devised.

(2) The specific gravity of silver sulphate (previously fused) was found to be 5.45.

(3) Indication was obtained that Stas was unable wholly to reduce silver sulphate in hydrogen.

(4) Silver sulphate was found to be occluded by silver chloride from solutions containing an excess of sulphuric acid.

(5) It was proved that silver sulphate can be completely converted into silver chloride by heating in a current of hydrochloric acid gas.

(6) 100.000 parts of silver sulphate were thus found to yield 91.933 parts of silver chloride.

(7) The atomic weight of sulphur as calculated from this ratio, if oxygen is taken as 16.000, with several assumed values for silver is:

Ag=107.93   S 32.113
Ag=107.89   S 32.078
Ag=107.88   S 32.069

THE CONSTITUTION OF AMMONIUM AMALGAM.

BY GEORGE MCPHAIL SMITH.

The substance known as ammonium amalgam was first obtained by Seebeck[1], immediately following Davy's announcement of the discovery of potassium and sodium. Seebeck prepared the amalgam by the electrolysis of moistened ammonium carbonate, with a mercury cathode. About the same time, Berzelius and Pontin obtained a like result with a

[1] Ann. 66, 191 (1808).

solution of ammonia. This discovery they communicated to Davy, declaring their conviction that ammonia, like potash and soda, must be an oxide, and that the new substance was a compound of its metallic constituent with mercury. Davy[1] immediately began a series of elaborate experiments on the preparation and properties of the amalgam ; and, in an account of these experiments laid before the Royal Society, he first used the name "ammonium" to indicate the supposed metallic basis of ammonia. Davy discovered that ammonium amalgam could also be readily prepared by the action of moistened sal ammoniac on potassium amalgam.

In the following year Gay-Lussac and Thénard investigated the properties of the amalgam, and were led to regard it as a triple compound of mercury, ammonia, and hydrogen. Thénard afterwards described the amalgam, in his "*Traité de Chimie*," under the name of "ammoniacal hydride of mercury."

In 1816, Ampère[2], in the passage where the now universally received views on the constitution of ammoniacal compounds are first propounded, refers to the amalgam. Speaking of the difficulty of assimilating the constitution of ammoniacal to metallic salts, he says that this difficulty would disappear if it was admitted that, just as cyanogen, although a compound body, exhibits all the properties of the simple bodies which are capable of acidifying hydrogen, so the combination of one volume of nitrogen and four volumes of hydrogen which is united to mercury in the amalgam discovered by Seebeck, and to chlorine in the hydrochlorate of ammonia, behaves in all the compounds which it forms like the simple metallic substances.

This theory was more fully developed by Berzelius, and was soon generally received, excepting as regards the amalgam. Concerning this, various conflicting opinions have been entertained. Daniell, for example, speaks of it as a mere mixture of mercury and gases, resulting from the cohesion of the mercury and the adhesion of it to the gases ; and he cites the absorption of oxygen by melted silver as a similar case. Grove, in 1841, made a few experiments on the amalgam and advanced the idea that it is a chemical compound of mercury and nitrogen, merely swelled up with hydrogen. Weatherill[3] investigated the amalgam, and came to the conclusion that it is not an alloy of mercury and ammonium. Landolt[4] showed that the electrolytically prepared amalgam contains approximately 2 volumes (2.15-2.4) of ammonia to 1 volume of hydrogen. According to Landolt, however, the amalgam differs from those of potassium and sodium in not giving double decompositions with aqueous solu-

[1] Phil. Trans. 1808, 353.
[2] Ann. chim. phys. 1816, II, 16 (Note).
[3] Silliman's Amer. J. (2) 40, 160 (1864).
[4] Ann. (Suppl.) 6, 346 (1868).

tions of copper, silver and iron salts; although it contains the group NH_4 in combination with mercury, it should not be considered as a veritable metallic amalgam.

In 1872, Routledge[1], who regarded Landolt's volume determinations as unsatisfactory, repeated his experiments and obtained as the mean of four determinations the values: vol. NH_3 : vol. $H_2 = 1.96 : 1$. Routledge also determined the effect of pressure on the inflated mass; its compressibility agrees fairly well with the supposition of its being a gas and mercury, though it is somewhat less compressible. Routledge concludes that ammonia and hydrogen are here combined, because of the evolution of the gases in atomic proportions[2]; and that the compressibility of the mass proves that the enlarged volume or swelling up is due to free gases entangled in it. That the NH_4 is combined with mercury he thinks probable, because of the apparently uniform diffusion of NH_4 throughout the mass, and from the fact that such a union would be only one additional instance of the innumerable cases in which this radicle plays the part of a metal. He says: "We may admit that such a compound is originally formed, and decomposes rapidly into mercury, ammonia, and hydrogen, while the gases, becoming entangled in the mass, impart to it that remarkable turgescence, which is not, however, a property of the original compound, but merely an accidental result of its decomposition."

