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## ORIGINAL PAPERS.

### A NEW GAS CALORIMETER.

By S. W. PARR.

Received June 27, 1910.

Undoubtedly the calorimetry of gases will receive more attention in the future than it has in the past, owing to the fact that both for lighting and power the heat content is of more importance than the candle value; and, while there is a certain relation between the two, it is not sufficiently consistent to permit of the heat units being deduced from the indicated candle power. That there is to be a transfer of standards is indicated by the recent action of the Railroad Commission of Wisconsin<sup>1</sup> and the careful study of the matter now being carried on by the Gas Commissioners of New York State,<sup>2</sup> and also by a special committee appointed by the American Gas Institute on the Calorimetry of Gases.<sup>3</sup>

The importance of the subject, therefore, being in a fair way to receive recognition, it is well at this stage to scrutinize closely the essential conditions necessary for the accurate measurement of the heat

<sup>1</sup> Report, Wisconsin Railroad Commission, No. U 21, July, 1908, pp. 19-33.

<sup>2</sup> N. Y. Public Service Commission, 2nd District, 3rd Annual Report, 1909, p. 19.

<sup>3</sup> *Proc. Am. Gas. Inst.*, 1908, p. 287.

value of a combustible gas. In the first place, the conditions are essentially different from the usual methods available for the calorimetry of coal, in that the products of combustion being gases, the absorption of heat involves the principle of convection rather than that of conduction; that is to say, the passage of heated gases over absorbing surfaces is a necessary condition where combustion of gases is involved. If, now, we will add to this fundamental conception the fact that the composition of the majority of combustible gases is of such a nature as to yield upon burning a certain amount of water which condenses, we have a condition resembling that of a wet bulb thermometer over which the currents of air are passing and which affect by the process of vaporization the temperature of the water of the interior of the system. That the exterior parts of such an apparatus are insulated and that the absorbing surfaces are on the interior and hidden from view does not alter the case. If these bare surfaces with the currents of air passing over them were placed on the outside and kept moistened, we would see, though in an exaggerated manner perhaps, the actual condition by which we are attempting to measure heat imparted by the burning of a gas which at the same time carries with it a large excess of circulating air. To just what extent there is thus brought about a modification in the actual heat discharged, it is not easy to determine. An estimate may be made of the relative quantity of air which accompanies a certain metered volume of gas and the humidity of such air taken upon entering and assumed to be saturated when discharged. Coste<sup>1</sup> has made such calculations based upon certain conditions which would seem to indicate a loss of less than 1/10 per cent. and is, therefore, negligible. There are, however, too many uncertainties or variables, such as relative humidities and ratio of air volume to gas, to admit of thus finally disposing of the matter. The loss also due to direct radiation must be considerable, since the outflowing water where the temperature is taken exceeds the room temperature by from 10° to 20°.

In order to directly indicate the error due to these conditions, a flow-type calorimeter was installed to operate upon a standard gas of known value. The procedure was as follows: pure hydrogen generated on the principle of the Parsons generator<sup>2</sup> for sul-

<sup>1</sup> *J. Soc. Chem. Ind.*, 28, 1233.

<sup>2</sup> *J. A. C. S.*, 25, 231.

BIBLIOTECA POLITECNICA

phuretted hydrogen was used, a continuous supply being thus secured in such quantity as to operate a Junker calorimeter at standard speed and under prescribed conditions. The precautions for accuracy may be briefly outlined as follows: after washing the gas in a dilute alkaline solution it was passed through a wet meter and pressure regulator. In standardizing the meter it was found to be not only in error approximately 2 per cent. to 4 per cent., but the error was variable and for no assignable cause. No suitable device was present on the meter for establishing a water-level—the automatic drain could be made to yield a water-level varying by over 100 cc. After extended and quite elaborate efforts to make this meter read correctly or with a known and determinable factor of error, it was abandoned as impossible. A meter from the American Meter Company was substituted, with satisfactory results in this regard. It is true, however, that a variation in speed causes a variation from the exact or standard volume, but in carrying on the experiments a speed was adopted which more nearly represented the correct reading for the volume of gas passing through the meter; namely,  $6\frac{1}{2}$  feet per hour. A series of experiments to determine the best type of burner resulted in the adoption of an acetylene burner known as Bray's "Elta," or rather two  $1\frac{1}{4}$  foot burners of this type placed side by side and mounted in the ends of a glass Y, the branches softened and brought close together so as to be properly adjustable in the combustion chamber. The type of burner used as well as the mounting on a glass stem insured the minimum of conduction of heat downward, and the type of flame insured a complete combustion at all speeds.

According to the specification of the Committee on Gas Calorimetry for the American Gas Institute, the ideal conditions and those which would seem to be theoretically necessary require that the exhaust gases from the instrument and the room temperature, as well as the entering gas, be as nearly as possible the same. A series of tests shown in Table I was made in which these conditions were maintained, giving a heat value per cubic foot of hydrogen, calculated to  $60^\circ$  and  $30''$  of mercury, as indicated in Table I.

If we adopt Thomsen's value for the conditions indicated, which would be 325 B. t. u., we see that there is present a constant error of 13 to 15 B. t. u., or approximately 4.5 per cent., referring to 325 as a basis.

If, now, we vary the conditions as to the temperature of the exit gases, we will be proceeding on the theory that a compensation is due the system for the heat carried away by the evaporation of water. This will be accomplished by having the exit gases lower than the temperature of the room. By this

means a point could be reached where the heat absorbed by the system would compensate for the heat carried away by the circulating atmosphere.

TABLE I.

Gas temp. Degrees F.	Room temp. Degrees F.	Exhaust temp. Degrees F.	Heat value. B. t. u./cu. ft.
79.0	80.3	80.0	311.1
79.0	79.0	79.0	311.4
82.0	82.0	82.0	310.0
83.0	84.0	84.0	311.5
83.0	84.0	84.0	311.7
83.0	84.0	84.0	312.0
83.0	82.5	82.5	310.4
83.0	82.5	82.5	312.1
83.5	83.0	84.0	310.9
83.5	83.0	84.0	310.4
81.0	82.0	82.0	309.8
81.5	82.0	82.0	310.2
78.0	77.5	78.0	310.7
78.0	77.5	78.0	311.5
78.0	80.0	80.0	311.1
78.0	81.0	80.0	309.9
77.0	78.0	78.0	309.3
77.0	78.0	78.0	310.7
77.0	78.0	78.0	311.5
76.5	77.0	76.5	311.5
76.5	77.0	76.5	311.1

The following table, II, not only establishes the fact of such compensation, but arrives at the factor of error directly and not by calculation from uncertain premises. By reference to the table it will be seen that with the temperature of the exhaust gases  $5.5^\circ$  below that of the room, the indicated heat value comes up to  $325^\circ$ , the accepted value for hydrogen. By examination of the entire series which ranges from a temperature of  $+4^\circ$  to  $-10^\circ$  and plotting a curve from the points thus indicated as ordinates

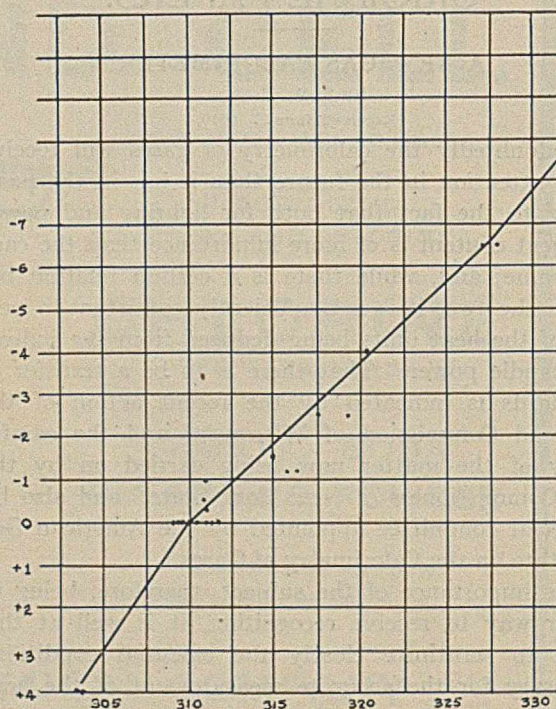


Fig. 1.

with the B. t. u. derived from each test at the designated temperature as abscissas, we have a very con-

sistent showing as to the effect of the variations in temperature of the outlet gases:

TABLE II.

Gas temp. Degrees F.	Room temp. Degrees F.	Exhaust temp. Degrees F.	Heat value. B. t. u./cu. ft.
82.0	83.5	82.0	315.0
83.0	83.0	79.0	320.6
83.0	83.0	72.5	336.1
77.0	79.0	78.0	315.9
77.0	79.0	78.0	316.6
78.0	76.5	72.5	320.6
82.0	82.0	82.0	310.0
83.0	82.0	72.0	335.6
83.0	82.0	72.0	334.9
80.0	78.0	71.5	327.4
80.0	78.0	71.5	328.1
80.0	78.0	75.5	317.6
80.0	78.0	75.5	319.4
81.0	82.0	82.0	309.4
86.0	86.0	90.0	303.4
86.0	86.0	90.0	303.5

From this data it would appear that under the conditions prescribed by the Committee of the American Gas Institute the Junker calorimeter is in error, aside from errors of the meter, from 13 to 15 units in 325, or approximately  $4\frac{1}{4}$  per cent. Doubtless the entire explanation for this does not reside in the matter of relative humidity of the air but involves also, as already indicated, a loss due to radiation. It is difficult, if not impossible, to measure this latter loss, but from the curve it seems possible to arrive at an average of all errors though they may vary appreciably under the different conditions of operation as to temperatures, humidity, etc.

If we wish to compare this indicated error with conditions of humidity, evaporation, etc., which would result in an equivalent variation from the standard, we would need approximately the following data;

10 cu. ft. of air to 1 cu. ft. of gas.	
Room temperature.....	77° F.
Relative humidity of air .....	20 per cent.

Then, 10 cu. ft. saturated air at 77° F. would carry 6.5 grams of water. A vaporization, therefore, of, say, 5 grams of water at 2.4 B. t. u. per gram shows a loss of 12 B. t. u. per cu. ft. of gas burned, or a little less than 4 per cent. A part of the variation undoubtedly should be ascribed to radiation, but the above hypothetical calculation alone accounts for the major part of the error. It is, moreover, entirely within the range of working conditions and shows a result in marked contrast to the calculation by Coste above referred to. In any event, if a less error is due to heat of vaporization, then more should be ascribed to radiation since the above experimental method of arriving at the sum of the variables would seem to be preferable to any calculation based on uncertain premises.

In the new type of instrument here proposed, two parallel systems are so arranged that equal volumes of gases may be taken and placed under equivalent conditions as to temperature and pressure, being submerged in the same vessel of water and

having the same water head for pressure. These gas volumes are arranged with burners placed under equivalent amounts of water, with conduits and stirrers devised so as to extract all of the heat. The rise in temperature is indicated on thermometers graduated to tenths, readable by means of the lenses to hundredths of a degree Fahrenheit. It will be seen that the rise in temperature of the two systems will be in proportion to their heat values. If, therefore, one of the systems employed be a standard gas, such as hydrogen or acetylene, and the value of that gas be taken at standard conditions, such as 60° F. and 30" of mercury, the standard chosen will be to the heat value of the unknown gas, at the same condition as to temperature and pressure, as the ratio of the indicated rise in temperature of the two thermometers. The details of the apparatus are carried out with reference to this principle. The stirring of the water is effected by a small motor with a common belt actuating the two pulleys, with turbines arranged on the interior of the heaters.

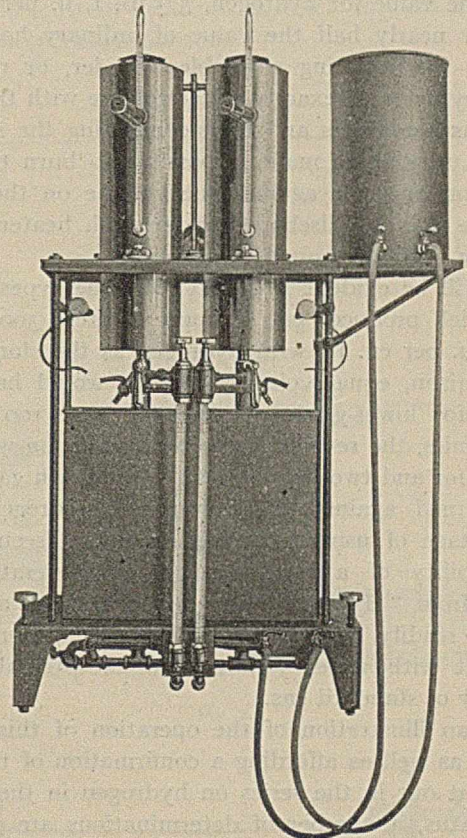


Fig. 2.

The heaters are arranged with automatic overflows at the rear, which can be adjusted to measure exact equivalents of water. Provision is made for measuring the volumes of the gases with accuracy by reducing the area of the containing vessels above and below so that the starting and stopping point may be accurately indicated on the glass gauges in front. The gas-holders are cylinders, 3" by 10", reducing

above and below to a neck of 1" in diameter and holding approximately 1½ liters. They are submerged in the large square tank which rests on the base of the instrument and hence do not appear in the figure. A swinging pilot light is provided at left and right for simultaneous ignition of the burners. From 7 to 9 minutes are required for burning out the contents of the gas cylinders, the needle valves controlling the flames being finely adjusted so that the water-levels on the glass gauge may be made to stop exactly at any desired graduation. Corresponding graduations on the two gauges represent exact equivalents of gases. It is not necessary to know the exact volume in cubic centimeters, since it is only essential to have equivalent quantities. Since these quantities are subjected to the same temperature and pressure, the operation is independent of barometric conditions and room temperature. The only condition, therefore, not covered by the above provisions is the matter of varying radiation. For this element in the case, advantage is taken of the fact that the value for hydrogen, 325 B. t. u. per cu. ft., is very nearly half the value of ordinary house gas. Hence, by installing a double cylinder, or rather a third cylinder, of exactly equal volume with the other two gas containers and cross-connecting the same in such a way as to make it possible to burn two volumes on one side against one volume on the other, we are able to discharge under each heater almost exactly equivalent quantities of heat.

It will be evident also that for some types of gas, as a rich producer gas of approximately 300 to 350 B. t. u. per cu. ft. with hydrogen as the standard of comparison, equal volumes of each would be taken, while for lower-grade material of, say, 100 to 150 heat units, the reverse of the first condition would be called for and two volumes of the unknown gas would be burned against one volume of hydrogen. The advantage of using hydrogen is further seen in the availability of a pure product by generating the same from "Hydrone," an alloy of sodium and lead which readily decomposes in a simple generator by contact with water yielding an exceptionally pure quality of standard gas.

As an illustration of the operation of this instrument, as well as affording a confirmation of the error brought out in the series on hydrogen in the Junker apparatus, a number of determinations are given in Table III, in which gas from the city supply was drawn simultaneously into each instrument and the B. t. u. determined in the prescribed manner for each apparatus, the new device using hydrogen as the standard on which calculations for that method were based. The tests extended over a number of days. The percentage of error is seen to be closely in accord with the relative temperatures of exhaust gases and the room. Where the exhaust tempera-

ture is lowest with reference to the room (2° lower as in No. 8), the percentage of error is also lowest, and where the exhaust gases are highest (2° above, as in No. 1), the percentage of error is highest. Thus, not only is the fact of the error confirmed, as shown in Table I, where the Junker is run on pure hydrogen, but also a marked consistency in the amount of error in each series is apparent, averaging approximately 3½ per cent. on the house gas and 4¼ per cent. with the hydrogen.

TABLE III.

Test No.	A. Gas temp.	B. Room temp.	C. Exhaust temp.	D.	E.	F. Diff. E-D.	Per cent. of diff. E/F × 100.
				per cu. ft. Junker.	per cu. ft. Parr.		
1	83	81	83	684	713	29	4.0
2	83	81	83	631	658	27	4.1
3	83	81	82	691	719	26	3.6
4	79	78	78	602	625	23	3.7
5	79	79	79	605	628	23	3.6
6	80	79	79	627	649	22	3.4
7	83	80	79	636	658	22	3.3
8	81	80	78	630	647	17	2.6

The results of Table III suggest another series of tests parallel with those of Table III, wherein the Junker apparatus was run under conditions indicated by the curve in Fig. 1; that is, to compensate for an average loss of 3½ per cent., or 22-24 B. t. u. for an average gas, a difference in temperature approximating 11 or 12 degrees would be called for as between the exhaust gas and the room. The results of this series are shown in Table IV:

TABLE IV.

Test No.	Gas temp.	Room temp.	Exhaust temp.	Degree lower for exhaust.	B. t. u.	B. t. u.	Diff. in B. t. u.
					per cu. ft. Junker.	per cu. ft. Parr.	
1	80	79	67	-12	636	634	+2
2	80	80	67	-13	630	627	+3
3	80	80	67	-13	633	629	+4
4	80	79	67	-12	631	630	+1
5	81	79	67	-12	618	618	0
6	78	78	67	-11	627	627	0
7	78	78	66	-12	623	620	+3
8	78	78	66	-12	620	617	+3

From these results it would seem that for a gas averaging 650 B. t. u., the Junker apparatus would need to be operated in a manner to deliver the exhaust gases at from 10° to 12° lower than room temperature.

Concerning other features of the new apparatus, the indicated values are gross and not net. From the above showing of the tables it must be evident that any attempt to arrive at the net values by taking account of the water of condensation is an approximation only. Moreover, practically all authorities agree that the gross value is the basal factor and should be recognized as such. As for portability, it has been considered far more practicable to bring the gas to the instrument rather than attempt to carry the apparatus to the gas. Since only approximately 1½ liters are employed in each determination, this is seen to be entirely feasible. A new or

different sample of gas can be charged into the cylinder as free from contamination as is possible in the filling of a gas pipette. In regular operation upon city gas drawn directly from the service pipes, approximately 10 minutes is occupied in adjusting and reading the temperatures of the heaters and filling the gas cylinders. An additional length of time is used in burning out the gas volumes and reading the final temperatures.

I wish to acknowledge my indebtedness to Mr. N. W. Hill for the diligence and care exercised in deriving the data which accompanies this paper.

**DISSOLVING CHEMICALS AND AGITATING SOLUTIONS: SOME PROBLEMS IN THE MANUFACTURE AND AGITATION OF SULPHIDE SOLUTIONS.**

By OSKAR NAGEL, Ph.D.  
Received June 24, 1910.

Sulphide of barium is produced by reduction of barytes by means of powdered coal in a reverberatory furnace. In a suitable installation of this kind about 90 per cent. of the barytes may be reduced.

The crude mass obtained by reduction is never used as such, as the impurities—coal dust, etc.—contained therein are rather undesirable for all uses which sulphide of barium is put to. In the majority of cases the sulphide has to be brought into solution by means of water, and for many uses, such as the manufacture of barium salts, lithopone, etc., the solution should be as concentrated as possible. Hence the dissolving appliances most fit for this purpose should be of great interest to the respective industries, the more so as in most factories manufacturing these products rather primitive methods are used.