The next important addition to the solution of the problem was furnished by LeBlanc,[3] in 1890. LeBlanc considers that Landolt's failure to obtain double decompositions with ammonium amalgam and the salts of copper, etc., did not disprove the metallic nature of ammonium in its amalgam. It is rather possible that, owing to its instability, ammonium has not the force necessary to displace metals from their compounds, but that it immediately decomposes on severing its union with mercury. Employing mercury cathodes, LeBlanc electrolyzed solutions of alkali, and alkaline-earth salts, and measured the polarizations between the resulting amalgams and amalgamated zinc. He found them greater by about 1 volt than the polarization arising from the electrolysis of hydrochloric acid. He then electrolyzed ammonium salt solutions under the same conditions, and compared the resulting polarization on the one hand with those given by the metallic amalgams, and on the other hand with that arising from the electrolysis of hydrochloric acid. According to whether the value obtained with ammonium amalgam corresponded with the former or with the latter of these values, the conclusion could be drawn that here in the mercury a body analogous to the alkali metals

[1] Chem. News, 26, 210. The writer acknowledges his indebtedness to this paper for much of the historical data in the preceding.
[2] It is, however, hard to see how this fact alone can prove combination.
[3] Z. physik. Chem. 5, 467.

was present, or that the polarization was due only to hydrogen.[1] The values obtained led to the conclusion that a metallic body analogous to potassium and sodium was combined with the mercury to form ammonium amalgam. A difference between it and sodium and potassium amalgams was noticed in the greater fall in potential, in the case of ammonium amalgam, on breaking the primary circuit. This LeBlanc ascribes to the greater instability of this amalgam, as well as to its low NH_4 content.

Some ten years later, Coehn and Dannenberg[2] compared the phenomena of depolarization, which were observed in the case of alkali salt solutions with a mercury cathode, with those observed with ammonium salts under the same conditions. The potential necessary for the continuous evolution of hydrogen on a mercury cathode is 1.52 volts. Coehn and Dannenberg found that if alkali metals are present in the solution hydrogen is evolved at a point below 1.52 volts. This point is characteristic of the metal, and corresponds to the formation of its amalgam. In the case of ammonium such a point was found also to exist (at 1.24 volts), in full analogy with the alkali metals. In consequence of the results of LeBlanc and of himself and Dannenberg, Coehn[3] repeated Landolt's experiments with ammonium amalgam and copper sulphate solution, only to meet with the same negative result. But, on treating ammonium amalgam, prepared at 0° by the electrolysis of a solution of ammonium sulphate, with a solution of copper sulphate, previously cooled to 0°, he found that copper was displaced from the solution. It is conceivable, however, that this reduction might be due to nascent hydrogen, resulting from the decomposition of the amalgam ; and, in order to remove this objection, Coehn sought to reduce metals by means of ammonium amalgam which are not reducible by hydrogen. On bringing the amalgam into a solution of cadmium sulphate, cadmium was precipitated, and, in order to remove the still possible objection that hydrogen might be liberated from the amalgam at a sufficiently high pressure to reduce the cadmium, it was finally shown that zinc, "the most electropositive metal[4] that can be deposited from aqueous solution," is also reduced from its sulphate solution by ammonium amalgam. Coehn says this should remove the last objection as to the metallic nature of ammonium.

But Coehn has overlooked the fact that, according to LeBlanc,[5] atomic

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[1] Not being an ion, NH_3 would have no influence.

[2] Z. physik. Chem., 38, 609 (1901).

[3] Z. anorg. Chem., 25, 430 (1900).

[4] Zinc, however, is not in reality the most positive metal that can be deposited from aqueous solutions in presence of mercury. Kraut and Popp (Ann., 159, 188 (1871)) discovered that even potassium is precipitated from its salt solutions by sodium amalgam. Cf. Smith : J. Physic. Chem., 8, 212 (1904); 9, 13 (1905). Am. Ch. J. 37. 506 (1907).