In order to elute the material perfectly, care has to be taken that the water is sprayed uniformly over the entire batch. Provision must be made for conveniently charging the material and discharging residue. The water used should be warm. Furthermore, the sulphide solution first obtained should circulate and pass several times through one or more batches of solid material, if possible, according to the countercurrent principle, in order to yield a somewhat concentrated solution.

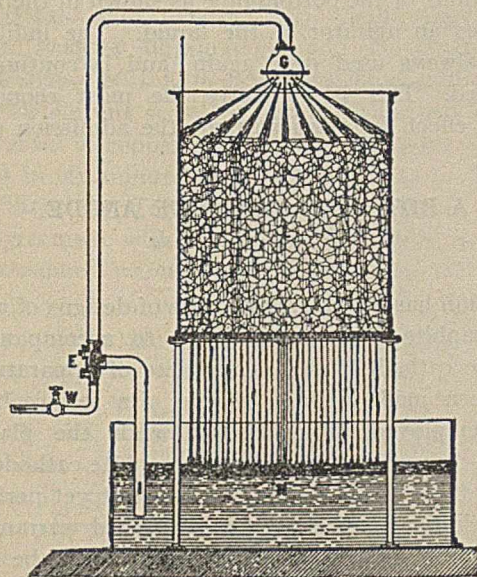


Fig. 1.

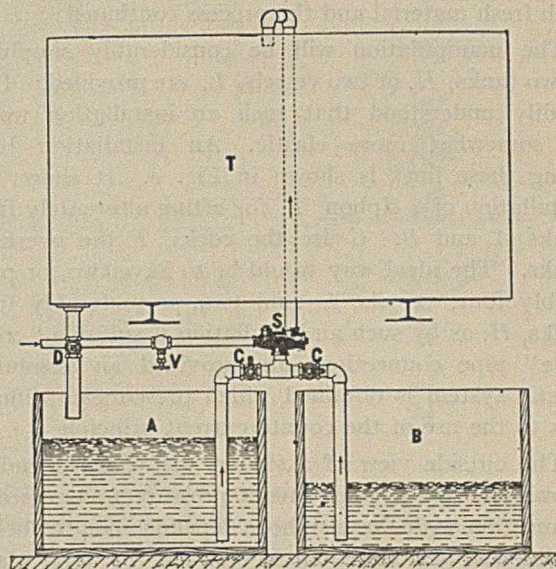


Fig. 2.



Fig. 3.

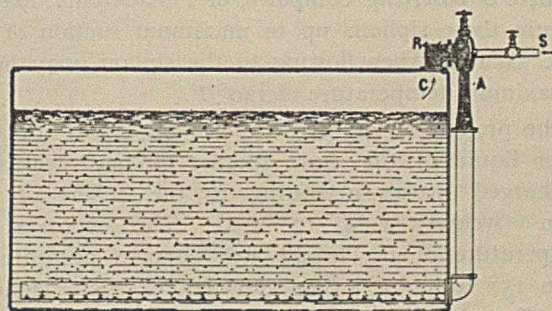


Fig. 4.

An installation in which all these points are considered is shown (in one unit) in Fig. 1; *L* is the vessel holding the material to be eluted. The material is charged at the top and discharged through a door or manhole. The water reaches the material through a spray, whereby a uniform elution is effected. The solid material is preferably supported by coarse filter cloth or perforated screens and the solution flows finally into tank *H*. The water is pumped to *L* by means of a steam-jet siphon, *E*, whereby the water or other liquid passing through the siphon is heated simultaneously. For starting up, tank *H* is partly filled with water and the steam valve opened. The steam issuing from a nozzle carries along the liquid to be transported, a considerable part of the momentum of the steam being utilized for conveying the liquid. After a short time tank *H* will contain a solution of sulphide, whereupon it may be again, by means of the same siphon, lifted and passed through *L*, which process, if only a single unit is at hand, may be repeated until the solution is obtained in the desired strength. Then the liquid can be removed from *H* and replaced by fresh water, which may be passed once through the solid (if the latter is not yet perfectly extracted); now *L* can be discharged, charged with fresh material and the process continued.

The manipulation will be considerably simplified if two tanks, *H*, or two vessels, *L*, are provided. It is readily understood that such an installation would be somewhat more elastic. An installation built along these lines is shown in Fig. 2. It shows the installation of a siphon, *L*, for lifting alternately from tanks *A* and *B*. *C* are the cocks, *T* the overhead tanks. The ideal way would be to have two, or preferably four, vessels, *L*, and two, or preferably four, tanks, *H*, as by such an installation if suitable "cross-wise" pipe connections are provided an absolutely elastic system is obtained which presents no difficulties to the use of the countercurrent principle.

The outside view of a siphon with flanged ends is shown in Fig. 3. The steam pressure to be used in connection with these siphons depends upon the height of lift and should equal in pounds the total elevation in feet. The minimum steam pressure is 20 pounds. This will pump to a height of 20 feet. The Schutte & Koerting Company, of Philadelphia, manufacture these siphons up to maximum suction of 24 feet. Water, when flowing to the siphon, may have a maximum temperature of 140° F.

The proportion of the steam to the water (or any other liquid of the same specific gravity) which is discharged varies according to the height of lift from (weight) 1.84 to 1.42. The increase of temperature of the liquid also changes accordingly from 15° to 32° F. The capacity of these siphons in gallons of water per hour is from 200 to 30,000.

For liquids of higher specific gravity the capacity is correspondingly lower.

In the manufacture of sulphides and other chemicals it is sometimes desirable to agitate liquids without causing any contact with air. Direct steam would always be satisfactory, but the immense steam consumption of the plain steam agitator prevents the use of this apparatus; the application of the ordinary steam jet blower, which furnishes a mixture of air and steam, is not permissible with substances that are oxidized by air. Hence the proper thing to use would be a steam-jet blower, which is connected to a supply of an indifferent gas. This, however, is too expensive, and the only solution of this problem that I know of is the one shown in Fig. 4. The tank *C* which contains the liquid to be agitated is provided with an air-tight cover, the space between liquid and cover being filled out by an indifferent gas. A so-called duplex steam-jet agitator is connected to the top of the tank. The steam passes through *S*, and the steam-jet issuing through nozzles provided in the body of the agitator draws in (at *C*) the indifferent gas; the mixture of gas and steam travels through *A* and passes through the perforations of the bottom pipe as shown in the figure, acting as an agitator of the liquid. The indifferent gas is always used over again, and is continuously circulated. This is evidently the most economical way to effect agitation without the admission of air.

### A ROTATING GRAPHITE ANODE.<sup>1</sup>

By J. W. TURRENTINE.

Received June 7, 1910.

Mention has already been made of designs of a rotating graphite anode which was to accompany the graphite cathode dish.<sup>2</sup> This piece of apparatus has now been made and is in use. Its serviceableness when employed in connection with the platinum Classen dish, as well as with the graphite cathode dish, is such that, although the anode is not yet perfected, this preliminary account of it is deemed warranted.

The graphite anode, it is hoped, may be found capable of supplanting the vastly more expensive platinum anode in electrochemical analysis and other electrochemical processes where the rotating anode is used. As has been pointed out, many of the beautiful and time-saving methods of electro-analysis and of electrochemical operation might fail of adoption because of the expense of the platinum apparatus involved. When graphite is employed the expense is minimized.

Little attention has been paid heretofore to special forms of anodes in electro-analysis. The efforts of

<sup>1</sup> A paper presented at the Seventeenth General Meeting of the American Electrochemical Society, at Pittsburg, Pa., May 5-7, 1910.

<sup>2</sup> Turrentine, *J. Phys. Chem.*, **13**, 438 (1909). *Trans. Am. Electrochem. Soc.*, **15**, 505 (1909). *Chem. Abstr.*, **4**, 691 (1910).

the developers of this branch of electrochemistry have been directed rather towards perfecting the cathode. There are, therefore, several useful forms of cathodes which possess both of the desired qualities of lightness in weight and of large surface area. There is still, however, need of a cheap form of rotating anode which is constructed of some non-corrodible material and which presents a large surface area. The electrical resistance within the cell then may be so slight that currents of considerable strength may be passed without difficulty.

The chief advantage to be gained from rotating the anode instead of the cathode is that the anode is then placed above the cathode, instead of in the reverse order; the oxygen which is evolved from the former does not bubble over the surface of the latter and there oxidize the deposited metal. On the other hand, the stirring in the cathode region is not so effective when the anode is rotated as when the cathode is rotated. However, when the two poles are as close to each other as they are in the apparatus which is to be described in this paper, there can be but a very slight difference in the relative effectiveness of the stirring in the electrode regions.

By means of a rotating dish anode and a dish cathode, both of platinum and the two of the same general shape, Miss Langness<sup>1</sup> performed electro-analyses with current strengths as great as 16 amperes. A half gram of copper was precipitated with this apparatus in six minutes, and an equal amount of silver in two minutes. The results obtained showed a very good agreement with the theoretical values, and the time consumed was unprecedentedly short.

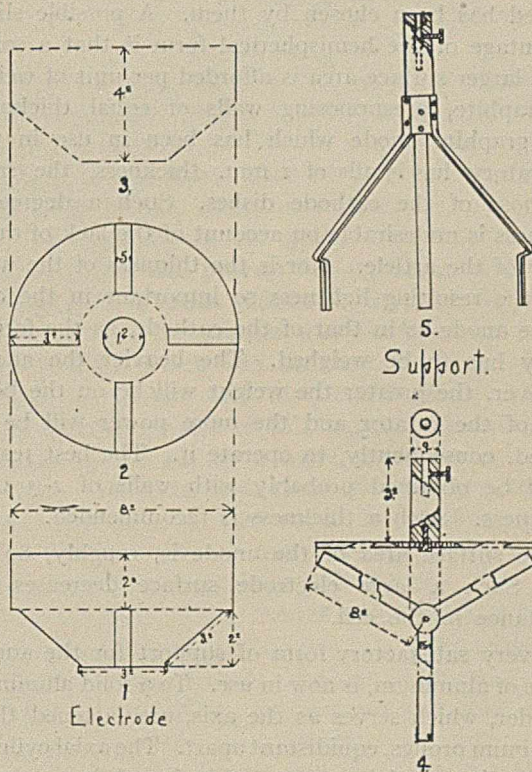
The anode used was fashioned from a platinum dish by cutting ten radial slits in its sides and by soldering, or otherwise fastening, across its top, a stout platinum wire, to the center of which was attached, T-wise, a perpendicular platinum rod to serve as the axis. This apparatus, being constructed of platinum, is expensive

The anode which it is the purpose of this paper to describe is constructed of an especially hard grade of Acheson graphite. It is dish-shaped. It is cut from stick graphite, and is turned down on a lathe to the desired size and thickness.

The anode in use was designed to accompany the graphite cathode dish, and is constructed so as to conform in shape to the shape of that dish. Its diameter is 8 cm. and its depth 4 cm. For a depth of 2 cm. from the top the object is cylindrical (see Figs. 1, 2 and 3). The contour below the cylindrical portion is that of a truncated cone. The truncation serves as the base. The slope of the frustum reduces the diameter from 8 cm. at the bottom of the cylindrical portion to 3 cm. at the truncation. The lateral dimension of the cone is also 3 cm. In the walls of

the conical portion are cut four radial, equidistant slits. These extend from the lower edge of the cylindrical part to the edge of the base. In the base is also an opening, centrally placed, which is circular in shape and is 1.2 cm. in diameter.

The orifices permit the solution contained in the cell to flow into the interior of the electrode. However, when the anode is being rotated, the centrifugal force generated holds nearly all of the solution in the space outside the anode. When the cathode is also dish-shaped, this space may be quite narrow. Then, while the electrode rotates, practically the entire volume of the solution is held constantly within



the zone of activity between the two electrodes. The arrangement of the openings is also such that the effect of a Witt stirrer is produced. The solution is drawn into the interior of the anode through the lower, axially-placed opening in the bottom of the anode, where the centrifugal force is low, and is thrown out through the lateral slits, where the centrifugal force is high. Gravitational forces then bring the solution back to the bottom of the cell.

From these statements it may be inferred that the active surface of the electrode is the outside surface. This is practically true, though it has been noted, when the electrode has been used as a cathode for the deposition of metal, that some metal is deposited on the interior, in regions near the edges of the orifices.

The dish-like contour of the anode is of special advantage when the anode is used in connection with a cathode dish. The two poles may then be

<sup>1</sup> J. A. C. S., 29, 459 (1907).

brought quite close together along their entire surfaces. The distance through the solution traversed by the current is then very short, and the resistance is correspondingly low. The diameter of the anode is 8 cm. The diameter of the graphite cathode dish designed to be accompanied by the anode is 9.5 cm. The space between anode and cathode then may be as short as 0.75 cm.

The truncated conical shape of anode was planned with the thought in mind that perhaps an object with straight edges might be more easily cut than one whose periphery was a spherical section. Drawings of both the spherical and the truncated conical shape were given the manufacturers.<sup>1</sup> The one described has been chosen by them. A possible slight advantage of the hemispherical form is that a somewhat larger surface area is afforded per unit of weight of graphite, presupposing walls of equal thickness. The graphite anode which has been in use in this laboratory has walls of 1 mm. thickness, the same as those of the cathode dishes. Such a degree of thinness is undesirable on account of the lack of durability of the article. Nor is the thinness of the walls and the resulting lightness so important in the case of the anode as in that of the cathode, as the former rarely has to be weighed. The heavier the anode, however, the greater the weight will be on the bearings of the rotator and the more power will be required, consequently, to operate it. The best results could be obtained probably with walls of 2-3 mm. thickness. Such a thickness is recommended.

The surface area of the anode is, roughly, 80 sq. cm. Such a large electrode surface decreases the resistance in the cell.<sup>2</sup>

A very satisfactory form of support for the anode, made of aluminum, is now in use. To a solid aluminum cylinder, which serves as the axis, are fastened three aluminum prongs, equidistant apart. The axial cylinder is 4 cm. long and for 2.8 cm. of its length is 0.9 cm. in diameter; for the remaining distance it is 1.2 cm. in diameter. It is provided with a hole in its top, inserted axially, to accommodate the axis of an electric motor or other rotating device. A screw enters this opening at right angles, by means of which the connection with the motor may be made secure. To the lower, enlarged portion of the cylinder are fastened the three prongs by means of rivets. The prongs are 8 cm. long, 0.5 cm. wide, and 0.2 cm. in thickness. They extend downward and outward from the axis; the circumference of the circle described by their points when the support is rotated is somewhat larger than that of the anode. When these are pressed inward, the anode may be slipped over them. Then, on being released, they press outward against the inner walls

of the anode with sufficient force to hold it in position. Fig. 5 was drawn from this support.

A support of practically the same plan and of equal efficiency could be made by cutting the prongs in one piece from sheet aluminum and fastening this piece by means of a screw to the bottom of the cylindrical piece. The prongs could then be bent to the desired angle and shape. This method of manufacture is illustrated in Fig. 4.

The cylindrical piece is 3 cm. in length. The prongs should be cut as represented, each being about 8 cm. in length from their common center. Through this center passes the screw which fastens the prongs to the axis. The finished support would have very much the same appearance as that shown in Fig. 5.

The aluminum support so far has been found entirely satisfactory. It is not necessary that the ends of the prongs should come into contact with the solution at all, this depending on the depth of the solution inside the anode. Yet, when they do, the corrosion is extremely slight, as aluminum becomes passive in solutions of most electrolytes. Nor would the presence of small amounts of aluminum in the solution undergoing electrolysis prove disadvantageous. The oxidation of the aluminum does not become sufficient to interfere with the electrical contact between the aluminum and the graphite. Should the solubility of the aluminum make its use prove undesirable, other metals could be substituted in part or in whole. The tips of the prongs could be covered with platinum foil without very materially increasing the expensiveness of the apparatus.

As suggested, the rotation is effected by fastening the support directly to the shaft of a small electrical motor of the "Ajax" type. This is the simplest and is perhaps the cheapest arrangement. Current may be admitted to the motor from a 110-volt circuit through incandescent lamps as resistance. By means of lamps of low candle power, the current, and, therefore, the speed of the motor, may be regulated satisfactorily. Electrical connection is made with the anode through the metal bearings of the motor, or by means of a brush playing on the aluminum support. The insulation in such cheap motors is often so poor that leakage currents from the circuit operating the motor may find their way through the solution undergoing electrolysis. This tendency may be controlled or entirely overcome by a suitable arrangement of the electrical connections and the resistance controlling the electrolyzing current.

The rotating apparatus here described affords a perfectly smooth agitation of the solution and causes no spattering; only that arising from the liberation of a large volume of gas is noticed.

The qualities possessed by graphite which make it a desirable substance of which to construct an anode are its absolute insolubility, its cheapness and its high

<sup>1</sup> Messrs. Eimer & Amend, New York.

<sup>2</sup> Turrentine, "The Meaning of Current Density," *J. Phys. Chem.*, **14**, 152 (1910).



conductivity. Platinum is usually accepted as the more nearly ideal metal for use as a non-attackable anode. However, it can no longer be regarded as an insoluble metal, although for most electrolyses, where its behavior is known beforehand, it is entirely satisfactory. Anodes of other metals plated with platinum would be both expensive and quite untrustworthy.

The objections to graphite so far discovered are its porosity and its tendency to flake off at high current densities.

While porosity would be quite non-permissible in a cathode, it need not be such an objection in an anode. This is especially true where the anode is being used exclusively in solutions of the same character. Under these conditions no impurities would be introduced by absorbed materials entering the solution from the anode. However, the porosity of the graphite has been practically entirely overcome by the treatment with paraffin or ceresine already described.<sup>1</sup>

The disintegration of the graphite at the anode is noticed only at high current densities. This would be objectionable because it would mean the eventual destruction of the anode. Likewise it is conceivable that in quantitative electro-analyses of metals, particles of graphite would be occluded by the depositing metal and the weight of the latter thereby increased. Yet this phenomenon is noticed only at high current densities, and the large surface area of the graphite anode makes possible the use of large current strengths without at the same time producing high current densities.

The problem, how to prevent the "flaking off" of the graphite, is now being investigated in this laboratory. Electrodes treated in various ways to render them more resistant are being compared with each other under like conditions in solutions of various electrolytes and at various current densities. The results so far obtained would indicate that no disintegration occurs with a paraffined graphite anode under a current density of 6 amperes per square decimeter. With the anode described, then, a current of at least 5 amperes may be employed with impunity.

It has been thought by some that paraffining graphite would decrease its conductivity. While probably no accurate measurements have been made to determine the effects of paraffining on the conductivity, that property of the graphite is not conspicuously impaired. It appears that the resistance of the solution and that due to polarization phenomena are so great in comparison with that produced by the presence of the paraffin that the latter resistance is entirely negligible.

The anode as described has been employed with success in numerous electrochemical processes, in electrochemical analyses and separations of metals

and in electrochemical oxidations. It has been employed also as a rotating cathode. In its present state of development it has shown itself a useful piece of apparatus. After further experimentation it is hoped that its present defects may be overcome so that it may be given an unqualified recommendation.

WESLEYAN UNIVERSITY.  
April, 1910.

### A COMPARISON OF THE EFFICIENCY OF OTTO PFEIFFER'S AND DENNIS & MCCARTHY'S METHOD FOR DETERMINING BENZENE IN ILLUMINATING GAS.

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In determining the benzene vapors in Minneapolis illuminating gas (which is a mixture of carburetted water gas and coal gas) by the Dennis and McCarthy method, it was found that by passing the gas back and forth in the nickel ammonium cyanide pipette and subsequently in the 5 per cent. sulphuric acid pipette that if this process was continued longer than two minutes in either pipette, a higher result was obtained than if the process was continued for exactly two minutes, which was contrary to the results obtained by Dennis and McCarthy.<sup>1</sup> These observations led the writers of this paper to determine the benzene in the gas by a more exact method and to compare the results with those obtained by the above-mentioned method, and to an investigation of the cause of the increased and varying results obtained by a longer absorption than two minutes.

The principle of the Dennis and McCarthy method is the absorption of the benzene in a nickel ammonium cyanide solution passing the gas back and forth in the pipette for about two minutes and then passing it back and forth into a pipette containing a 5 per cent. solution of sulphuric acid for about two minutes.

The exact method used was that of Otto Pfeiffer,<sup>2</sup> the principle of which is the oxidation of the benzene to dinitrobenzene, the separation of the dinitrobenzene with ether and its reduction to diamidobenzene in an alcohol solution with a standard hydrochloric acid solution of stannous chloride and the determination of the excess of stannous chloride by titrating with a N/10 normal solution of iodine.

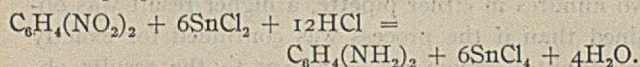
The method in detail is as follows: An accurately calibrated separatory funnel of about 500 cc. capacity is filled with gas. The funnel is inverted and 2 cc. of mixed sulphuric and nitric acids (equal volumes of concentrated H<sub>2</sub>SO<sub>4</sub> and fuming HNO<sub>3</sub>) are introduced into the outlet tube and carefully run into the separatory funnel. The funnel is rotated so as to distribute the acids as much as possible over the

<sup>1</sup> "A Graphite Cathode Dish," *Loc. cit.*

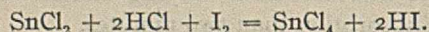
<sup>1</sup> *J. A. C. S.*, **30**, 233.

<sup>2</sup> *Chem. Zeit.*, **76**, 884.

inner surface and then allowed to stand one-half hour. It is then inverted and 30 cc. of concentrated soda solution carefully introduced and the funnel shaken until the vapor formed disappears. If the solution is still acid it is neutralized with the soda solution and then rendered just acid with hydrochloric acid. The dinitrobenzene is then separated by extracting successively with small amounts of pure ether and the ethereal extracts run into a small flask to which is added one gram of dry potash and about one-half gram of animal (blood) charcoal. After repeated shaking the solution is filtered into a 200 cc. flask, the filter washed with ether, and the ether completely removed in a water bath. About 10 cc. of alcohol and exactly 10 cc. of stannous chloride solution (150 grams of tin dissolved in hydrochloric acid plus 50 cc. of hydrochloric acid, and made up to one liter with water) are added and the flask heated in a water bath for ten minutes. The solution is then made up to the 200 cc. mark and 20 cc. titrated with N/10 iodine solution, using starch as an indicator. The reaction between the stannous chloride and the dinitrobenzene takes place according to the following equation:



A blank experiment is made by heating 10 cc. of the stannous chloride solution with alcohol, diluting to 200 cc. and titrating 20 cc. with the standard iodine solution. The reaction between the stannous chloride and the iodine takes place according to the reaction



In determining the benzene the writers of this paper used an absorption funnel of 1202.7 cc. capacity and the proportionate amounts of sulphuric and nitric acids. Ten cc. of stannous chloride solution were added to the dinitrobenzene solution which was then diluted to 500 cc. instead of 200 cc. and 10 cc. taken for titration. This dilution made much less difference between the strength of the stannous chloride and iodine solutions resulting in a greater accuracy in titrating.

In comparing the results obtained by the two methods the gas was passed back and forth in the fuming sulphuric acid pipette containing the nickel ammonium cyanide for exactly two minutes and then in the sulphuric acid pipette for exactly two minutes. The results obtained were as follows:

	Otto Pfeiffer method. Per cent. of benzene.	Dennis and McCarthy method. Per cent. of benzene.
Nov. 29, 1909.....	1.59	1.4
Dec. 1, 1909.....	1.87	1.8
Dec. 4, 1909.....	1.6	1.5
Dec. 15, 1909.....	0.67	0.80
Dec. 15, 1909.....	0.75	0.80
Dec. 17, 1909.....	1.20	1.25

The carbon dioxide, benzene, and unsaturated hydrocarbons were absorbed by the respective absorbents—potassium hydroxide, nickel ammonium cyanide, and bromine water—with the subsequent removal of the bromine vapors with potassium hydroxide and these results compared with those obtained by passing the gas successively into the nickel ammonium cyanide pipette for different lengths of time and then into the sulphuric acid pipette for two minutes, with the following observations:

Dec. 6. I.	(1) Per cent.	(2) Per cent.
CO <sub>2</sub> by KOH, 2 min.....	2.7	2.6
C <sub>6</sub> H <sub>6</sub> by Ni(CN) <sub>2</sub> .NH <sub>3</sub> 2 min. H <sub>2</sub> SO <sub>4</sub> 2 min..	1.1	1.0
C <sub>6</sub> H <sub>6</sub> by Ni(CN) <sub>2</sub> .NH <sub>3</sub> 4 min. H <sub>2</sub> SO <sub>4</sub> 4 min. . . .	1.3	1.3
C <sub>6</sub> H <sub>6</sub> by Ni(CN) <sub>2</sub> .NH <sub>3</sub> 11 min. H <sub>2</sub> SO <sub>4</sub> 5 min. . . .	1.9	1.9
C <sub>6</sub> H <sub>6</sub> by Ni(CN) <sub>2</sub> .NH <sub>3</sub> 16 min. H <sub>2</sub> SO <sub>4</sub> 6 min. . . .	2.2	2.2
C <sub>6</sub> H <sub>6</sub> by Ni(CN) <sub>2</sub> .NH <sub>3</sub> 31 min. H <sub>2</sub> SO <sub>4</sub> 8 min. . . .	2.8	2.8
C <sub>6</sub> H <sub>6</sub> by Ni(CN) <sub>2</sub> .NH <sub>3</sub> 46 min. H <sub>2</sub> SO <sub>4</sub> 10 min. . . .	3.3	3.3
C <sub>6</sub> H <sub>6</sub> by Ni(CN) <sub>2</sub> .NH <sub>3</sub> 66 min. H <sub>2</sub> SO <sub>4</sub> 12 min. . . .	4.0	4.0
Unsat. hydrocarbons by Br water 7 min.		
KOH 1 min.	9.9	7.0

Dec. 8. II.	(1) Per cent.	(2) Per cent.
CO <sub>2</sub> by KOH 2 min.....	2.8	2.8
C <sub>6</sub> H <sub>6</sub> by Ni(CN) <sub>2</sub> .NH <sub>3</sub> 2 min. H <sub>2</sub> SO <sub>4</sub> 2 min..	1.1	1.2
C <sub>6</sub> H <sub>6</sub> by Ni(CN) <sub>2</sub> .NH <sub>3</sub> 9 min. H <sub>2</sub> SO <sub>4</sub> 4 min. . . .	2.0	2.0
C <sub>6</sub> H <sub>6</sub> by Ni(CN) <sub>2</sub> .NH <sub>3</sub> 19 min. H <sub>2</sub> SO <sub>4</sub> 6 min. . . .	3.0	3.0
C <sub>6</sub> H <sub>6</sub> by Ni(CN) <sub>2</sub> .NH <sub>3</sub> 29 min. H <sub>2</sub> SO <sub>4</sub> 8 min. . . .	3.5	3.5
C <sub>6</sub> H <sub>6</sub> by Ni(CN) <sub>2</sub> .NH <sub>3</sub> 39 min. H <sub>2</sub> SO <sub>4</sub> 10 min. . . .	3.8	3.8
C <sub>6</sub> H <sub>6</sub> by Ni(CN) <sub>2</sub> .NH <sub>3</sub> 59 min. H <sub>2</sub> SO <sub>4</sub> 12 min. . . .	4.2	4.2
Unsat. hydrocarbons by Br water 7 min.		
KOH 1 min.	9.6	6.7

Dec. 14. III.	(1) Per cent.	(2) Per cent.
CO <sub>2</sub> by KOH 2 min.....	2.6	2.5
C <sub>6</sub> H <sub>6</sub> by Ni(CN) <sub>2</sub> .NH <sub>3</sub> 2 min. H <sub>2</sub> SO <sub>4</sub> 2 min..	1.3	1.3
C <sub>6</sub> H <sub>6</sub> by Ni(CN) <sub>2</sub> .NH <sub>3</sub> 12 min. H <sub>2</sub> SO <sub>4</sub> 4 min. . . .	2.0	2.0
C <sub>6</sub> H <sub>6</sub> by Ni(CN) <sub>2</sub> .NH <sub>3</sub> 22 min. H <sub>2</sub> SO <sub>4</sub> 6 min. . . .	3.2	3.2
C <sub>6</sub> H <sub>6</sub> by Ni(CN) <sub>2</sub> .NH <sub>3</sub> 32 min. H <sub>2</sub> SO <sub>4</sub> 8 min. . . .	3.7	3.7
C <sub>6</sub> H <sub>6</sub> by Ni(CN) <sub>2</sub> .NH <sub>3</sub> 57 min. H <sub>2</sub> SO <sub>4</sub> 10 min. . . .	4.3	4.3
C <sub>6</sub> H <sub>6</sub> by Ni(CN) <sub>2</sub> .NH <sub>3</sub> 87 min. H <sub>2</sub> SO <sub>4</sub> 12 min. . . .	4.9	4.9
Unsat. hydrocarbons by Br water 7 min.		
KOH 1 min.	9.9	6.3

March 31. IV.	(1) Per cent.	(2) Per cent.
CO <sub>2</sub> by KOH 2 min.....	2.4	2.5
C <sub>6</sub> H <sub>6</sub> by Ni(CN) <sub>2</sub> .NH <sub>3</sub> 2 min. H <sub>2</sub> SO <sub>4</sub> 2 min..	1.4	1.5
C <sub>6</sub> H <sub>6</sub> by Ni(CN) <sub>2</sub> .NH <sub>3</sub> 7 min. H <sub>2</sub> SO <sub>4</sub> 7 min. . . .	2.0	2.0
C <sub>6</sub> H <sub>6</sub> by Ni(CN) <sub>2</sub> .NH <sub>3</sub> 17 min. H <sub>2</sub> SO <sub>4</sub> 6 min. . . .	2.6	2.6
C <sub>6</sub> H <sub>6</sub> by Ni(CN) <sub>2</sub> .NH <sub>3</sub> 27 min. H <sub>2</sub> SO <sub>4</sub> 8 min. . . .	3.1	3.1
C <sub>6</sub> H <sub>6</sub> by Ni(CN) <sub>2</sub> .NH <sub>3</sub> 37 min. H <sub>2</sub> SO <sub>4</sub> 10 min. . . .	3.7	3.7
Unsat. hydrocarbons by Br water 7 min.		
KOH 1 min.	10.6	8.3

Dec. 23. V.	(1) Per cent.	(2) Per cent.
CO <sub>2</sub> by KOH 2 min.....	2.2	2.3
C <sub>6</sub> H <sub>6</sub> by Ni(CN) <sub>2</sub> .NH <sub>3</sub> 2 min. H <sub>2</sub> SO <sub>4</sub> 2 min..	1.3	1.3
C <sub>6</sub> H <sub>6</sub> by Ni(CN) <sub>2</sub> .NH <sub>3</sub> 13 min. H <sub>2</sub> SO <sub>4</sub> 4 min. . . .	2.3	2.3
C <sub>6</sub> H <sub>6</sub> by Ni(CN) <sub>2</sub> .NH <sub>3</sub> 33 min. H <sub>2</sub> SO <sub>4</sub> 6 min. . . .	3.5	3.5
C <sub>6</sub> H <sub>6</sub> by Ni(CN) <sub>2</sub> .NH <sub>3</sub> 30 hrs. H <sub>2</sub> SO <sub>4</sub> 8 min. . . .	6.7	6.7
C <sub>6</sub> H <sub>6</sub> by Ni(CN) <sub>2</sub> .NH <sub>3</sub> 31 hrs. H <sub>2</sub> SO <sub>4</sub> 10 min. . . .	6.7	6.7
Unsat. hydrocarbons by Br water 7 min.		
KOH 1 min.	9.2	...

April 5. VI.	(1) Per cent.	(2) Per cent.
CO <sub>2</sub> by KOH 2 min.....	3.0	3.0
C <sub>6</sub> H <sub>6</sub> by Ni(CN) <sub>2</sub> .NH <sub>3</sub> 2 min. H <sub>2</sub> SO <sub>4</sub> 2 min..	1.2	1.2
C <sub>6</sub> H <sub>6</sub> by Ni(CN) <sub>2</sub> .NH <sub>3</sub> 10 min. H <sub>2</sub> SO <sub>4</sub> 2 min. . . .	2.8	2.8
C <sub>6</sub> H <sub>6</sub> by Ni(CN) <sub>2</sub> .NH <sub>3</sub> 20 min. H <sub>2</sub> SO <sub>4</sub> 4 min. . . .	3.6	3.6
C <sub>6</sub> H <sub>6</sub> by Ni(CN) <sub>2</sub> .NH <sub>3</sub> 30 min. H <sub>2</sub> SO <sub>4</sub> 6 min. . . .	4.4	4.4
C <sub>6</sub> H <sub>6</sub> by Ni(CN) <sub>2</sub> .NH <sub>3</sub> 40 min. H <sub>2</sub> SO <sub>4</sub> 8 min. . . .	5.1	5.1
C <sub>6</sub> H <sub>6</sub> by Ni(CN) <sub>2</sub> .NH <sub>3</sub> 50 min. H <sub>2</sub> SO <sub>4</sub> 10 min. . . .	5.7	5.7
C <sub>6</sub> H <sub>6</sub> by Ni(CN) <sub>2</sub> .NH <sub>3</sub> 60 min. H <sub>2</sub> SO <sub>4</sub> 12 min. . . .	5.7	5.7
Unsat. hydrocarbons by Br water 7 min.		
KOH 1 min.	9.9	5.6

The illuminating gas was passed into the nickel ammonium cyanide pipette for two minutes, then repeatedly into the sulphuric acid pipette for varying periods of time with the following results:

Nov. 5. VII.		Per cent.		
CO <sub>2</sub> by KOH 2 min.		2.0		
C <sub>6</sub> H <sub>6</sub> by Ni(CN) <sub>2</sub> .NH <sub>3</sub> 2 min.	H <sub>2</sub> SO <sub>4</sub> 2 min.	1.0		
	H <sub>2</sub> SO <sub>4</sub> 5 min.	1.4		
	H <sub>2</sub> SO <sub>4</sub> 10 min.	1.6		
	H <sub>2</sub> SO <sub>4</sub> 16 min.	2.0		
	H <sub>2</sub> SO <sub>4</sub> 22 min.	2.4		
	H <sub>2</sub> SO <sub>4</sub> 27 min.	2.8		
	H <sub>2</sub> SO <sub>4</sub> 31 min.	3.3		
	H <sub>2</sub> SO <sub>4</sub> 36 min.	3.8		
	H <sub>2</sub> SO <sub>4</sub> 48 min.	4.6		
		(1)	(2)	(3)
	Per cent.	Per cent.	Per cent.	
April 5. VIII.				
CO <sub>2</sub> by KOH 2 min.		3.0	3.1	3.0
C <sub>6</sub> H <sub>6</sub> by Ni(CN) <sub>2</sub> .NH <sub>3</sub> 2 min.	H <sub>2</sub> SO <sub>4</sub> 2 min.	1.2	1.3	1.3
	H <sub>2</sub> SO <sub>4</sub> 4 min.	1.5	1.4	
	H <sub>2</sub> SO <sub>4</sub> 6 min.	1.6	1.6	
	H <sub>2</sub> SO <sub>4</sub> 8 min.	1.7	1.7	
	H <sub>2</sub> SO <sub>4</sub> 10 min.	1.7	1.8	
	H <sub>2</sub> SO <sub>4</sub> 12 min.	1.9	1.9	
	H <sub>2</sub> SO <sub>4</sub> 14 min.	2.0	2.0	
Unsat. hydrocarbons by Br water 7 min.		9.9	9.2	9.1
	KOH 1 min.			
	(1)	(2)		
	Per cent.	Per cent.		
April 5. IX.				
CO <sub>2</sub> by KOH 2 min.		3.1		
C <sub>6</sub> H <sub>6</sub> by Ni(CN) <sub>2</sub> .NH <sub>3</sub> 2 min.	H <sub>2</sub> SO <sub>4</sub> 2 min.	1.2	1.2	
	H <sub>2</sub> SO <sub>4</sub> 4 min.	1.4		
	H <sub>2</sub> SO <sub>4</sub> 6 min.	1.6		
	H <sub>2</sub> SO <sub>4</sub> 8 min.	1.7		
	H <sub>2</sub> SO <sub>4</sub> 10 min.	1.9		
	H <sub>2</sub> SO <sub>4</sub> 12 min.	2.1		
	H <sub>2</sub> SO <sub>4</sub> 14 min.	2.3		
Unsat. hydrocarbons by Br water 7 min.		9.9		
	KOH 1 min.		9.9	

In comparing the percentages of unsaturated hydrocarbons in 1 and 2 of each determination in the foregoing tables it will be observed that each respective difference is equal to the increased absorption after the first two minutes of absorption, respectively, in the nickel-ammonium-cyanide and sulphuric acid pipettes. These differences are shown by the following tabulation:

I.	II.	III.
9.9—7.0 = 2.9 cc.	9.6—6.7 = 2.9 cc.	9.9—6.3 = 3.6 cc.
4.0—1.0 = 3.0 cc.	4.2—1.2 = 3.0 cc.	4.9—1.3 = 3.6 cc.
10.6—8.3 = 2.3 cc.	9.9—5.6 = 4.3 cc.	9.9—9.2 = 0.7 cc.
3.7—1.5 = 2.2 cc.	5.7—1.2 = 4.5 cc.	
		9.9—9.1 = 0.8 cc.
		2.0—1.3 = 0.7 cc.

From these observations it is evident that the nickel-ammonium-cyanide and sulphuric acid each continue the absorption after the first two minutes and that this increased absorption is due to the unsaturated hydrocarbons present.

Unsaturated hydrocarbons were prepared and, unmixed with air or illuminating gas, their rate of absorption determined respectively in nickel-ammonium-cyanide and sulphuric acid.