[5] loc. cit., 476 f.

hydrogen is capable of precipitating zinc under strikingly similar conditions. To 10 cc. $N/1$ HCl Le Blanc added a small amount of $N/1$ NaCl or $N/1$ BaCl$_2$ etc., and on electrolyzing the solution no increase in the voltage of the polarization current was observed,—an indication that amalgam formation did not take place. This he explains as the result of the greater migration velocity of hydrogen as compared with the metals; relatively few metallic atoms would arrive at the cathode, and, owing to the high concentration of hydrogen, even they would be prevented from amalgamating. On the addition of ZnCl$_2$, however, in place of NaCl or BaCl$_2$, zinc amalgam was formed and the evolution of hydrogen on the cathode ceased altogether. LeBlanc says this process cannot be primary, for against this the experiments with NaCl, etc. solutions speak, and furthermore it is not apparent how the evolution of hydrogen could cease in that case. '' The phenomenon is doubtless secondary : hydrogen is separated, and this precipitates the zinc from the zinc chloride solution with the formation of hydrochloric acid.''

In a recent investigation, Moissan[1] prepared ammonium amalgam by the action of pasty sodium amalgam on a solution of ammonium iodide in liquid ammonia.[2] At $-39°$ the reaction proceeded smoothly, and the amalgam became more fluid without inflation or evolution of gas. The product was washed with liquid ammonia, and then, at $-80°$, with ether. The amalgam was found to be stable in a vacuum at $-80°$, but on coming to the room temperature it gradually decomposed : it began to swell at $-30°$, and at $-15°$ its volume was 15-20 times that at $-80°$. During its decomposition the temperature of the sealed tube containing the amalgam rose $5°.6°$ above the surrounding temperature. As the mean of seven experiments, Moissan obtained the volume relation : NH$_3$:H$_2=$ 1.99:1. He says: '' In this series of analyses the radicle NH$_4$, corresponding to two volumes of ammonia and one volume of hydrogen, would seem to exist in the metallic mass prepared at $-39°$. That however can hardly be ; in reality the hydrogen of hydriodic acid appears to furnish a simple or double ammoniacal metallic hydride, and it is the decomposition of this hydride which produces the inflation.''

Still more recently, Rich and Travers[3] have made a series of cryoscopic determinations with ammonium amalgam, similar to those of Tammann[4] with sodium amalgam. From their results they conclude that : ''The resemblance in the behavior of sodium amalgam and ammonium amalgam is very marked, and leaves no room for doubt that the latter is really a solution of ammonium in mercury. This view is sup-

[1] Bull. soc. chim. (3) 27, 714 (1902).

[2] The liquid ammonia alone had no action whatever on the sodium amalgam.

[3] J. Chem. Soc. (London) 89, 872 (1906).

[4] Z. physik. Chem., 3, 440.

ported by the fact that the amalgam continues to evolve ammonia and hydrogen after it has been allowed to stand for many hours at the temperature of the experiment. Further, if the temperature of the amalgam is allowed to rise until the volume begins to increase, and the amalgam is then cooled, it appears to return to its original state ; hence it is not impossible that 'ammonium' can exist transitorily in the free state.''

It is seen from the foregoing that at the present time there are three theories in regard to the constitution of ammonium amalgam : (1) the German theory of LeBlanc (1890), according to which it is a compound of the metallic radicle NH_4 with mercury; (2) the French theory of Moissan (1902), who, in harmony with the old view of Gay-Lussac and Thénard, regards the substance as a simple or double ammoniacal hydride of mercury ; and (3) the theory of Rich and Travers (1906), according to which it is simply a solution of free NH_4 in mercury.

The experimental results of the present paper are in complete accord with the theory of LeBlanc. Furthermore, they show the views of Moissan and of Rich and Travers to be untenable.

Experimental Part[1]

Moissan[2] supports his opinion that ammonium amalgam is in reality an ammoniacal hydride of mercury, not containing the radicle NH_4, with the sole fact that when a solution of sodium hydride in sodium amalgam is allowed to stand with aqueous ammonia, an intense swelling takes place, with formation of a buttery mass which maintains itself for two or three days in the ammoniacal solution ; while, if sodium amalgam alone is treated with the same liquid, hydrogen is slowly evolved, with no inflation of the amalgam.