Ethylene was prepared by heating a mixture of alcohol and concentrated sulphuric acid and puri-

fied by passing it successively through sulphuric acid and potassium hydroxide. To insure a complete purification, the gas was shaken successively in pipettes containing potassium hydroxide and sulphuric acid immediately before determining its rate of absorption. The following results were obtained:

	(1)	(2)
Ethylene with Ni(CN) <sub>2</sub> .NH <sub>3</sub>	1 min. 0.3 cc.	2 min. 0.8 cc.
Ethylene with Ni(CN) <sub>2</sub> .NH <sub>3</sub>	2 min. 0.9 cc.	4 min. 1.3 cc.
Ethylene with Ni(CN) <sub>2</sub> .NH <sub>3</sub>	3 min. 1.3 cc.	6 min. 2.0 cc.
Ethylene with Ni(CN) <sub>2</sub> .NH <sub>3</sub>	4 min. 2.0 cc.	8 min. 2.7 cc.
Ethylene with Ni(CN) <sub>2</sub> .NH <sub>3</sub>	5 min. 2.4 cc.	10 min. 3.4 cc.
Ethylene with Ni(CN) <sub>2</sub> .NH <sub>3</sub>	7 min. 2.8 cc.	12 min. 4.0 cc.
Ethylene with Ni(CN) <sub>2</sub> .NH <sub>3</sub>	9 min. 3.3 cc.	14 min. 4.7 cc.
Ethylene with Ni(CN) <sub>2</sub> .NH <sub>3</sub>		16 min. 5.4 cc.
Ethylene with Ni(CN) <sub>2</sub> .NH <sub>3</sub>		18 min. 6.2 cc.
	(1)	(2)
Ethylene with 5 per cent. H <sub>2</sub> SO <sub>4</sub>	2 min. 3.3 cc.	2.5 cc.
Ethylene with 5 per cent. H <sub>2</sub> SO <sub>4</sub>	4 min. 6.0 cc.	4.9 cc.
Ethylene with 5 per cent. H <sub>2</sub> SO <sub>4</sub>	6 min. 8.3 cc.	8.1 cc.
Ethylene with 5 per cent. H <sub>2</sub> SO <sub>4</sub>	8 min. 10.7 cc.	10.9 cc.
Ethylene with 5 per cent. H <sub>2</sub> SO <sub>4</sub>	10 min. 13.2 cc.	12.3 cc.
Ethylene with 5 per cent. H <sub>2</sub> SO <sub>4</sub>	12 min. 15.5 cc.	

Pure acetylene was prepared and its rate of absorption determined with the following results:

Acetylene with Ni(CN) <sub>2</sub> .NH <sub>3</sub>	1 min. 4.3 cc.	
Acetylene with Ni(CN) <sub>2</sub> .NH <sub>3</sub>	2 min. 8.5 cc.	
Acetylene with Ni(CN) <sub>2</sub> .NH <sub>3</sub>	6 min. 25.1 cc.	
Acetylene with Ni(CN) <sub>2</sub> .NH <sub>3</sub>	11 min. 45.2 cc.	
Acetylene with Ni(CN) <sub>2</sub> .NH <sub>3</sub>	16 min. 63.7 cc.	
Acetylene with Ni(CN) <sub>2</sub> .NH <sub>3</sub>	26 min. 87.2 cc.	
Acetylene with Ni(CN) <sub>2</sub> .NH <sub>3</sub>	31 min. 94.6 cc.	
	(1)	(2)
Acetylene with 5 per cent. H <sub>2</sub> SO <sub>4</sub>	1 min. 22 cc.	.....
Acetylene with 5 per cent. H <sub>2</sub> SO <sub>4</sub>	2 min. 41 cc.	40 cc.
Acetylene with 5 per cent. H <sub>2</sub> SO <sub>4</sub>	3 min. 65 cc.	68 cc.
Acetylene with 5 per cent. H <sub>2</sub> SO <sub>4</sub>	4 min. 72 cc.	75 cc.
Acetylene with 5 per cent. H <sub>2</sub> SO <sub>4</sub>	5 min.	83 cc.
Acetylene with 5 per cent. H <sub>2</sub> SO <sub>4</sub>	6 min.	91 cc.
Acetylene with 5 per cent. H <sub>2</sub> SO <sub>4</sub>	7 min.	95 cc.
Acetylene with 5 per cent. H <sub>2</sub> SO <sub>4</sub>	8 min. 96 cc.	

These hydrocarbons are each soluble in a pure state in nickel-ammonium-cyanide and 5 per cent. sulphuric acid.

It is concluded that the Dennis and McCarthy method for determining benzene in coal gas is accurate if the gas is left respectively in the nickel-ammonium-cyanide and sulphuric acid pipettes for exactly two minutes; that if left a longer time than two minutes an increased absorption takes place and that this increased absorption is due to the unsaturated hydrocarbons which is contrary to the observations of Dennis and McCarthy.<sup>1</sup>

In all these determinations a 100 cc. sample was used and measured in a Hempel pipette. The solutions were saturated with the gas before using, and no corrections were made for the slight changes in volume caused by slight changes in temperature and pressure.

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<sup>1</sup>J. A. C. S., 30, 233.

## THE RAPID DETERMINATION OF LEAD IN ORES BY ELECTROLYSIS WITH STATIONARY ELECTRODES.

By R. C. BENNER.

Received May 9, 1910.

The determination of lead by electrolysis, when weighed as the peroxide, has, in the past, been uncertain. Nearly all investigators have found the use of a different factor necessary, but in no case has the use of the theoretical been allowable.

When the peroxide is deposited on a dish it is possible to ignite and weigh as the monoxide with excellent results,<sup>1</sup> but with the gauze electrode it is impossible to make the ignition over the Bunsen flame in a satisfactory manner. Sand<sup>2</sup> has been able to deposit the peroxide in such a condition that the error caused by the use of the theoretical factor when working with small amounts of lead is negligible. This was accomplished by depositing from a solution free from ammonium nitrate and the oxides of nitrogen, at a temperature of from 94° to 97° C., using a current of five amperes. When the deposition was performed under these conditions he used the factor 0.8651 after drying the deposit with alcohol and ether.

Recently, in the western part of the United States, the electrolytic method has been used to a great extent for the determination of lead in ores; therefore, a rapid means of carrying out this determination is of interest.

A lead nitrate solution containing 0.2508 gram of lead in 10 cc. was prepared, in order that the gauze electrode<sup>3</sup> might be experimented with. The following determinations were made in 75 cc. of solution, in the presence of 103 cc. of nitric acid (sp. gr. 1.40) with a current of 4.8 amperes and 2.5 volts. The electrolyte was warmed during the deposition, so that the temperature of the cell was kept just below the boiling point, *e. g.*, the highest temperature at which it is possible to carry on the electrolysis without the liberation of the oxides of nitrogen, which, according to Sand,<sup>3</sup> tends to make the deposit non-adherent. The results below verify those obtained by Sand and give an idea of the accuracy of the method:

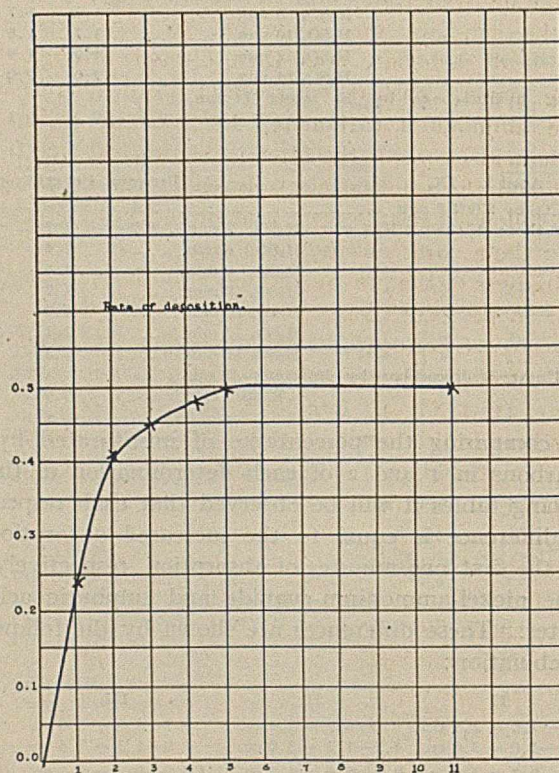
PbO <sub>2</sub> found.	Equivalent to Pb. Factor 0.886.	Pb taken.	Time.
0.2889	0.2502	0.2508	13
0.2905	0.2516	0.2508	20
0.2903	0.2513	0.2508	20
0.5814	0.5035	0.5017	20
0.5797	0.5020	0.5017	25
0.8734	0.7564	0.7525	25
0.8715	0.7547	0.7525	25

The rate of precipitation was determined with a current of 3.5 volts and 4.2 amperes at a temperature between 94 and 97° C. The solution in each

case contained 0.5018 gram of lead and 10 cc. of concentrated nitric acid and had a volume of 75 cc.:

Time. Min.	RATE OF PRECIPITATION.		
	Lead taken.	Lead deposited. Factor 0.886.	Peroxide deposited.
1	0.5008	0.2412	0.2789
2	0.5008	0.4126	0.4766
3	0.5008	0.4536	0.5237
4 1/2	0.5008	0.4871	0.5623
5	0.5008	0.5012	0.5787
11	0.5008	0.5007	0.5782

These results show that it is possible to deposit all of the lead, which can occur in a 0.5000 gram sample of ore, in from 5 to 10 minutes. In this case, as with copper, by far the greater part of the lead was deposited in the first few minutes. 90 per cent. was deposited in the first 3 minutes, while the remaining 10 per cent. took 3 minutes longer.



It was possible to remove all of the sulphur from galena as well as from some other sulphides, in form of hydrogen sulphide, by warming with hydrochloric acid (2 to 1). This made it possible to use the following process for those ores which contain no interfering sulphides. From 0.5 to 1.0 gram of the finely pulverized ore was weighed out, warmed with 15 to 20 cc. of hydrochloric acid (2 to 1) until completely disintegrated and all of the sulphur evolved as hydrogen sulphide, but not concentrated so far that the lead chloride crystallized out (this caused violent bumping). Then 20 cc. of concentrated nitric acid were added and boiling continued until all of the hydrochloric acid was expelled and the nitric

<sup>1</sup> Treadwell, "Analytical Chemistry," New York, 1904, Vol. II, p. 140.

<sup>2</sup> Chem. News, 100, 269.

<sup>3</sup> THIS JOURNAL, 2, 195.

acid had a volume of 10 cc. It was then diluted to 75 cc. and electrolyzed in the usual manner. Those ores containing sulphides, which rendered the use of the preceding method impossible, were disintegrated with nitric and hydrochloric acids, 15 cc. of sulphuric acid added and the solution evaporated until heavy white fumes of sulphuric anhydride were evolved. After cooling, 50 cc. of water were added; it was boiled until all of the basic iron sulphate was dissolved, then the solution was diluted to 200 cc., filtered, and washed free from sulphuric acid. (As much lead sulphate as possible was left in the beaker and washed by decantation.) The lead sulphate was washed from the filter with the smallest possible amount of water into the beaker containing the bulk of the sulphate. Then 10 cc. of a warm saturated solution of ammonium carbonate were poured through the filter, received in the beaker containing the lead sulphate and warmed until all of the sulphate was converted to the carbonate. The lead carbonate was then filtered through the same paper, washed with water until nearly free from ammonium carbonate, dissolved in 40 cc. of nitric acid (1 to 3), the filter paper washed free from lead and the solution electrolyzed in the usual way. The following results on a lead ore containing copper show the accuracy of the method:

Analysis of the ore by ordinary methods: Ore No. 1—2.70 per cent. copper, 21.50 per cent. lead. Ore No. 2—2.28 per cent. copper, 22.20 per cent. lead.

Electrolytic determination of lead: Ore No. 1—21.52, 21.51, 21.59. Ore No. 2—22.20, 22.06.

Where it was desired to do away with the use of the factor and, at the same time, use the electrolytic method of determination, it was possible to do so by igniting, in a muffle, or small electric oven at a temp. of about 500° C., the gauze electrode on which the peroxide had been deposited. The following results show the accuracy of this modification of the electrolytic method:

Lead taken.	Lead found.
0.2509	0.2511
0.2509	0.2506
0.5018	0.5035
0.5018	0.5026
0.7527	0.7518

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**THE VALUE OF A CHEMICAL ANALYSIS AS  
SHOWN IN TRACING THE CAUSE OF  
A TYPHOID FEVER EPIDEMIC  
IN GEORGIA.**

By H. B. ARBUCKLE.

Received June 25, 1910.

Last October a sudden and virulent outbreak of typhoid fever occurred in a college community in Georgia, four institutions being simultaneously affected.

It was thought at first that some form of food supplies, as canned goods, which were served uncooked, was responsible for the epidemic, but chemical and bacterial examinations of all the canned supplies placed them above suspicion. A competent bacteriologist went over the situation and after carefully examining the dairy products, the pantry, the sanitary arrangements and the water supply, issued a written statement to the effect that as far as his investigation went no local cause was discovered. Already twenty had contracted fever, and three to four cases were being reported daily.

At this point the author undertook an investigation in which he was ably assisted by the local physician, Dr. Mary Sweet, who furnished a comprehensive history of each case. The data showed that all the cases were located in two brick dormitories which housed about 75 per cent. of the students. These buildings were infested with ants, while the others were not, and it was thought probable that these pests were distributing the bacilli, but experiments with a large number of ants, collected in many parts of both buildings, gave no indication of pathogenic germs.

Another examination of the pantry, the dairy and its products, confirmed the first and showed very satisfactory conditions. By this time the situation had become so serious that it was deemed wise to boil the water, milk and butter, as well as to sterilize every particle of food by thorough cooking.

The water supply, obtained from a well, was next taken up, although the bacterial examination was considered satisfactory by the local physician. The first chemical test applied to the drinking-water placed it under suspicion, as it showed high nitrites, a rough quantitative test giving one-tenth of one part per million, which is quite unusual in waters of the vicinity. Chlorides were present in unusual quantity and free ammonia was far above the amount found in a normal water of the vicinity. All of these data indicated pollution of the well water and gave a starting point for further investigation.

The well from which the drinking-water is obtained is forty feet deep, situated over fifty feet from the buildings, and on the opposite of the water-shed from the sewers. This well was cleaned twice during each year and was carefully cased with brick and cement for three feet above ground. The well and pump appeared to be in good condition.

The investigation was pushed in every direction. One hundred and fifty feet from the well supplying the drinking-water was an old well, kept as a protection against fire. The water of this well was examined and the quantities of nitrites, free ammonia and chlorides were even greater than those found in the first well, giving conclusive evidence of recent sewage pollution. Samples of water from both

wells were sent to the Johns Hopkins Bacteriological Laboratory. Their report confirmed that of the local bacteriologist in regard to the drinking-water: "There were found no distinct traces of pathogenic germs," but concerning the water from the old well the statement is: "We find strong presumptive evidence of the presence of Bacilli Coli and would condemn the water as badly contaminated." In the meantime, the author had had the sewers leading from the dormitory nearest the old well uncovered, and in one sewer, at a point within eight feet of the wall of the well, was found a broken joint and a hole in the side of the sewer an inch in diameter. A connection between the two wells was proved by introducing three pounds of potassium iodide into the old well and after one hour detecting iodine in the water of the well from which the drinking supply was obtained.

Two weeks after the sewer was repaired the chlorides in the well used for drinking-water had fallen from 57 parts to 15 parts per million. Another fact which strengthens the conclusion that the fever was caused by the drinking-water is that the last case was reported on the twentieth day from the date when boiling the water was begun. No straggling cases appeared. It was also found that a student, who had come to the college two weeks previous to the outbreak and just after recovery from a severe attack of typhoid fever, roomed in the building served by the broken sewer.

One beneficial result of this investigation was the abandoning of many shallow wells as a source of domestic supply.

A table of partial analyses of water from a number of wells in the town is given below, all of which, with the exception of two, the Childers and the Lovejoy wells, show serious pollution.

This article has been written not only to show the use chemistry may be to the epidemiologist but to bring again to the attention of sanitarians that while bacteriology gives much information regarding continuous pollution of a water supply, it is useless in giving knowledge of past pollution or past history of a water.

Waters analyzed.	Parts per million.			
	Chlorine in chlorides.	Nitrogen in nitrites.	Ammonia (free).	Ammonia (albu- minoid).
Storage well at college, break in sewer 8 ft. dis- tant.....	167.5	0.24	0.544	0.095
Well used for drinking water at college.....	57.4	0.15	0.236	0.09
Blanchard well.....	106.0	0.02	0.12	0.07
Donnell well <sup>1</sup> .....	110 <sup>1</sup>	0.015	0.10	0.09
Gaines well.....	35.6	0.02	0.095	0.08
Hathaway well.....	64.0	trace	0.09	0.06
Childers well.....	18.5	none	0.06	0.06
Lovejoy well.....	10.0	none	0.07	0.05
Town water (creek is source of supply).....	3.15	none	0.008	0.08

<sup>1</sup> A servant had thrown salt in this well.

[CONTRIBUTION FROM THE TEXAS EXPERIMENT STATION.]

## RELATION OF POT EXPERIMENTS TO THE ACTIVE PHOSPHORIC ACID OF THE SOIL.<sup>1</sup>

By G. S. FRAPS.

Received June 9, 1910.

By active phosphoric acid we here mean the phosphoric acid extracted by digestion of 200 grams of soil for five hours at 40° C. with 2000 cc. N/5 nitric acid without correction for neutralization. Factors which affect this method have previously been discussed.<sup>1</sup>

For about four years we have been conducting pot experiments upon a variety of Texas soils, and it is our purpose here to compare the results of these pot experiments with our chemical work.

### METHOD OF WORK.

Five kilograms soil were placed in a Wagner pot which had previously received 2 kilograms gravel. To one pot was added 2<sup>1</sup>/<sub>2</sub> grams acid phosphate, 1 gram nitrate of soda, and 1 gram sulphate of potash. To another pot was added nitrate of soda and sulphate of potash. A comparison of the growth of the crop in these two pots shows the effect of phosphoric acid. Other pots were included in this work, but the description of them is foreign to the purpose of this article. Each pot received the same weight of seed and equal amounts of water. The water content was maintained during the growth of the crop by adding a sufficient quantity three times a week to restore the loss of weight. The pots were kept in glass or canvas houses. At the end of the period the crops were harvested, dried, weighed, and, in many cases, subjected to analysis.

### DEFICIENCY OF SOILS.

The weight of the crop without phosphoric acid divided by the weight with phosphoric acid gives the extent of deficiency. If the unfertilized crop is 50 per cent. or less of the fertilized crop, the soil is regarded as very deficient (DD); if less than 90 per cent., as deficient (D); and if more than 90 per cent., not deficient (S).

Several crops were sometimes grown on the same soil. In finally deciding on the deficiencies for soils, all crops grown upon the soil were considered and also any other circumstances which may affect the conclusions.

We have divided the soils into groups, according to their content of active phosphoric acid. Group 1 contains soils having less than 10 parts active phosphoric acid per million; group 2, less than 20; group 3, less than 30; and so on.

The results of our pot tests are combined in Table I, in which the number of soils decided to be very

<sup>1</sup> Full details of this work will be published in Bull. 126 of the Texas Experiment Station.

<sup>1</sup> *Am. Chem. J.*, 32, 1; *J. A. C. S.*, 28, 823.

deficient, deficient and not deficient, are given. Also the percentages of the total number in the group is given.

Of the 38 soils containing less than 20 parts per million of active phosphoric acid, we find 32 highly deficient, five deficient, and 1 sufficient. The sufficient soil had only one pot experiment made on it, with mustard, and the results might very possibly have been deficient had more tests been made.

*Soils containing 20 parts per million, or less, of active phosphoric acid are highly deficient in phosphoric acid.*

Considering the table further, we find that the percentage of very deficient soils decreases rapidly from 87 per cent. in the first group to 14 per cent. in the fourth, after which it decreases slowly to the 11-17 group, after which there is a sudden increase. One soil, however, makes a great difference in the percentage in these groups.