Moissan's experiments with sodium amalgam and ammonia have been extended by the writer to potassium, lithium, barium, strontium and calcium amalgams. The amalgams were prepared by the electrolysis of salt solutions of the corresponding metals with mercury cathodes. The mercury was contained in a small beaker, under the solution to be electrolyzed, and was connected with the circuit by means of a platinum wire fused through the closed end of a small glass tube. The tube in turn contained mercury, and into this dipped the copper wire of the circuit. The anode was of platinum foil. The mercury was stirred from time to time during the electrolysis, in order to distribute the amalgam throughout the mass. The amalgams prepared were approximately of

[1] The mercury used in the following experiments was carefully purified by shaking it with a solution of potassium dichromate acidified with the sulphuric acid, and then causing it to run several times in succession, through a capillary tube, into a tall, upright cylinder containing a solution of mercuric nitrate, strongly acidified with nitric acid. Its purity was finally confirmed by analysis. The salts employed were of Kahlbaum's manufacture.

[2] loc. cit.

the compositions : 0.5 per cent. K ; 0.5 per cent. Na ; 0.04 per cent. Li : 0.35 per cent. Ba ; 1.0 per cent. Sr ; and 0.03 per cent. Ca.

In six test tubes, mixtures of 1 cc. each of the respective amalgams with 5 cc. of saturated ammonium chloride solution were allowed to stand at 20°. The potassium amalgam gradually swelled up, until at the end of one hour its volume had increased to 9 cc. It remained stationary at this point for many hours. The sodium amalgam overflowed the test tube and reached a volume of about 20 cc. in one minute. The lithium amalgam gradually expanded to 3 cc., but did not exceed that volume. This was apparently owing to the size of the gas bubbles, which quickly escaped from the amalgam. The barium amalgam expanded very slowly, attaining a maximum volume of 2.5 cc. in one hour and 25 minutes. The strontium amalgam expanded to 10 cc. in 5 minutes, and after 40 minutes it had regained its original volume. The calcium amalgam expanded to nearly 2 cc. in 1 hour and 15 minutes. It then gradually receded to its original volume.

After having thus ascertained that all the amalgams in question gave ammonium amalgam (recognizable by the phenomena accompanying its decomposition) with ammonium chloride solution, the experiments were repeated in the same way with aqueous ammonia. The amalgams were treated, in portions of 1 cc., with 5 cc. of chemically pure ammonia water (sp. gr. 0.90), taken from a freshly opened bottle. In order to prevent the formation of ammonium salts, due to the absorption of acid vapors by the ammonia, the test tubes were loosely stoppered and then covered with larger, inverted test tubes. In this way the ammonia was completely protected from any acid fumes present in the air. Without this precaution the sodium amalgam began to inflate after 10 or 12 hours.

In this solution the potassium amalgam attained a volume of 4 cc. in 24 hours. This volume remained constant for eight days, and on the ninth day it had shrunk back to 1 cc. Hydrogen was very feebly evolved all along, but much more slowly than from sodium amalgam and the same solution. The sodium amalgam did not become inflated at all, and hydrogen was evolved from it with about the same rapidity as in a blank experiment with 1 cc. of the same amalgam and 5 cc. of distilled water. The lithium amalgam expanded to 3 cc. in 20 minutes, and then it gradually went back to 1 cc. in about six hours. The barium, strontium and calcium amalgams slowly swelled to maxima of 1.2 cc. in 25 minutes, 1.3 cc. in one hour, and 1.4 cc. in three and one-half hours, respectively.

The inflation of the amalgams is plotted graphically on the accompanying charts. Although the sodium amalgam, for some reason, does not become inflated when treated with aqueous ammonia, all the others do ; and, taken in this connection, the experiments of Moissan with sodium amalgam alone, and with sodium amalgam containing sodium