TABLE I.—NUMBER AND PERCENTAGE OF DEFICIENT SOILS GROUPED ACCORDING TO CONTENT OF ACTIVE PHOSPHORIC ACID.

Group.	Number of soils.			Percentage of soils in Group.		
	DD.	D.	S.	DD.	D.	S.
No. 1.....	13	2	0	87	13	0
No. 2.....	19	3	1	83	12	4
No. 3.....	7	10	1	39	55	6
No. 4.....	1	5	1	14	71	15
Nos. 5-6.....	1	4	2	14	57	28
Nos 7-8.....	2	13	0	13	87	0
Nos. 9-10.....	1	5	2	13	63	24
Nos. 11-19.....	1	5	5	9	45	46
Nos. 32-42.....	2	0	4	33	0	66
Total.....	48	47	16			

The percentage of non-deficient soils increases with fair regularity throughout the table, though there are some breaks, notably in group 7-8.

In groups 3 to 10 are fifty-five soils, twelve of which are very deficient, 37 are deficient, and 6 appear to yield sufficient phosphoric acid; that is to say, about eleven per cent. are not deficient. The average corn crop without phosphoric acid is from 34 to 71 per cent. of that with phosphoric acid. We feel justified in drawing the following conclusions:

Soils containing from 30 to 100 parts per million of phosphoric acid soluble in N/5 nitric acid, are, as a rule, deficient in phosphoric acid, and the extent of their deficiency is related to the quantity of active phosphoric acid.

Groups 11-19 contain only eleven soils. Nearly 50 per cent. are not deficient. We draw the following conclusions, subject to modification, when a larger number of soils are studied:

Soils containing from 100 to 200 parts per million of active phosphoric acid are possibly deficient in phosphoric acid, the chances being even that they are, or are not.

Group 32-42 contains only six soils. Such soils are likely *not* to be deficient in phosphoric acid, but

this conclusion is likewise subject to modification from further study.

#### PHOSPHORIC ACID REMOVED.

We determined the phosphoric acid removed by the crops in a number of our pot experiments.

Assuming that 40 bushels of corn require 25 pounds of phosphoric acid, and a weight of 2,000,000 pounds of soil to the acre, we have calculated the number of bushels of corn which would be produced by the phosphoric acid withdrawn from the soil. One bushel of corn we estimate to require 0.00156 gram phosphoric acid per pot of 5,000 grams of soil.

A summary of the results of these calculations are presented in Table II. We find that the average possible corn crop increases regularly with each group, the only exception being groups 9 and 10, containing three soils and three crops. Right here we must call attention to the fact that these crops were grown under diverse conditions, and the climatic conditions were sometimes not favorable to the crop. But we feel that the relation between the average corn possibility and the quantity of active phosphoric acid in the soil is very significant.

The first two groups of soils, which are highly deficient in phosphoric acid, have an average possibility of 4.5 and 12.5 bushels of corn, respectively. Groups 3 to 10, the soils of which are prevailingly deficient in phosphoric acid, as we have pointed out, have an average corn possibility of 19.7 to 26.5 bushels of corn per acre—the variation is not large.

Groups 11-19 and 32-42 have an average corn possibility of 50-60 bushels per acre. A soil may be highly productive, and yet appear deficient in a pot experiment.

If we consider the *maximum* corn possibility within the groups, we find that, like the average corn possibility, it increases with the quantity of phosphoric acid extracted from the soil by N/5 nitric acid, with the exceptions of groups 9-10 and 11-19. We find a maximum possibility of 31 bushels in group 2, from 37 to 59 in groups 3-10, and from 94-101 in groups 11-42.

TABLE II.—AVERAGE CORN POSSIBILITY AND AVAILABILITY OF PHOSPHORIC ACID.

Group.	Soils.	Crops.	Corn equivalent (bu. per acre).		Availability percentage.	
			Average.	Maximum.	Average.	Maximum.
1.....	9	11	4.5	9	27.0	43
2.....	13	13	12.5	31	28.8	87
3.....	6	6	20.8	36	31.2	52
4.....	6	7	19.7	37	18.4	39
5 and 6.....	6	6	24.4	42	14.4	25
7 and 8.....	13	13	26.5	59	11.7	28
9 and 10.....	3	3	22.0	39	7.9	13
11 to 19.....	4	5	52.5	101	11.1	25
32 to 42.....	5	6	60.7	94	4.7	7

It appears that soils may provide sufficient phosphoric acid for large crops, and yet respond to applications of phosphatic fertilizers. The response may,

however, vary with climatic conditions. The application of pot experiments to field conditions is a matter which we shall study.

#### AVAILABILITY OF ACTIVE PHOSPHORIC ACID.

Assuming that the phosphoric acid removed by the crop comes from the phosphoric acid extracted by N/5 nitric acid, we can calculate the percentage of phosphoric acid taken up by the crops from the data we have secured. A summary of the results of such calculation is presented in Table II. We term the percentage of the active phosphoric acid taken up by the crop, its availability. We do not wish to say, however, that the phosphoric acid taken up may not come from sources other than that soluble in N/5 nitric acid.

Considering first the average availability, we find it rises from 27 to 31.2 in the first three groups. This rise, however, is of little significance—we can almost say that the average availability is the same for the three groups.

If the phosphoric acid dissolved by N/5 nitric acid comes from the natural phosphates of lime, we cannot expect them to have a high availability. An average availability of 27.31 per cent. for the phosphoric acid of the first three groups must lead to the conclusion that some of the phosphoric acid taken from the soil comes from other sources than that soluble in N/5 nitric acid. In other words, the assumption we started with is not justified, at least in these three groups of soils.

In the first group of soils, those containing less than ten parts per million of active phosphoric acid probably do not contain any phosphate of lime at all. The 7–10 parts per million of phosphoric acid dissolved represents the solution of a portion of some highly insoluble phosphates. The availability of the phosphates based upon the portion dissolved is thus incorrect.

The availability should be based upon the total quantity of the insoluble phosphate, which is not known.

The considerations which apply to group 1 also apply to the other groups, their importance decreasing with the grade of the group. In other words, some of the phosphoric acid withdrawn by crops comes from the less soluble phosphates. It is, of course, possible that other phosphates of importance may be present in the soil. This is apparent when we consider the high maximum availability of the active phosphoric acid in the different groups.

While not decreasing regularly, the percentage availability decreases with the grade of the group. This decrease may be because the assumption is incorrect that the phosphoric acid withdrawn comes entirely from the N/5 nitric acid extracts. It is probable that the availability in the higher groups

represents more nearly the availability of the active phosphoric acid than that in the lower groups.

This matter of the availability of the phosphoric acid of the soil is being subjected to further study.

#### SUMMARY AND CONCLUSIONS.

1. Soils containing 20 parts per million or less of active phosphoric acid are highly deficient in pot experiments.
2. Soils containing from 30 to 100 parts per million of active phosphoric acid are deficient, as a rule, in pot experiments, and the extent of their deficiency is related to the quantity of active phosphoric acid in them.
3. Soils containing 100 to 300 parts per million of active phosphoric acid may or may not prove deficient in pot tests, the chances being even.
4. The quantity of phosphoric acid removed by the crop grown in our pot experiments is on an average closely related to the quantity of active phosphoric acid.
5. The phosphoric acid removed from the soil by the crop comes from other sources in addition to the active phosphoric acid.

## REVIEWS.

### RECENT PROGRESS AMONG MEDICINAL SYNTHETICS.

By V. COBLENTZ.

The multiplication of medicinal synthetics during the last year has been less marked than previous periods, much to the relief of the already overburdened therapists. During the fruitful period of synthetics, which marked the discovery of phenacetin, aspirin, heroin, eucaïne, etc., the market was fairly overrun with all sorts of combinations serving as succedaneums; then followed a veritable avalanche of proprietary mixtures which threw the medical fraternity into a state of hopeless confusion. Adding to this condition of affairs, many of the latter class adopted titles of astonishing similarity with the legitimate synthetics. For illustration, what is the apothecary to dispense, when with the often illegible writing of the physician, distinctions must be made between Chinosol, Chinoro, and Chinoral; Jecoral, Jecorol and Jecoval; Thiodin or Thiolin, and so on? Also how is he to financially cope with this growing family? During the last three years the atmosphere has cleared somewhat through the aid of European State Boards of Health and the Council of Medicine and Pharmacy, who have established clear distinctions between true synthetics, medicinal combinations and the quack nostrums. The physician is now able to distinguish the real from the imitation.

#### Antipyretics.

Since the field of the p. phenetidin derivatives has produced nothing new or even offered any improvement over phenacetin, attention has been directed to the pyrazolon nucleus with the hope of securing some new combinations which might offer possible advantages over phenacetin or antipyrin. As is well known, (4) amidoantipyrin is less toxic than antipyrin, hence, as might be anticipated, pyramidon, a dimethyl (4) antipyrin, has proved itself to be a very successful and safe succedaneum, also more potent because of the presence of 2 more methyl groups. Knoll & Co. return to the base (4) amidoantipyrin and patent its valeryl derivative under the name of *Neopyrin*. This prod-



uct fuses at 203°, and, according to experiments, is less toxic than antipyrin, causing no change of the hemoglobin into methemoglobin. It is also rapid in its action. As a substitute for antipyrin-caffeine migraine powder, which has been withdrawn from the markets abroad, the J. O. Riedel Co. introduce Astrolin, a compound of methylglycolic acid (38.5 per cent.) and antipyrin (61.5 per cent.), similar to salipyrin (salicylate of antipyrin).

#### Antiseptics and Disinfectants.

No class of antiseptics has established itself more thoroughly and with general satisfaction than the organic and colloidal silver combinations. Among the former class, Argonin (casein silver) and Protargol (protein silver) are popular prototypes. The new addition belongs to the latter class, being a combination of colloidal silver with albumoses, a soluble crystalline substance known as *Syrgol* (Chem. fab. Siegfried Co., Switz.).

Under this heading may be included a new mercurial, Asurol (Elberfelder Farbenfab.). Various combinations have been devised in order to overcome the caustic, irritant and albumin-coagulating action of mercuric chloride when employed either locally or subcutaneously. Among the many organic salts proposed, the salicylate is the best, but can only be used, in intramuscular injections, when dissolved in liquid petrolatum. Asurol fulfils all possible objectionable features in being readily soluble, can be given in large doses, no local inflammation, and does not coagulate albumin. This compound is a double salt of mercury salicylate and amido-oxyisobutyrate of sodium containing 40.3 per cent. of mercury.

#### Sedatives.

Valerian and its preparations have always been highly prized as sedatives. Under the belief that valeric acid (isovaleric) reduced reflex excitability, several preparations have been introduced and enjoyed considerable popularity, among which are Valeryl (valeryl diethyl amid),  $C_6H_5CO.N(C_2H_5)_2$ , and Volidol (valeryl menthol ester),  $C_{10}H_{19}O.CO.C_4H_9$ . It has since been demonstrated that the medicinal virtues of valerian rhizome reside more in the borneol than in the valeric acid. With this in view, Borneyval, valeryl borneol ester ( $C_{10}H_{17}O.C_6H_9O$ ) was introduced, but with little success. Recently an improvement has been made in selecting isovaleric acid, which is present in the rhizome, and combining it as an isoborneol ester under the name of *Gynoval*.

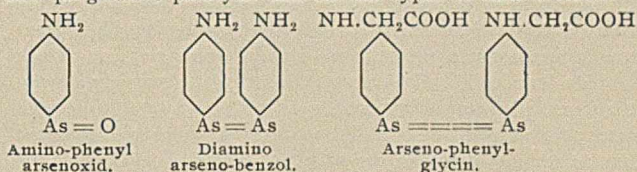
#### Arsenicals.

During recent years a wide field has been opened to arsenical therapy, which, up to this time, has been more or less limited, owing to the objectionable secondary actions attending the administration of arsenious acid. In the search for a less toxic ideal arsenical, recourse was had to the methyl derivatives of arsenious acid, oldest among these were cacodylic acid (dimethyl arsenious acid) and Arrhenol, di-sodium-mono-methyl arsenate,  $O = As(CH_3)(ONa)_2 + 6H_2O$ . In these preparations, the arsenic is so firmly linked that only a very small percentage is split off in the organism. For example, 1 gram of sodium cacodylate (66 per cent.  $As_2O_3$ ) can be readily taken and tolerated. The therapeutic value of arsenic in this form, in treatment of all diseases arising from disturbances of the nutrition, as well as a great variety of other diseases, stimulated research. A number of alkyl as well as aromatic groups have been tried by substituting one or more hydroxyls of arsenic acid with the hope of finding derivatives of valuable therapeutic properties and only one or two have found acceptance.

The mono-phenyl arsenic acid was found to be less toxic than the diphenyl arsenic acid and still less toxic is the amido derivative of the former, the sodium salt of which is known as atoxyl,  $C_6H_4(NH_2).(AsO.OH.ONa) + 3H_2O$ , which has been the center of attraction since Robt. Koch began the study of trypanosomiasis. Owing to the very stable nature of this

arsenical, 50 times as much arsenic can be administered as is permissible in the form of Fowler's solution. While varied success has attended the use of atoxyl in "sleeping sickness," it has become an accepted remedy in pellagra, syphilis, malaria, skin diseases, etc. Less uncertain and toxic, because of greater molecular stability, is Arsacetin, an arsenical built on the atoxyl type. This is the sodium salt of acetylated-para-amino-phenyl-arsenic acid, that is an acetylated atoxyl,  $C_6H_4(NH_2.CH_3CO)$  ( $AsO.OH.ONa$ ). The stability in the human organism, of this anilid, may be compared to other acid anilids (acetanilid, benz-anilid) which undergo a very slow splitting up in the system producing a minimum arsenical effect.

Arsacetin is 3 to 5 times less toxic than atoxyl, while its power of destroying trypanosomes appears to be greater. The peculiarity that atoxyl failed to destroy trypanosomes in laboratory experiments, while the contrary has been demonstrated in its administration, led Ehrlich to study the action of this remedy in the organism. He found that arsenic acid was reduced to arsenious, consequently the reduction products of arsanilic acid were studied, namely, *p*-amino-phenyl-arsenoxid and *di*-amino-arseno-benzol. These possessed a marked bactericidal action, while their relative toxicity rendered them unfit for therapeutic use. A relatively non-toxic product was found in *Arsenophenylglycin*, a reduction product of *p*-glycin-phenyl-arsenic acid. The sodium salt of the former is now marketed by the Hoechst Fabrik as a remedy for the "sleeping" sickness, also progressive paralysis and certain types of skin diseases.



## ADDRESSES.

### AN OUTLINE OF THE LEATHER INDUSTRY.<sup>1</sup>

By ALLEN ROGERS.<sup>2</sup>

Received June 3, 1910.

When the pelts of animals are allowed to remain moist they soon putrefy and decay, while if dried they become hard and horny. To obviate these conditions, certain processes known as tanning are employed. The object of this treatment is to convert the putrescible animal matter into a material which is permanent, and at the same time possessing sufficient softness or flexibility for the purpose for which it is intended. As these range from heavy sole leather to light kid there are wide divergences, therefore, in the processes employed, materials used, and the method of their application.

The skins of various animals appear, at first glance, to have very little in common; on closer examination, however, it will be seen that they all have a general structure, thus a description of one will apply almost equally well to all others. It consists of two principal layers, the epidermis and the corium. The epidermis is very thin as compared with the true skin or corium which it covers and is entirely removed preparatory to tanning. Ordinarily the corium or true skin is the only portion which is used in the production of leather, and in order to obtain it in a suitable condition for the various tanning processes, the hair or wool, together with the epidermis, must be completely removed without damaging the skin itself; and especially, great care must be taken that the grain, or portion next the epidermis, does not suffer any injury during the treatment.

The pelts of animals come to the tanner in three conditions:

<sup>1</sup> Symposium on Leather, New York Section, American Chemical Society, April 8, 1910.

<sup>2</sup> Pratt Institute, Brooklyn, N. Y.

as green (fresh from the animal), salted (where salt has been rubbed on the flesh side), or dried (usually stretched on boards in the sun). The pelts so received are divided according to their size into three general classes, namely: *Hides*, comprising the skins from large and fully grown animals such as the cow, horse, camel, walrus and other large animals; these form thick, heavy leather, used for shoe soles, machinery belting, and other purposes where stiffness and strength, combined with great wearing qualities, are necessary. They are also cut into splits for use as shoe uppers, bag and case leathers, automobile and carriage tops, furniture and upholstery. *Kips*, the skins of undersized animals of the above species, are used for shoe leather and for a number of other purposes. *Skins*, the covering of small animals such as calves, sheep and goat, are employed for a large variety of purposes, such as uppers for shoes, pocket-books, book-binding, gloves and fancy leather.

Whether the skins are green, salted, or dried, they must first be soaked in water in order to remove the blood, dirt and salt, and in the case of dried skins to bring them to a soft condition. It is very essential that the skins should be free from all of this foreign matter before entering the limes or other unhairing solution, as the presence of salt retards the plumping, and albuminous matter is apt to set up an undesirable fermentation in the after-treatments. The time of soaking varies from one or two days to several weeks, depending upon the thickness of the hide and the age and temperature of the soak. Putrid soaks soften quicker than fresh ones, but great care is necessary in using them lest the decomposition attack the hide fiber itself. For heavy hides, which soften very slowly, it is found advantageous to run in a drum for a short time with water at a temperature of about 40° F., the tumbling movement thus materially aiding in the softening process. Following the soaking operation comes the removal of the hair, which process is known as depilation. This is necessary in all kinds of leather except that used for furs. The earliest method for accomplishing this result was by means of incipient putrefaction, in which case the soft mucous matter of the epidermis became affected, thus causing hair to become loosened without materially injuring the true skin. This method is still employed by many tanners of sole leather and is called "sweating." The operation is conducted in closed rooms which are kept at a temperature of about 70° F. The hides are hung in small chambers ("sweat pits") holding about 100 hides each. After four to six days of this treatment the hair is sufficiently loosened to be removed by working over a rounded beam with a blunt knife made for the purpose. No matter how carefully this operation may be conducted there is liability, however, that the putrefaction attacks the skin itself, thus causing a weak grain, and for this reason we find it being used less and less.

A depilating agent which works very satisfactorily is lime, and it is the agent which is almost universally employed. Although it has its disadvantages, its good points far outweigh those of any other substance. In preparing the lime for this operation a quantity of fresh lime, calcium oxide, is slaked by placing it in a shallow tank, similar to that used by builders, and sufficient water added to thoroughly moisten it. At the end of one or two hours it becomes heated and falls to a powder, and is then mixed with enough water to form a thick paste. In this condition it may be kept for weeks, or even months, without any material change. When required for use a sufficient amount is dug out, stirred with water to remove rocks, and then run into the pits. As only the lime in solution is available for unhairing it will be seen that the addition of a large excess is unnecessary, it being essential simply to provide a surplus of solid lime to replace that taken up by the hide. The usual method of liming is to lay the hides one at a time in the lime solution, taking care that each hide is well immersed be-

fore entering the next one. The hides are taken out each day ("hauled") and the liquor well plunged up in order to distribute the undissolved lime throughout the pit. They are then thrown back ("set"), care being taken to see that they are fully spread out. In some tanyards the hides are joined by hooks and reeled from one pit to another or to the same pit. It is sometimes customary to suspend the hides in the solution, and by means of a paddle keep the limes in motion.