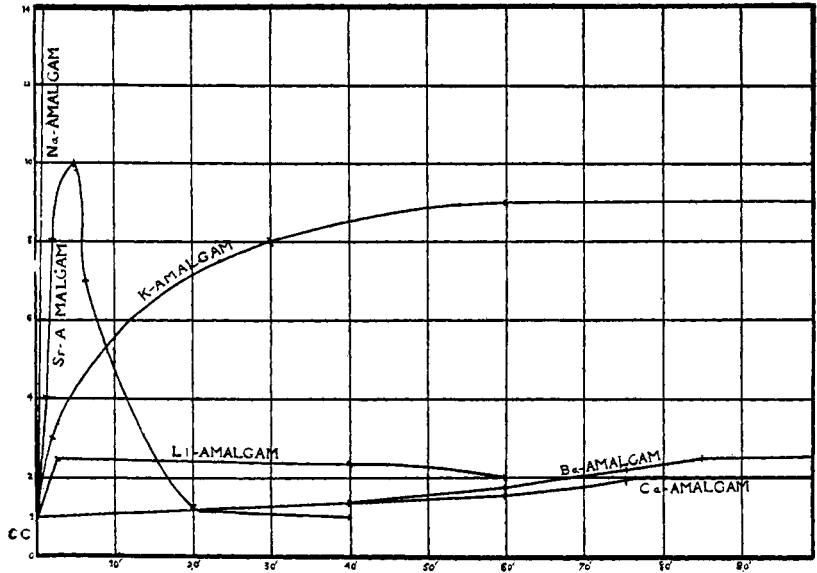hydride are seen to be irrelevant. They furnish no evidence that am-

CHART 1.
Inflation with NH_4Cl Solution at Room Temperature.

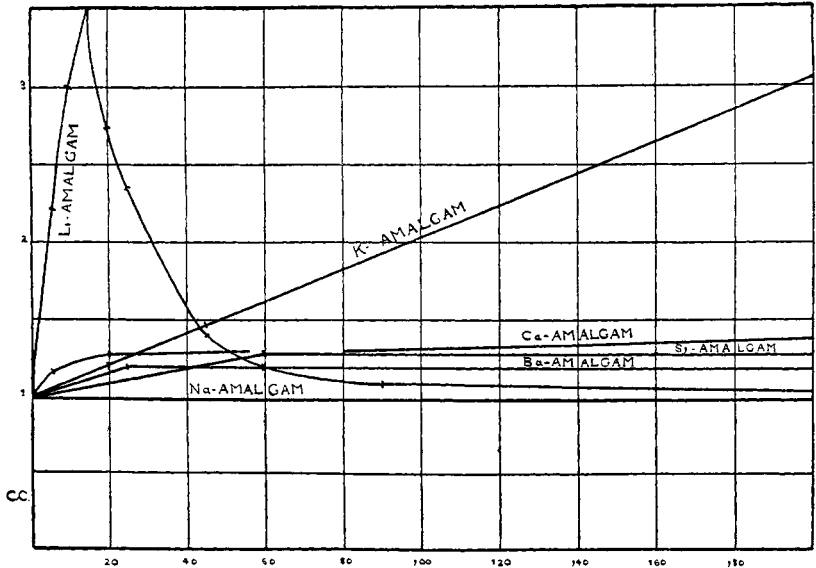monium amalgam does not contain the radicle NH_4, or that it is an am-

CHART 2.
Inflation with Aqueous Ammonia at Room Temperature.

moniacal hydride of mercury.

Moreover, a very slight tendency towards inflation was noticed in the case of the sodium amalgam and ammonia ; the action of the water appeared, however, to predominate over that of the slightly dissociated ammonium hydroxide present in the ammonia. To obviate this difficulty the experiment was repeated several times in duplicate as follows, —and always with similar results. One of the tubes, containing 1 cc. of amalgam and 5 cc. of ammonia, was allowed to stand at the ordinary temperature, as before, while the other was kept for about one hour in a freezing mixture at from 3° to 10° below zero. The amalgam in the first tube evolved hydrogen continually at constant volume, while that in the cold ammonia showed at its surface a slight, but distinct inflation. When taken from the freezing mixture and allowed to stand at room temperature, it attained in 45 minutes a volume of from 1.3 to 1.7 cc., depending on the concentration of the sodium amalgam used, and the degree and time of the cooling. This volume it maintained for a couple of days.

The question was next investigated whether ammonium amalgam con‑ tains the metallic radicle NH_4. Coehn's[1] work with ammonium amalgam and solutions of copper, cadmium and zinc sulphates would be direct evidence of this, if it were not for the possibility that the zinc, etc., might have been reduced by nascent hydrogen arising from the decomposition of ammonium amalgam. In addition to showing that nascent hydrogen is capable of reducing zinc, LeBlanc[2] at the same time showed that barium, potassium, etc., are not reduced in this way, even in the presence of mercury. Therefore, if ammonium amalgam should be found capable of displacing barium, potassium, etc., from their salt solutions, this displacement could only be the result of an exchange with NH_4 in the amalgam. The writer[3] has found that the metals of the alkali and alkaline-earth groups are reversibly displaceable in the form of their amalgams, and if ammonium is analogous in its amalgam to potassium in potassium amalgam, it should also possess this characteristic. This has actually been found to be the case.