The action of lime on the hide is to swell up and soften the epidermis cells, dissolve the mucous layer and loosen the hair so that it may be scraped off with a blunt knife. The action on the true skin is also very vigorous, causing the hide to become plump and swollen, at the same time dissolving the cementing material of the fibers, thus causing them to split up into finer fibrils. The swelling is probably due to the formation of a lime soap, caused by the union of the lime with the fatty matter of the hide.

The time of liming varies with the season of the year, and with the kind of skins being treated, the time being from three to fifteen days. The age of a lime also has a great influence on the time of treatment as well as on the character of the finished product. As old limes unhair much quicker than fresh ones it is often customary to place the hides in an old lime for several days, or until the hair and epidermis have started to loosen, then change them to a fresh lime, which produces the necessary plumping of the fiber. Great care, however, must be taken that the limes do not become too old, as this condition will be very apt, especially in hot weather, to produce a transparent swelling of the goods, with destruction of the fiber.

Other depilating agents are sometimes employed, either alone or in conjunction with lime. The red sulphide of arsenic is one of commonly used substances, and in connection with lime is very beneficial in the case of fine leathers, to which it gives the necessary stretch, softness, and clearness of grain, without the loss of hide substance and loosening effect caused by ordinary liming. The amount varies somewhat, but may be said to run from 0.1 to 0.4 per cent. of realger and 4 to 6 per cent. of lime, reckoned on the weight of the green skins.

When sodium sulphide is employed in strong solutions, say 5 per cent. and over, it has the effect of very rapidly reducing the hair and epidermis to a sort of pulp, which may be easily swept off with a broom, or even washed off in the drum. The operation is usually conducted in a paddle, taking about two hours for the complete removal of the hair and epidermis. The action on the hide substance, and especially the cementing material, is very slight, although the grain is swollen and temporarily rendered somewhat tender. As this strong solution destroys the hair it is only used on such stock as goat or horse where the hair is of minor importance. On the other hand, when used in weak solutions, say 0.25 per cent. and less, in conjunction with lime, the hair is but little injured, the hair-roots and dirt being rapidly loosened, with a result somewhat similar to that produced by arsenic sulphide.

When the process of depilation is completed the skins are removed from the pits and allowed to drain for an hour or so. They are then placed on the beam and the hair removed as described under the sweating process. In recent years various machines have been devised to accomplish the removal of the hair, although many tanners still prefer to keep to the older hand method.

After being unhaird the skins are "fleshed," which operation is for the purpose of removing any fat or flesh that has been left on the pelt by the butcher. The fleshing may be accomplished on the beam in a somewhat similar manner as that described for unhairing, except that the knife employed is heavier and sharp on both sides. In nearly all modern tanneries, however, the beam has been discarded, as machines for the purpose have taken its place.

It is very essential that the lime, or other depilating agent, should be completely removed when it has done its work, since its action is very harmful when brought into contact with tanning materials. For most leather, also, it is not only necessary that the lime be completely removed, but that the skin should be brought from its swollen to a soft and open condition. To accomplish this result on the heavier classes of dressing leather, such as split hides, kips, colt, and calf skins the stock is run in a weak fermenting infusion of pigeon or hen manure, the time depending upon the strength of the liquor, and upon the nature of the goods under treatment, the process being known as "bating." "Puering" is a very similar process, applied to the lighter and finer skins, such as glove-kid and moroccas, in which dog manure is substituted for that of birds. As the mixture is used warm and the skins are thin, the process is complete in a few hours. Neither bating of puering are very effective in removing lime, but seem to act by means of bacterial products upon the hide substance, thus causing the pelt to fall, that is, to become soft and flaccid.

Following the bating, and sometimes taking its place, comes the "drenching" operation, the purpose of which is to remove the last traces of lime and to slightly plump the skins. The drench liquor is prepared by allowing an infusion of bran in warm water to ferment under the action of special bacteria which develop lactic and acetic acids.

The method of deliming just mentioned, although it presents many difficulties and is uncertain in its action, is very largely used, notwithstanding the fact that many substances have been put on the market to replace it. But as the other papers of the evening will take up this subject we will not consider them at this time.

Having passed through all of the processes mentioned above, the hide or skin is now in the proper condition for the actual tanning operation, which may be conducted by any one of several different methods. As my time is limited, however, it will perhaps be best to mention only briefly the various processes, as they will be discussed more in detail by those who have papers on the special topics.

The oldest method in vogue is that known as "oil tannage," which consists in treating the hide or skin with a mixture of fish and other oil in a machine which works the skin by a sort of kneading motion known as the "stocks." During this operation heat is developed, resulting in the formation of aldehydes and other oxidation products. The excess of oil is removed by scraping and pressing, the product obtained being known as "dégras." The skins are then washed with a fairly strong alkaline solution, the alkaline solution neutralized with an acid with the result that fatty acids are produced known as "sod oil." This method of tannage is used especially for the so-called "chamois" leather.

For the manufacture of white and light colored leather it is usually customary to employ an "alum tannage." This method consists in treating the skins with a mixture of sulphate of aluminium, salt, flour, egg yolk and olive oil. This treatment produces a hard "crust" in which the skins are allowed to remain for quite a length of time, after which they are softened, sized and finished.

The most important method of tanning is that in which a vegetable material is employed, the results obtained being due to the presence of tannic acid. The operation consists in placing the skins in a dilute solution of the tanning material, such as quebracho extract, and gradually increasing the strength of the liquor until the treatment is completed. On removing from the tanning solution the skins are washed, dried, softened, colored, seasoned and finished as desired.

A recent process, and one which is meeting with increased application, is that known as "chrome tannage." The Schultz process was the first to meet with any commercial application

and consists in saturating the skin with a solution of dichromate of sodium or potassium together with hydrochloric acid. The chromic acid thus produced is absorbed by the hide substance, and is finally reduced to the chromic hydroxide condition by means of sodium thiosulphate and hydrochloric acid. A second process, brought to perfection by Martin Dennis, consists in treating the skin with a basic sulphate of chromium. The latter method has the advantage over the former in that it is more easily controlled and less expensive in its operation.

Within the past few years formaldehyde has been introduced as a tanning material and bids fair to open up a new field for the production of leather by chemical means.

As my part in the program of the evening was to pave the way for the other speakers, I will draw my remarks to a close, leaving the more detailed description of tanning, coloring and finishing for those who are better able to handle the respective subjects.

### THE SMOKE PROBLEM AND THE COMMUNITY.<sup>1</sup>

By CHARLES BASKERVILLE.

The problem of smoke abatement has been a vital one for many centuries. Some six hundred years ago, the citizens of London petitioned King Edward I to prohibit the use of "sea coal." He replied by making its use punishable by death. This stringent measure was repealed, however, but there was again considerable complaint in Queen Elizabeth's reign, and the nuisance created by coal smoke seems to have been definitely recognized at this period. Since this time there has been continual agitation, together with much legislation, both abroad and in this country. In the seventeenth century, King Charles II adopted repressive measures in London, and in the present century anti-smoke crusades have been frequent. In fact, the smoke problem will undoubtedly continue to demand attention until it is either entirely solved by the abolishment of the use of solid fuel or by the installation of devices and methods which shall prevent the formation of smoke in furnaces, regardless of the nature of the fuel.

It has been suggested that the production of fuel gas at the collieries, and its transmission to the various centers for combustion, will solve the problem by elimination. However, we are at present dependent upon local installations for the minimization of this unnecessary evil, but a realization of numerous rational changes in methods of generating heat and power is necessarily near at hand.

At the conference on smoke abatement held in London in 1905, Lodge suggested two methods for smoke abatement: the burning of coal at the mines to produce gas or electricity for transmission to cities, and the electrification of the air on a large scale. The latter suggestion cannot be given attention on account of the expense that would be entailed, although it has received favorable consideration by some.<sup>2</sup>

Good firing is admittedly an important factor in smoke prevention, and it has even been regarded as the main factor of the problem,<sup>3</sup> but it would appear that most authorities favor the distribution of gas as a means of at least alleviating the smoke nuisance.<sup>4</sup>

The economy resulting from smoke abatement is a potent argument in its favor. That this phase of the problem has

<sup>1</sup> Opening address in the symposium on "Smelter Fumes," San Francisco meeting of the American Chemical Society, 1910.

<sup>2</sup> Lord Rayleigh has a theory on dispelling smoke and fog by electricity. On the possibilities of smoke deposition by electrical means, see *J. Roy. San. Inst.*, 27, 42; and *Elec. Rev.*, 47, 811.

<sup>3</sup> Caborne, *J. Roy. San. Inst.*, 27, 142.

<sup>4</sup> For example, Lodge, Des Voeux, A. J. Martin and A. S. E. Ackermann. In this connection, see *J. Roy. San. Inst.*, 27, 42, 64, 80, 85.

little to do with the ethical side of the subject cannot be gained, since all communities have the right to demand its abatement regardless of economic considerations. In this connection, it is appropriate to discuss the legal status and different phases of the smoke problem, a subject which the writer has dealt with in detail elsewhere.<sup>1</sup>

Every individual has the right to have the air distributed over his properties and habitation in its natural condition, that is, free from all artificial impurities. In fact, it may be stated that no one has the right to interfere with the distribution and amount of pure air which flows over another's land any more than he has to interfere with his neighbor's soil. This right is strictly a natural one, and every use of property that causes an unwarrantable impregnation of the air with foreign substances to the detriment of another, is a nuisance, and is actionable as such. The air must be as free and pure as can be reasonably expected.

Based largely on the preceding, it is laid down broadly as a general rule in law that any act, omission or use of property which results in polluting the atmosphere with noxious or offensive gases or vapors, thereby causing material physical discomfort and annoyance to persons residing in the vicinity, or injury to their health or property, is a nuisance. This rule has been supported by decisions in Delaware, Illinois, Kentucky, Missouri, Pennsylvania, Texas, and Wisconsin.

#### WHAT CONSTITUTES A NUISANCE.

The question as to what degree of impurity imparted to the atmosphere by one in the use of his property constitutes a nuisance, is one of fact, and is determined by the jury from the circumstances of each case. Injury is, of course, a question of compound facts. No precise tests may be given that are applicable to all cases. In the consideration of the surrounding circumstances of a case, the character and nature of the gas complained of is of prime importance, and the times and periods of the generation of the gas, or the constancy and frequency of inconvenience caused, and the nature of the business, its location, management and manner of construction, must all be taken into careful consideration.

To illustrate the last condition, a manufacturing business may be a nuisance because it is located in a residential or populous part of a city or county, whereas it should be located in a more remote locality; or a nuisance may arise merely from the faulty construction of a plant or from the negligent or improper manner in which the business is conducted and the works kept.

Although diminution in value is the proper element of damages and in some cases the actual measure of the nuisance, yet it has been ruled in New Jersey that mere diminution of the actual or rental value of a property is not sufficient to make a business a nuisance. According to common law, a sensible injury is only a visible injury, and in general it may be stated that injuries must not be dependent upon scientific tests to discover. Theoretical injuries furnish no ground for abatement, and an injury to property must be irreparable to cause a court of equity to interfere to abate.

#### VARIOUS STATE DECISIONS.

It has been ruled in Connecticut that a manufactory which produces such unwholesome odors that the workmen of a neighboring manufactory are prevented from working therein, is a nuisance; and it has been given as a decision in Iowa, Kentucky, Massachusetts, New York, Texas, and Vermont, that a noxious trade may be a nuisance even in a remote locality, providing it is located near a public highway and inflicts serious discomfort on people passing by. However, it has been ruled in Tennessee that such odors or gases must be really dangerous to public health and not merely offensive to certain individuals.

Odors which are carried a great distance by the wind and

which are "unpleasant and objectionable," according to a decision handed down in North Carolina, is not sufficient ground for the interference of a court. Odors or gases must work some substantial annoyance or some material physical discomfort to maintain an action; this point is well supported by precedents. It has been decided in South Carolina that where the plaintiff has sustained injury from the escape of noxious gases from the defendant's factory and also injury from other causes, the defendant is not relieved from liability for the injury he has caused.

Dust, smoke and cinders, even when accompanied by noxious gases, are not nuisances *per se*, but amount to nuisances, whether accompanied by noxious gases or not, if they cause injury to neighboring property to such an extent that its value is diminished, or if they so pollute the air as to cause inconvenience materially interfering with physical comfort and the enjoyment of the property (California, Connecticut, Illinois, Indiana, Kentucky, Maryland, Massachusetts, Missouri, New Jersey, New York, North Carolina, Ohio, Pennsylvania and Tennessee). If smoke and its accompanying gases cause sickness or injury to health, an action for damages lies, even though the fuel producing the nuisance is necessarily used.

#### A DUCKTOWN SUIT.

In the suit of the Ducktown Sulphur, Copper and Iron Company *vs.* Barnes, *et al.*, where smoke and noxious gases from a smelting works injured the property and endangered the health of the adjoining land-owners, the action for damages lay, even though the business was being carried on in a suitable locality, with the most improved appliances, and furnished employment to nearly the whole community. It was decided that it is no defense to an action for damages that there were similar establishments in the neighborhood before the plaintiff moved there, and that it is no defense that the works could not be operated without giving rise to noxious vapors. It was decided that the owner was entitled to recover all the damages sustained without reference to the incidental benefits or advantages to the land by reason of the market it afforded for timber and garden products.

The decision in the preceding would seem to indicate that no prescription can be pleaded for a nuisance, and that neither its collateral benefit to the community, nor the good intent of the projector is a defense. It would appear that it is alone sufficient to sustain a conviction that the comfort of the community is impaired. However, the findings in some cases in Montana in part conflict with aforesaid decisions and stand out in sharp contrast.

#### SOME MONTANA DECISIONS.

In the suit of Hugo Magone *vs.* The Colorado Smelting and Mining Company, *et al.*, in which the plaintiff sought \$20,000 damages and a permanent injunction for alleged damage to his land and crops through the action of tailings and tailings waters, the prosecution attempted to demonstrate the cause of the damage by chemical analyses. The defense was based on the fact that the water carried mere traces of possible poisonous salts in solution, and that the soil, which was poor black alkali in nature, was not properly irrigated. Although damages amounting to \$1700 were awarded the plaintiff, the injunction was refused on the principle of the "greatest good to the greatest number."

One of the most extensive suits ever heard was the one brought by F. J. Bliss *vs.* The Anaconda Copper Mining Company and Washoe Copper Mining Company. This suit involved the question of fumes, and was brought for a perpetual injunction. During the case it was brought out that the Anaconda Company pays more than half the taxes of Deer Lodge County, where its smelter is located; about one-third of the taxes of Silver Bow County, where its mines are located; and with asso-

<sup>1</sup> *Eng. Min. J.*, May 1, 1909, pp. 884-7.

ciated companies they are the principal tax-payers in nearly every part of Montana. It was shown that the company had erected a stack 300 feet high and that, before the erection of this stack, when they used several smaller stacks, claims for about \$340,000 were settled.

The injunction was refused for the same reason as in the preceding case. The amount of damages fixed by the master in chancery was small. A further hearing in the case was ordered to ascertain if there is not some means of reducing the amount of arsenic in the flue dust, in order that a specific rule may be made which will afford relief.

#### THE CONTRA COSTA CASE.

In Contra Costa County, California, where an ordinance was passed to regulate the distribution of noxious gases by smelting plants, the board of supervisors of the county granted the companies involved 60 days' time to instal apparatus and appliances to prevent the nuisance. County ordinances of a similar nature may yet solve the problem in affected parts of the country, especially in the Western States. City ordinances usually afford little relief.

The doctrine that an industry or business erected in the vicinity of similar establishments could not become a nuisance in that locality, or that any exceptions should be made in favor of a business lawful in itself and useful in its results, that is otherwise clearly a nuisance, excepting for the fact of location and usefulness, is generally considered to stand out of the pale of recognition of modern authority and to be entitled to no weight outside of Pennsylvania. However, some jurists, particularly in the western smelting districts where a broader view must necessarily be given to the matter, have rendered decisions which would seem to be contrary to this general rule.

#### OTHER LOCALITY CONSIDERATIONS.

In the case of *Dittmann vs. Repp*, the Supreme Court of Maryland held that in determining the question of nuisance from smoke or noxious vapors, reference must always be had to the locality. For instance, a party dwelling in a city in the midst of crowded commercial and manufacturing activities, cannot claim the same quiet and freedom from annoyance that he might rightfully claim in the country. When the population moves up to a nuisance which was previously in solitude, then, as a general rule, the nuisance must recede. It must, however, be reasonably offensive.

On its first introduction, gas was declared to be deleterious to the health of the community, and in some localities steam railways were at one time so offensive to particular local authorities that attempts to prosecute them as nuisances were not infrequent. Grievances of prosecutors in such cases as pertain to damaging gases in particular are often sentimental or speculative—just as they were at the time when the use of gas as a fuel was regarded as a nuisance—without due regard to the substantiality of the "nuisance."

#### POPULAR MISCONCEPTIONS.

Persons engaged in agricultural pursuits in manufacturing districts invariably have impressions of the destructive action of the waste gases resulting from fuel combustion, etc., upon vegetation, but these are generally founded on observation and tradition. There are many instances of sympathetic juries having fostered these impressions, basing their awards on miscellaneous general evidence and not upon scientific examination. In such cases, too much reliance is often placed on the appearance of individual trees and of isolated trees.

In some cases, the injury through atmospheric influence resembles smoke injury. A lack of iron and the ravages of insects produce yellow or red blotches on flora leaves. A distinction from fume poisoning can be discovered, however, by transverse sections under the microscope, when mycelium strings will be observed between the cells. In the case of pines,

stronger trees absorb less than the weaker ones, and even though there is no visible injury, as observed in the change in the appearance of the needles, a microscopical examination will demonstrate that the chlorophyll substance has undergone changes or destruction when treated or exposed to sufficiently concentrated sulphur dioxide or hydrogen chloride.

Poor soil, exposure of wind, especially dry wind, diminished water supply, and fungi, all produce morphological conditions in vegetation which lead to the gravest misapprehensions in the minds of rural folk, and oftentimes accusation of fumes and gases as the cause results, either wrongfully or on *à priori* grounds. Ordinary testimony based upon odor alone should, as a rule, carry little weight.

It is well known that the present sociological and political ideas which obtain in the rural communities, and certain abuses of the centralization of capital on the part of corporations, have resulted in injuring the chances of the latter in suits of this nature. While it is true that certain corporations conceal their processes of manufacture, the nature and amount of materials used and the output of product, as well as employ other precautions in order to render the recognition of damage done by fumes more difficult, yet many instances are known where gardens are purposely set out with expensive flowers unsuited to the climate, just to profit by the damage for destruction by "noxious gases," and manufacturers are not protected from such malicious actions.

#### EXPERT BOARD TO ASSESS DAMAGES.

Some time since I made the suggestion with the aim of justice in mind, that complaints of this nature be settled by a commission composed of three experts in such matters, one being selected by each of the parties and the third being chosen by these two; or two of the experts may be appointed by the court, and a third selected by these two. Such a board of experts could investigate the facts of the case scientifically on the spot, and, if damage has been done, fix the amount and warn the offenders that a recurrence will bring forth more severe penalties. Negligence on the part of the manufacturers would cease, as well as annoying and expensive interruptions of business. I am convinced, and I have reasons for making the statement, that honest manufacturers would welcome such a change. It is recognized that such settlements would not be looked upon with particular favor by the legal fraternity, but is interesting to note that a recent case brought against the Mammoth Copper Company, in Shasta County, California, was settled by an arbitration board composed of three horticulturists, both parties to the suit having agreed to abide by their decision.