Ammonium amalgam was prepared by the electrolysis of a solution of 25 g. of ammonium carbonate (volatile without residue) in 50 cc. of water. The solution was previously heated to 75°, in order to remove any ammonium carbamate present in it. The electrolysis was carried out, at —3° to 0°, in a 600 cc. beaker, the cathode consisting of 2 kg. of mercury, connected with the circuit as already described, and the anode of a horizontally disposed strip of platinum foil. The current strength was 2.3–2.5 amperes at 7 volts, and on breaking the primary circuit, a polarization current of about three volts was noted. The electrolysis was con-

[1] loc. cit.
[2] loc. cit.
[3] Am. Ch. J., **37**, 506.542 (1907).

tinued for five minutes ($=$ about 0.13 g. NH_4), during which the cathode was frequently stirred with the thermometer. The solution was at once poured off, and the amalgam washed once by decantation with ice water. It was then rapidly poured through ice water contained in a series of five beakers, the wash water being decanted each time.

The freshly prepared ammonium amalgam was immediately added, in portions of about 500 grams, to four solutions which had been previously cooled to $-1°$. These were : (1) a saturated solution of potassium chloride; (2) a solution of 25 g. of potassium hydroxide in 50 cc. of water; (3) a saturated solution of barium chloride ; and (4) a saturated solution of barium hydroxide. The mixtures were allowed to stand for 30, 45, 60 and 75 minutes respectively, the temperature being kept between 0° and $-3°$. The solutions were then decanted, and the amalgams washed as already described in ice water. They still contained ammonium, as was seen from their tendency to become slightly inflated. Especial care was taken to prevent any of the original solution from being carried along; the amalgams were poured through the water in a thin stream, and eight beakers, each containing 100 cc. of ice water, were used in the washing. The barium-ammonium amalgams displayed a tendency to form bubbles at the surface after pouring, and in every case these were broken with a blunt glass rod before the amalgam was poured into the next beaker. The wash-water from the seventh beaker was tested for barium, of which not a trace was present. Moreover the experiments were performed five or six times with identical results. The amalgams were finally extracted with hydrochloric acid, and the extracts analyzed.

In making the analyses the extracts were first evaporated to dryness. In every case some ammonium chloride was present,—especially in the case of the potassium residues. The barium residues consisted mainly of well formed crystals of barium chloride. The potassium residues were freed from ammonium chloride by volatilizing the latter, after which the potassium was weighed as K_2PtCl_6. The barium residues were taken up in water and the barium determined as $BaSO_4$. The results were as follows :

(1) $K_2PtCl_6 = 0.0192$ g. ($= 0.0014$ g. NH_4).
(2) $K_2PtCl_6 = 0.0445$ g. ($= 0.0033$ g. NH_4).
(3) $BaSO_4 = 0.0348$ g. ($= 0.0054$ g. NH_4).
(4) $BaSO_4 = 0.0090$ g. ($= 0.0014$ g. NH_4).

The foregoing experiments demonstrate positively that the radicle NH_4 in ammonium amalgam has the properties of an alkali metal ; it behaves analogously to potassium in potassium amalgam.

It remains to show that there is no evidence that the amalgam is a solution of free ammonium in mercury, while there is every indication that it is a compound of ammonium with mercury, dissolved in an excess of mercury.

Rich and Travers[1] conclude, solely on the ground of their cryoscopic investigation of ammonium amalgam, that the substance is undoubtedly a solution of ammonium in mercury. Their results are given in modified form in the accompanying table.

TABLE I.

Solute	g.NH_4 in 100 gHg m	Molecules NH_4 in 100 atoms Hg.	Depression of the freezing point $t-t_1$	Observed Mol. Wt. $\dfrac{425m.}{t-t_1}$	Theoretical Mol. Wt. of NH_4
NH_4	0.084	0.9297	2.20	16.23	18.07
"	0.057	0.6309	6.21	3.90	"
"	0.415	4.593	5.42	32.54	"
"	0.079	0.8744	1.41	23.81	"
"	0.027	0.2988	0.61	18.81	"
"	0.0094	0.1040	0.22	18.16	"
"	0.0117	0.1295	0.27	18.42	"

In cryoscopic measurements, the observed depression of the freezing point is proportional to the number of molecules of the dissolved substance in a given quantity of the solvent; hence $t-t_1$ would be practically the same, whether a given, very small amount of NH_4 were dissolved in a given, relatively very much greater quantity of mercury, in the form of free NH_4, or in the form of molecules of a compound, $NH_4.Hg_n$, containing only one NH_4-radicle to the molecule. This is readily seen from the following table, in which m_1 has been calculated from m in Table I., for a compound of the formula $NH_4.Hg_{12}$ (analogous to KHg_{12}), according to the relation:

$$m_1. = \frac{\dfrac{m. \text{ mol. wt. of } NH_4.Hg_{12}}{\text{`` at. wt.'' of } NH_4}.100}{100 - \left(\dfrac{m. \text{ mol. wt. of } NH_4.Hg_{12}}{\text{`` at. wt.'' of } NH_4} - m\right)}$$

TABLE II.

Solute	g$NH_4.Hg_{12}$ in 100 g. Hg. $m_1.$	Molecules $NH_4.Hg_{12}$ in 100 atoms Hg.	$t-t_1$	Observed mol. wt. $425.m.$ $\overline{t-t_1}$	Theoretical mol. wt. of $NH_4.Hg_{12}$
$NH_4.Hg_{12}$	12.653	1.0463	2.20	2444	2418.07
"	8.253	0.6826	6.21	565	"
"	123.74	10.648	5.42	9703	"
"	11.811	0.9768	1.41	3560	"
"	3.7443	0.3097	0.61	2609	"
"	1.2738	0.1054	0.22	2461	"
"	1.5904	0.1315	0.27	2503	"

This fact Rich and Travers have failed to realize. Their results only show that ammonium amalgam is a solution in mercury of a substance of the empirical formula $NH_4.Hg_n$; they furnish no evidence that n is

[1] loc. cit.

equal to zero.   On the other hand, the failure of Moissan[1] and of Ruff[2] to obtain any evidence for the existence of free NH_4 at very low temperatures is strong evidence to the contrary.

Furthermore, it has been shown by the writer[3] that the alkali and alkaline-earth metals exist in mercury, even in dilute solution, not in the form of single atoms, but in that of compounds of the general formula MHg_n, containing only one atom of the amalgamated metal to the molecule.   Ammonium amalgam behaves analogously to these, and we are justified in concluding that it also is a solution of a compound of the general formula $M.Hg_n$, in mercury.

The solution of the compound $(NH_4)Hg_n$ is not stable, however, except at very low temperatures. It decomposes slowly at $o°$, more rapidly at room temperature, into mercury, ammonia, and hydrogen.   The gases become entangled in the mass and give rise to the characteristic inflation, which, however, is not a property of the original compound, but merely an accidental phenomenon accompanying its decomposition.

URBANA, ILL.
February, 1907.

A NEW APPARATUS FOR POLISHING METAL SECTIONS.

By K. W. ZIMMERSCHIED.

In the teaching of metallography, the question of proper apparatus with which to provide students for polishing the sections has sometimes presented itself.   Where one is working alone, a machine such as is found on the market, with horizontal spindle carrying regularly four polishing wheels of different fineness answers very well, but where a number of persons must be provided for, this arrangement is quite unsatisfactory, since the finer wheels are too much exposed to contamination by material that will scratch the final surface of the metal, and the care requisite to avoid this contamination is exercised by a relatively small percentage of students.   Again, the outlay necessary to provide a sufficient number of such machines for a large class, and then to supply each with means for starting and stopping without interference with the work of other operators, is considerable.   The delivery of water to the surface of a wheel which revolves in a vertical plane also offers decided disadvantages, appreciated by all who have used the system, and the difficulty of taking care of the water thrown by such a wheel is still more annoying.

Having a number of men to take care of in a limited space, the author has devised the apparatus herein described, which overcomes a number of these difficulties, and which he hopes may help to solve the problem for others similarly situated.

[1] Compt. rend. 133, 713; 715; 771 (1901). Moissan obtained the reactions: $NH_4Cl + NH_3Li := Li\, Cl + NH_3 + (NH_3 + H)$; $2NH_3Li + H_2S = Li_2S + 2NH_3 + H_2$; etc., in liquid ammonia, at temperatures approaching — 100°.
[2] Ber. 34, 2604. Ruff worked at — 95°, and at pressures up to 60 atmospheres.
[3] Am. Ch. J., 36, 124 (1905); Ibid., 37, 506 (1907),