In this connection it may also be remarked for the benefit of those who have not had occasion to investigate the matter, that there is neither entire uniformity nor definiteness of statement in the codes of our several states in regard to the contamination of the air or the pollution of streams. When such contamination becomes wretchedly bad from any cause whatever, protests sometimes check the wrong and secure legislation. The continued pressure of unsubsidized publicity often encourages direct action in these matters.

#### CASES OF FEDERAL JURISDICTION.

When a manufactory in New Jersey generates gases which are complained of in New York or when smelter fumes produced in Montana or Tennessee affect the vegetation in a neighboring state, it becomes a Federal matter. In the latter case, we have also the same indefiniteness of statement in our laws.

Several rules based upon precedents and not specified regulations obtain, the rule of action is not clear, and there is a tendency toward a too technical construction of the law. Some have asserted that there is no need for legislation until there is a demand for it, but the law of equity is not the outcome of

specific needs and abuses of justice, and is rather contingent upon anticipated conditions; and manufacturers, as well as citizens, desire just protection. As in criminal law, it is to be deplored that cases may be lost in lower courts on judicial rulings which, in other similar cases, are afterward reversed by higher courts.

A Federal decision of great import was handed down in the case of the State of Georgia *vs.* The Tennessee Copper Company and the Ducktown Sulphur, Copper and Iron Company. The United States Supreme Court held that a state has the right to protect its forests and that a company can be enjoined for operating its smelting works in such a manner as to cause damage to property in a neighboring state. It was held that a state has the right to protect its citizens when their property is subject to damage by operations in another state.

The interest involved in the United States is sufficiently great and distributed to make it appear advisable for the Department of Agriculture to extend its operations and investigations in this field, co-operate with the similar departments in the states, formulate reasonable legislation, and recommend the enactment of a uniform and definite law. In such an event the government officials would undoubtedly receive the cordial support and encouragement of the owners of the industry, perhaps even financial complimentary support. Such has been the case in England, where there is in force a law defining what amounts of waste gases may be permitted in the air.

#### FOREIGN LEGISLATION.

A brief discussion of the foreign laws of importance may not be out of place in this connection. According to Lord Derby's alkali act, the sulphate works of England were not permitted to discharge more than 5 per cent. of the hydrogen chloride gas produced. This clause was later altered to forbid more than 0.464 gram of HCl per m<sup>3</sup>. With regard to the sulphuric anhydride, the Alkali Works Amendment bill of 1901 prohibits the discharge of more than 4 grains of SO<sub>2</sub> per ft<sup>3</sup>. of residual gas. The result of these laws has been a notable diminution of the amount of acid gases allowed to escape from works—a result not achieved by numerous prosecutions.

Until the beginning of 1907, the lead and copper smelting works in Great Britain were at liberty to discharge their fumes into the air as long as no objections were raised by persons near-by. Now these smelters are included in the new alkali works regulation bill. However, the method of dealing with the existing smelting works is left somewhat elastic by the act. Contrary to the American law, the gaseous output could not be restrained up to 1907 if the population moved up to the works. This is exemplified by the history of Swansea, Wales. In Prussia, in the granting of concessions for new works it is enacted that the amount of sulphuric anhydride in the waste gases should not exceed 5 grams in one cubic meter.

#### IS A UNIFORM FEDERAL LAW IMPRACTICABLE?

An objection which has been urged against the regulation of the amounts of acid gases discharged into the air is this, that it is not practicable to establish a permissible amount of noxious gas which may be emitted for all parts of a country owing to geographical and meteorological conditions. This is indeed well founded.

Other important questions to be considered in the formulation of a Federal law, such as referred to, are the enforced selected location for smelting works, etc., preferably on plains or level portions of the country with due regard to winds, and the advisability of enforcing the adoption of tall stacks and chimneys by all works generating noxious gases. In regard to the first, it has been suggested that smelting companies be given the right to condemn land within a certain radius of their works, especially if they were located before the advent of a definite number of people. Such a bill passed the legislature

of Utah but was vetoed in 1907 by Gov. J. C. Cutler on the ground that such a measure bore the marks of class legislation. The Utah bill providing for the condemning of land within a radius of four miles from a smelter in counties of less than 75,000 people.

As to the second question, the assumption that higher chimneys will diminish the amount of damage done by allowing the acid gases to become more dilute before reaching the vegetation is not realized, according to the experience of many industrial concerns. Notwithstanding the fact that unquestionable benefits are derived from dust chambers, and the contrivances associated with high stacks, and the fact that the adjacent vegetation is not so much injured from a high as from a low stack, there is considerable damage wrought by gases from high stacks, as remote vegetation is reached by smoke, etc., which would not be otherwise affected. In damp, heavy air, fumes heavier than air fall rapidly to the ground; and when the wind blows, the gases sink gradually, but hold together for considerable distances, so that no unusual dilution is effected by such means. This I have verified by experiments on a large scale.

#### THE WORK OF THE EXPERT IN THIS CONNECTION.

The usual gases which give rise to complaint in manufacturing localities are the following: Chlorine, which is emitted by pottery kilns and ceramic products manufactories, and plants for the electrolysis of halides; hydrogen chloride, which is produced by the combustion of coal, and by pottery kilns, ceramic products manufactories (partly from the coal and partly from the clay), nickel and cobalt smelting, platinum refining, glass manufacture, fertilizer manufacture, the chloride of lime industry, and soda manufactories; sulphur dioxide and sulphuric acid, which result from the combustion of coal, coke, and gas, copper smelting, and from many other industrial processes; and fluorine and hydrofluoric acid, which are emitted from phosphate fertilizer and heavy chemical plants.

However, the destructive action of fumes in the vicinity of chemical works is generally due to the presence of sulphurous acid, sulphuric acid or hydrochloric acid. Since hydrochloric acid is absorbed in the same manner as sulphurous acid and sulphuric acid by the leaf organs of plants, the proof of injury may, in a measure, be established by an estimation of the chlorine content. It is usually easy to establish an abnormal chlorine content in a plant, providing, of course, that actual hydrochloric acid action is apparent. In chemical factories the investigation of suspected injuries is very much complicated owing to the fact that the combined action of sulphurous acid, sulphuric acid, and hydrochloric acid, as well as that of coal fumes, must be taken into consideration. Consequently, it is often difficult to decide how far the injury done to vegetation, especially slight injuries, is due to the acid fumes coming from manufacturing processes and the injury caused by the combustion of coal. In general, however, one does well to make himself acquainted, as far as possible, with the surrounding neighborhood and the pathological conditions. The forms of injury found furnish abundant points of distinction as to the nature of the injurious gases; and repeated local examinations and observations at different periods are advisable.

The chemical analyses should be more comprehensive than simple determinations of the abnormal sulphuric acid and chlorine content of the affected plants: If the whole investigation is to be of value, the presence of abnormal amounts of the noxious gases must be shown in the vicinity of the source of contamination at various points at different distances. An exhaustive local examination is necessary. Injury from sulphur dioxide often shows itself by the increased sulphur trioxide content of the foliage of the affected vegetation, but in order to ascertain whether the injury to vegetation is due to the action of sulphurous acid and sulphuric acid or to the ac-

tion of hydrochloric acid, it is necessary to make estimations of both in the neighborhood of the manufactory. Since rain water and dew nearly always contain sulphuric acid and chlorine (calculated as such) in small amounts, no reliable conclusion can be drawn in regard to the increase of these gases from the source of contamination, except by long-continued observations at different distances and by exact quantitative analyses.

To determine absolutely the action of hydrochloric acid on plants, it is necessary to make estimations in the gas currents and then compare them with the normal chlorine content in the vicinity, as determined by analyses made at stations at different distances and in varying weather conditions. It is important to consider the chlorine contained in the soil in the neighborhood of factories, especially when estimations of chlorine in plants are made.

SULPHUR DIOXIDE AS AN IMPURITY OF CITY AIR.

Sulphur dioxide has been shown to be present in considerable amounts in the air of various manufacturing cities, when the total amount and not the concentration is considered; and, since the atmosphere is the great receptacle for all gaseous emanations, it may be said in general that this gas is a common impurity of city air.

The writer sometime ago made a number of determinations of the sulphur dioxide content of the air of New York City. Stations were established throughout greater New York City, including the high office buildings, parks, subways, stations, and railroad tunnels; and very variable results, as might be expected, were obtained. The determinations may, in part, be thus summarized:

Locality.	SO <sub>2</sub> in parts per million.
Elevated portion of city, near a high stack...	3.14
Various parks.....	0.84 (maximum: others negative).
Railroad tunnels.....	8.54-31.50
Subway.....	None
Downtown region.....	1.05-5.60
Localities near a railroad.....	1.12-8.40

In 1907, the residents of Staten Island, as well as some on Long Island, complained of the noxious nature of the air wafted over from various plants in New Jersey. This induced the Department of Health of the City of New York to investigate the air and vegetation in the vicinity of the Borough of Richmond, Staten Island, and some of the results obtained are given below by permission of the department:

Substance.	Impurity.
Air.....	Trace of sulphuric acid.
Air.....	0.0066 percent. SO <sub>2</sub> by weight.
Air.....	Trace of sulphuric acid.
Grass (three samples).....	Sulphuric acid present.
Grass.....	0.24 per cent. SO <sub>3</sub> .
Grass.....	0.70 per cent. SO <sub>3</sub> .
Leaves.....	0.19 per cent. SO <sub>3</sub> .
Leaves.....	0.28 per cent. SO <sub>3</sub> .
Soil.....	0.0015 per cent. SO <sub>3</sub> .

These results do not really give us anything definite, as the comparative factor is absent.

Sulphur dioxide to the extent of 1300 tons, calculated as 80 per cent. sulphuric acid, is discharged every twenty-four hours into the air of New York City from the combustion of coal alone. From an economic standpoint, this is an enormous, partly avoidable, waste, while from a sanitary standpoint, any disinfecting action it exerts on the organic wastes arising from the streets is greatly counterbalanced by its general injurious effects which may be thus summarized:

1. Its presence in atmospheric air is a menace to hygienic welfare, since it has serious effects on susceptible persons and particularly exerts deleterious effects upon the respiratory organs. SO<sub>2</sub> in the air of manufactories tends to produce bronchitis and anemia.

2. It exerts an injurious action on plant life. In this action it is less violent than hydrogen chloride, sulphuric acid and fluorine, but owing to its less solubility and consequent slower condensation, it has a wider distribution. In Manchester, England, in 1891, it was learned that the greatest injury to plant life is due to the emanations from dwelling-houses.

3. The condensation of sulphurous acid with moisture in fogs and hoar frosts seriously affects goods printed with colors sensitive to sulphurous acid; for example, logwood, Brazil wood shades, and aniline black.<sup>1</sup>

4. Sulphur dioxide proceeding from the combustion of coal and coal gas, the quantity of which in towns is considerable, necessarily destroys the ozone of the air. This may account for the definite variations of the proportion of ozone observed at various localities.

5. In anti-cyclonic periods the amount of sulphur dioxide rises considerably, and at such times this increase is accompanied by at least as large an increase in the amount of organic impurities in the air.

RECLAIMING DEVICES.

To conclude, the main solution of the "fume question" and "air pollution" would seem to be in the enforced use of waste-reclaiming devices by the enactment of a Federal law regulating the amount of waste gases to be permitted to pass into the air, but laws do not execute themselves, and strict administration, sufficient appropriations for the determination of facts, enlightenment of the public mind as to the effects of noxious industrial emanations, and civic interest would all be absolutely required for the enforcement of such a law. In England the enactment of similar laws laid the foundation of the great chloride of lime industry, and the subject has received merited attention since 1863; in fact, one might say since 1836, the year in which Gossage solved the problem of hydrochloric acid condensation.

In Germany, after extensive experiments in 1848, the furnaces in the smelting districts were remodeled and the volume of the dust chambers increased. This proved advantageous to the smelters, as the following shows: The Freiberg Smelting Works paid 55,000 marks for damage in 1864, and but 4,793 marks in 1870, after installing means of condensing the acid gases. In our own country it is encouraging to note that some manufacturers and smelters have at last begun the installation of waste recovering contrivances—surely a decided step toward the solution of a great national industrial problem, however novel and radical such devices may appear.

NOTES AND CORRESPONDENCE.

STANDARD SAMPLES, BUREAU OF STANDARDS, WASHINGTON.

The Bureau of Standards, Washington, D. C., is ready to distribute the following analyzed samples:

No. 6a. Iron D, replacing the original D of the American Foundrymen's Association.

No. 24. A vanadium steel with between 0.1 and 0.2 per cent. vanadium. At present only a provisional certificate of analysis can be issued with this steel.

No. 25. A manganese ore, for total manganese and available oxygen.

No. 26. "Crescent" iron ore, for alumina, lime and magnesia.

No. 27. "Sibley" iron ore, for iron, silica and phosphorus.

No. 28. "Norrie" iron ore, for manganese (low).

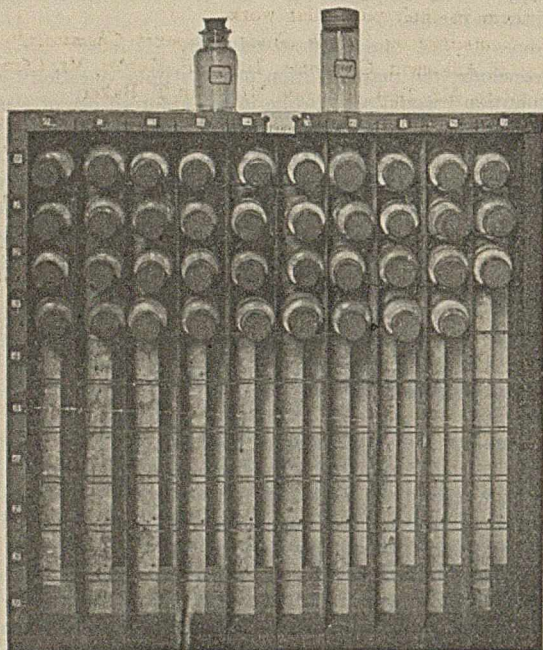
A new schedule of fees goes into effect July 1, 1910, and thereafter the only discount allowed will be ten per cent. (10%) on four or more samples, alike or different.

<sup>1</sup> Soft coal smoke interferes with the manufacture of delicate shades of silks; it has been asserted by manufacturers.

Two new circulars relating to the Bureau's standard samples have been prepared for free distribution. Of these, Circular 25 contains general information regarding all samples, and Circular 26 relates to the methods used by the Bureau chemists and many others in analyzing the above manganese and iron ores.

### SOME LABORATORY DEVICES.

The accompanying figure pictures the writer's device for filing and handling samples contained in bottles. The frame is made of board about 2 cm. thick; its internal dimensions are 57 x 57 x 11 cm. This space is divided into one hundred equal compartments by nine vertical strips of galvanized sheet iron and nine pairs of galvanized iron wires, which pass horizontally through the strips into the frame. The bottles lie on the wires and abutt at the back against flanges which form a part of each of the strips of sheet iron. The frame is made



No. 1.—A sample file.

ridged and held in shape by suitable braces at the corners, back side. The above are the construction and dimensions of our small transportable files for bottles of 100 to 200 cc. capacity; in the case of our larger and stationary files (for jars or bottles of 800 to 1000 cc. capacity) we use a cheaper construction, namely: shelves (board) take the place of the horizontal wires, and nails—a pair fore and aft driven into the board between the bottles—take the place of the vertical strips, and keep the bottles or jars in vertical alignment.

These files, about a score of the small transportable ones and over two score of the stationary ones, have been in use in our laboratory for the past seven or eight years and are regarded as indispensable. By their aid the chemist can place his hand, without confusion or loss of time, on any particular sample among several thousand.

Observe the label "7400" at the top of the frame; it means that this file contains that particular hundred samples whose first two figures are 74, namely, Nos. 7400 to 7499, inclusive. Observe also the figures 0, 1, 2, 3, 4, 5, 6, 7, 8, 9 on the top and left margins of the frame, beginning at the upper left-hand corner. The bottles are filed by tens, left to right; the first ten, 7400-7409, inclusive, occupy the top row; the second ten, 7410-7419, inclusive, the second row, and so on down to the

last ten, 7490-7499, inclusive, which occupy the last, or bottom, row. To find any particular sample that one might wish, say No. 7446, one goes to the file being the appropriate label, in this case "7400," runs the hand down the left-hand margin to figure "4" and thence horizontally to figure "6"—that gives the sample sought—7446.

The samples (fertilizers, feedstuffs, soils, etc.), prepared for analysis in the preparation room, are placed in the small files and carried to the weighing-room, where they are hung against the walls or set on tables near the balances. The original samples (fertilizers, for example) are returned—what is left of each—to its jar, sealed, placed in the large or stationary file for future reference, if need arise. The prepared original samples bear the same numbers.

J. M. PICKEL.

RALEIGH, N. C., June 22, 1910.

### BOOK REVIEWS AND NOTICES.

*Les Secheries Agricoles: Etude Economique et Technique de la Desiccation des Produits Agricoles.* Par D. SIDERSKY, Ingenieur-Chimiste. Paris: Lucien Laveur, Editeur, 13 Rue des Saints-Peres (VI<sup>e</sup>).

Sidersky has written a very useful brochure on the above subjects, showing how the science of desiccation may be profitably employed for agricultural purposes.

The work is especially interesting to those who have to deal with cattle foods derived from sources where there is a very large excess of water.

Among the subjects treated in the book are: The pulps of sweetmeats, the drying of sugar beets, the drying of leaves and necks of sugar beets, the drying of potatoes, the utilization of pulp from starch factories, the drying of artichokes, of the pomace of wine, of the slops of breweries, the desiccation of milk and of the products of the dairy and cheese factories, the drying of liquid products of the slaughter-houses, etc.

The chapter given on the various forms of apparatus used for drying purposes, both open and vacuum, is a very interesting chapter to the technologist. The book closes with a chapter on the organization of agricultural desiccating establishments and the laws of the French Republic relating to the supervision given by the state to agricultural products of this kind. Both the practical farmer and the chemical engineer will find M. Sidersky's book valuable.

H. W. WILEY.

### SCIENTIFIC AND INDUSTRIAL SOCIETIES.

#### AMERICAN CHEMICAL SOCIETY.

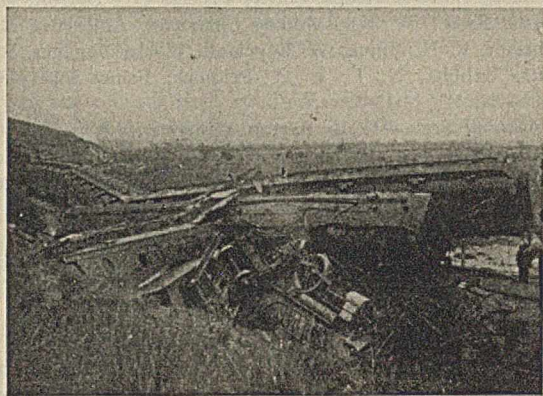
The excursion of the American Chemical Society to the Pacific Coast and the meeting at San Francisco were two of the most pleasurable undertakings in the history of the Society. About



100 members and guests were aboard the Santa Fe special train when it pulled out of Chicago on the evening of July 4th.



The Chicago section entertained the travelers with a reception and buffet luncheon during the afternoon and saw them off at the station. All events took place according to the pre-arranged schedule and no mishaps occurred until the morning of Tuesday, July 12. At 6 A.M. that day, while the train was a few hours out of San Francisco, it left the track at a curve, killing the engineer and fireman instantly and mortally injuring the conductor. Most of the party were in their berths. A few were hurt, but none seriously. The cause of the acci-



dent appeared to be too high speed on a series of curves. The buffet and baggage car were demolished, the diner turned over and partly smashed, the tourist (steel) not badly damaged, the compartment thrown upward so that one end was several feet in the air. Only the last two cars remained on the track. In these two cars the party was promptly taken to King City, breakfasted, and then on to San Francisco. On account of the wreck the Santa Clara and Palo Alto trips had to be abandoned.

The remainder of the meeting was most enjoyable. On Friday and Saturday the party broke up, some going to Salt Lake, some to Seattle, where they were again entertained, and some on to the Canadian Rockies. A few made the Alaska trip. The meetings of the Division of Industrial Chemists and Chemical Engineers are reported in detail below.

#### DIVISION OF INDUSTRIAL CHEMISTS AND CHEMICAL ENGINEERS OF THE AMERICAN CHEMICAL SOCIETY.

San Francisco Meeting, July 14 and 16, 1910.

THURSDAY, JULY 14TH.

The session of July 14th was held at St. Francis Hotel, San Francisco, and was called to order by W. R. Whitney. The reading of the minutes was omitted. The Secretary reported for the Executive Committee as follows:

The name of the "Committee on Definition of Trade Terms" was changed to "Committee for the Definition of Industrial Terms," upon request of the Committee Chairman. Likewise the term "Committee on Advertising" was changed to "Committee on Publicity." Reports were then read from the several outstanding committees of the Division.

(1) Report of the "Committee for Definition of Industrial Terms," Clifford Richardson, Chairman, presented by George P. Adamson.

The meeting for organization was held in New York on February 14, 1910, at which all the members were present. The subject of the work of the committee was discussed at some length, and it was agreed that sub-committees be organized as follows, of which the gentlemen named were invited to become chairmen as stated:

Definition of "Bronze," Mr. J. B. F. Herreshoff, *Chairman*.

Definition of "High Grade Inorganic Chemicals," Mr. Geo. P. Adamson, *Chairman*.

Definition of "Heavy Chemicals," Mr. T. Lynton Briggs, *Chairman*.

Definition of "Pharmaceutical Products," Mr. Geo. D. Rosengarten, *Chairman*.

Definition of "Iron and Steel," Dr. A. S. Cushman, *Chairman*.

Definition of "Portland Cement," Mr. Clifford Richardson, *Chairman*.

Definition of "Petroleum Products," Mr. Clifford Richardson, *Chairman*.

Subsequently a "Committee on the Definition of Bitumen and Asphalt" was organized, consisting of the same individuals who constitute a sub-committee of the American Society for Testing Materials.

The various chairmen of the sub-committees have reported as follows in regard to the individuals that they have associated with them in their particular work.

*Sub-Committee on "High Grade Inorganic Chemicals."*—Mr. George P. Adamson, *Chairman*, Dr. L. F. Keble, Mr. Campbell K. Walters, Mr. D. L. Murray, Mr. John T. Baker.

*Sub-Committee on "Pharmaceutical Products."*—Mr. George D. Rosengarten, *Chairman*, Dr. W. J. Schieffelin, Mr. Edward Mallinckrodt, Jr.

*Sub-Committee on "Iron and Steel."*—Dr. A. S. Cushman, *Chairman*.

Dr. Cushman will associate himself with the Committee of the American Society for Testing Materials, who are considering the subject.

*Sub-Committee on "Petroleum Products."*—Mr. Clifford Richardson, *Chairman*, Mr. T. T. Gray, Jr., Mr. P. H. Conradson.

This committee has asked for the views of various manufacturers of petroleum products, and Mr. M. Saybolt, of the Standard Oil Company, has submitted the following conclusion:

"*Naphtha*.—A generic term (light or heavy) that distills from petroleum before the lightest illuminating oil, be it *crude* or refined.

"*Gasolene*.—Both refer to refined naphthas.

Gasolene to a light refined naphtha.

"*Benzine*.—To a heavy refined naphtha.

"*Kerosene*.—A generic term for illuminating oils distilling from petroleum after heavy naphtha and before light lubricating oils."

As yet the manufacturers do not seem willing to limit the various classes by density, probably owing to the fact that the greater demand for the lighter products has compelled them to change these considerably from time to time.

*Sub-Committee on "Bitumen and Asphalt."*—Mr. Clifford Richardson, *Chairman*, Dr. Albert Sommer, Dr. A. S. Cushman, Mr. S. P. Sharples.

It has been thought best to delay the appointment of further committees until it has been determined how satisfactorily the few which have been named accomplish their work, and how the attempt to define industrial terms will be received by the producer and the consumer.

Your committee sent to the various trade journals of the country a statement of its objects as follows, which it asked them to put before their readers:

"Definition of industrial terms. At the recent annual meeting in Boston of the Division of Industrial Chemists and Chemical Engineers of the American Chemical Society, a committee was appointed by the chairman "On the Definition of Industrial Terms" to cooperate as far as possible with trade organizations in the several lines of industry in formulating definitions of their products which shall be as accurate and as fair as possible to the interests involved. The organization of such a committee has been suggested by various interests who desire a more author-

itative definition of some industrial terms, such as 'petroleum ether,' 'gasoline,' 'gasolene,' 'benzol,' 'bronze,' 'benzine,' 'steel,' 'Portland cement,' etc. It is proposed, when an interest is expressed for the definition of terms in any special field of industry, to organize a sub-committee to consider this field and define the principal terms in use in it. The committee is desirous of receiving suggestions from all who are interested in the subject as to terms which are considered the most important to be defined at the present time, owing to ambiguities which may now exist, and as to the best methods of accomplishing the work. The value of authoritative definitions as approved by the Industrial Division of the American Society will, of course, be recognized. Communications should be addressed to Clifford Richardson, 30 Church Street."

This has appeared in several of the journals, and from some of the editors, letters of appreciation of the work have been received.

With the organization of the sub-committees, the work for which the committee of the Division was appointed, has been organized, and it remains to be seen how much support it will receive. In consequence, this may be regarded merely as a progress report, and it is to be hoped that that which will be presented at the annual meeting will mark satisfactory progress.

#### COMMITTEE ON DEFINITION OF INDUSTRIAL TERMS,

(Signed) CLIFFORD RICHARDSON, *Chairman*,  
J. B. HERRESHOFF,  
GEO. P. ADAMSON.

(2) Report of "Committee on Official Specifications," Harvey J. Skinner, *Chairman*.

The committee was necessarily delayed in starting its work owing to the continued illness and subsequent death of one of its members, Dr. Rudolf de Roode. Mr. Robert Job, of the firm of Booth, Garrett & Blair, Philadelphia, Pa., was appointed to fill the vacancy.

It has been necessary to carry on a large part of the work by correspondence on account of the geographical location of the various members of the committee.

After carefully considering the problem set before them, the committee was of the opinion that the materials which should receive first consideration are those of a more strictly chemical nature, or those whose properties depend largely upon their chemical characteristics. The committee decided to carry out the ideas of the Division by the appointment of sub-committees—one for each material to be studied, the personnel of these sub-committees to consist so far as possible of three members—two representing the consumers and one the manufacturers. The following materials have been selected for our first consideration and committees appointed for each material:

Muriatic acid.	Soda ash.
Nitric and mixed acids.	Caustic soda.
Sulphuric acid.	Sulphate of soda.
Alum.	Solder.
Bleaching powder	Turpentine.

The personnel of these sub-committees is as follows:

*Muriatic Acid*.—Fritz H. Small, *Chairman*, Graton & Knight Mfg. Co., Worcester, Mass.; J. T. Baker, J. T. Baker Chemical Co., Phillipsburg, N. J.; J. O. E. Trotz, American Steel & Wire Co., Worcester, Mass.

*Nitric and Mixed Acids*.—Arthur M. Comey, *Chairman*, E. I. du Pont de Nemours Powder Co., Chester, Pa.; Henry Howard, Supt. Merrimac Chemical Co., Boston, Mass.; Oscar W. Pickering, 42 Holden St., Malden, Mass.

*Sulphuric Acid*.—Fred B. Porter, *Chairman*, Chemist Swift Fertilizer Works, Atlanta, Ga.; W. M. Kelsey, Supt. Acid Department, Mineral Point Zinc Co., Depew, Ill.; F. C. Robinson, Chemist Atlantic Refining Co., Philadelphia, Pa.

*Alum*.—William M. Booth, *Chairman*, Syracuse, N. Y.; F. A.

Olmsted; Arthur D. Little, Inc., 93 Broad St., Boston, Mass.; S. W. Wilder, Merrimac Chemical Co., 33 Broad St., Boston, Mass.

*Bleaching Powder*.—W. P. Atwood, *Chairman*, Hamilton Mfg. Co., Lowell, Mass.; Fred W. Farrell, Emerson Laboratory, Springfield, Mass.; Charles E. Acker, 97 Cedar St., New York City.

*Soda Ash*.—Henry W. Hess, *Chairman*, Libbey Glass Works, Toledo, Ohio; Martin L. Griffin, Emerson Laboratory, Springfield, Mass.; A. F. Shattuck, Solvay Process Co., Detroit, Mich.

*Caustic Soda*.—W. K. Robbins, *Chairman*, Amoskeag Mills, Manchester, N. H.; James W. Loveland, Works Manager, B. T. Babbitt, Babbitt, N. J.; J. D. Pennock, Semet-Solvay Co., Syracuse, N. Y.

*Sulphate of Soda*.—G. E. Barton, *Chairman*, Whitall-Tatum Co., Millville, N. J.; Herbert Hollick, Supt. General Chemical Co., Camden, N. J.; W. D. Livermore, Chemist Washington Mills, Lawrence, Mass.

*Solder*.—Carl F. Woods, *Chairman*, Secretary; Arthur D. Little, Inc., 83 Broad St., Boston, Mass.; W. M. Corse, Lumen Bearing Co., Buffalo, N. Y.; George O. Bassett, Western Electric Co., 463 West St., New York City.

*Turpentine*.—J. E. Teeple, *Chairman*, Hudson Terminal, 50 Church St., New York City; C. H. Herty, University of North Carolina, Chapel Hill, N. C.; L. F. Hawley, U. S. Forest Service, Washington, D. C.

Other sub-committees will be appointed from time to time, but it seems advisable to allow sufficient time to elapse to determine the progress made by those already appointed.

The standing committee is considering a standard form for these specifications, while the sub-committees are studying the requirements which are to be specified, and it is to be hoped that at the annual meeting in December the committee will have some finished specifications to submit to the Division.

(Signed) H. J. SKINNER, *Chairman*.

(3) "Committee on Special Compounds," Gellert Alleman, *Chairman*.

"The committee which you appointed to inquire into the prices of elements and compounds has gathered considerable information, and will have this properly tabulated and ready for presentation at the winter meeting.

"The committee earnestly requests that those who have information regarding the prices at which the rare elements may be obtained, will communicate such information for publication."

(Signed) GELLERT ALLEMAN.

(4) "Committee on Trade Customs."

The Secretary read a letter from Henry Howard, Chairman of the committee indicating that there was apparently no interest among the manufacturing chemists in the proposed work of this committee—whereupon the motion was made from the floor that the committee be discharged. The motion was carried.

(5) "Committee on Research Problems," George C. Stone, *Chairman*.

"The Committee on Research Methods of the Division of Industrial and Engineering Chemistry" have to report that, after meetings and correspondence, they published a circular in the May number of THIS JOURNAL, requesting suggestions and assistance from the members. In this circular they outlined the work they believed it practicable for them to undertake and in almost all lines the co-operation of the members of the Society is essential, and those who are willing to assist were asked to communicate with the committee. The replies have been so few as to be very discouraging and show a complete lack of interest in the work of the committee by the members.

The committee will meet as soon as possible and endeavor to discover other possible lines of work that will be of use to the

Society and that can be carried on without assistance from the membership at large.

(Signed) GEORGE C. STONE, *Chairman.*

(6) "Committee on Standard Methods of Technical Analysis."

The chairman made a statement referring to the handicap under which this committee had labored during the past several months, owing to the misunderstanding as to the relation between its Committee and the Parent Society Committee on the Standard Methods of Analysis. By recent action of the Council all questions as to the relations between the General and Divisional Committees have been regulated so that this Committee is now free to proceed with the very important work for which it was designed.

No definite reports were received from the Committee on Descriptive Bibliographies or from Committee on Advertising.

Papers comprising symposium on smelter smoke were then presented as follows:

(1) Charles Baskerville, "The Smoke Problem and the Community." In the absence of the author this paper was read by the Secretary. It dealt mainly with legal questions involved, and summarized the most important decisions, both American and foreign.

(2) W. C. Ebaugh, "The Neutralization and Filtration of Smelter Smoke."

This paper was supplementary to previous articles that have been published in the *Journal of the American Chemical Society* and THIS JOURNAL. The removal of solids from smelter fumes has greatly reduced the damage to surrounding vegetation and apparently promises a fair solution of the problem.

(3) F. G. Cottrell, "The Electrical Precipitation of Suspended Matter."

By the use of numerous lantern slides the author indicated the development, from the crude laboratory stage to the successful commercial installation, of his process for the precipitation of either solid or liquid suspensions from gases by the use of high potential electrical discharge. This interesting description was supplemented on the following day by demonstrations of the laboratory apparatus at University of California, and of the commercial installation at the plant of the Selby Smelting and Lead Company. This same process in a modified form is utilized in separating oil-water emulsions. This has proved commercially successful in the recovery of large quantities of California crude oil previously of little value because of the great permanency of the emulsions.

The discussion following the symposium was necessarily restricted as California hospitality not only left no time for extra sessions but intruded somewhat upon the time specified in the program. It is thus necessary to record that the meeting scheduled for July 15th at the University of California was by common consent omitted as otherwise there would have been no opportunity for visitors to inspect the numberless attractions that were to be discovered there.

SATURDAY, JULY 16TH.

At the meeting held at St. Francis Hotel, San Francisco, W. C. Ebaugh acted as temporary chairman.

The following papers were presented by the authors:

(1) W. C. Ebaugh, "The Composition of Solids Precipitated from the Atmosphere during a 'Salt Storm.'"

(2) Elwood Haynes, "Alloys of Nickel and Cobalt with the Metals of the Chromium Group."

(3) W. C. Blasdale, "Factors Affecting the Electrolytic Method for the Determination of Copper in Ores."

(4) George Kemmerer, "The Electrolytic Determination of Zinc in Ores."

There was also transferred from the Division of Physical and Inorganic Chemistry the two following papers:

(5) Charles H. Herty and E. N. Tillett, "The Unsaturated Character of the Resin of *Pinus Sabiniana*."

(6) Charles H. Herty, W. A. Houck and T. P. Nash, "A Study of the Resin of *Pinus Heterophylla*."

The following papers were read by the Secretary in the absence of the authors:

(7) A. F. Greaves-Walker, "Scum or Efflorescence on Brick."

(8) Kenneth Williams, "The Influence of Varying Quantities of Litharge in an Assay Charge."

(9) Leon Labonde, "The Scientific Use of Crude Petroleum as a Source of Power."

The following papers were read by title only:

(10) J. T. Baker, "Problems in Industrial Chemistry."

(11) Charles P. Fox, "The Cuban Hedge Cactus: a Proposed Source of Crude Rubber."

(12) Charles P. Fox, "*Ficus Elastica* in Florida."

(13) W. D. Richardson, "Rust as an Accelerator in the Corrosion of Iron and Steel."

(14) L. W. Bahney, "Rapid Estimation of Available Calcium Oxide in Lime Used in Cyanide Work."

Previous to adjournment the Division passed a resolution of thanks to the California Section for their hearty entertainment and many courtesies and to the several industrial plants which by opening their works for inspection contributed a great deal to the technical interest of the meeting.

F. E. GALLAGHER, *Secretary.*

ABSTRACTS OF PAPERS READ BEFORE THE SEMI-ANNUAL MEETING OF THE AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, NIAGARA FALLS, CAN., JUNE 22ND TO 24TH, 1910.

PROBLEMS IN CHEMICAL INDUSTRY.

By JOHN T. BAKER, Phillipsburg, N. J.

The number and complexity of the factors involved in chemical operations are so great that many operations are still carried on under the rule of thumb guidance and have not been reduced to a science. On the other hand, the trained scientific man is very prone to believe that the matter with which he deals will follow the laws which he has learned, and for this reason he often overlooks valuable facts which the untrained observer sees. The untrained observer ignores laws and systems, tries any suggestion that comes along, and therefore loses much valuable time and labor. The investigator who is successful follows a mean between these paths. A number of practical illustrations of these principles were given.

COMMERCIAL CALCIUM HYDRATE, ITS MANUFACTURE AND USES.

By LUCIUS E. ALLEN,<sup>1</sup> of New York.

This paper gives an outline of the method of manufacture of this product and calls attention to the many cases in which it can be used to better advantage than the unslaked lime. It is well adapted for water-proofing Portland cement. Its keeping qualities are excellent.

A NEW PRODUCT FOR USE IN THE ARTS.

By DR. F. G. WIECHMANN.

The base of this new material is vegetable-albumin, under which generic term, vegetable ivory, the vegetable caseins, glutens, hemi-celluloses, reserve-celluloses, horny-albumins, etc., are included.

The vegetable-albumin, from whatever source derived, is treated with one or more substances which convert it into a new substance, a plastic, eminently well adapted for use in the arts and industries. To this new plastic the name "Protal" has been given.

<sup>1</sup> Read by N. L. Turner.

Any and all materials commonly used in the rubber industry may be incorporated with protal. About one hundred different protal compounds have been produced and, of course, the properties of these compounds vary with the ingredients employed.

Protal can be molded, pressed, or otherwise formed into any desired shape. It is odorless, resilient, and can be cut, sawed, filed, polished, tapped and countersunk, like hard rubber. It can be colored by dyes, and all pigments can be incorporated with it. It is non-explosive and is very resistant to the influence of heat and electricity.

Among the great number of protal compounds which have been made, there are some which contain rubber, rubber substitutes, shellac, rosins, asbestos, etc. Some of these products remain plastic and moldable for a long time and possess the remarkable quality of hardening on immersion in water.

Compounds of protal with rubber, rubber fluxes and some of the so-called rubber substitutes, exhibit a wide range in their properties. They can be made hard, semi-hard and soft, which of these qualities they are to exhibit being determined by the choice of loading materials and by the conditions of heat and pressure governing their production.

Among the most important compounds of protal, is Protal-Bakelite—bakelite being that most interesting and valuable product, the discovery of which was announced last year by Dr. L. H. Baekeland, of Yonkers, N. Y., and which is, as is well known, a condensation product of phenol and formaldehyde.

Protal-Bakelite possesses many valuable qualities. It exhibits great resistance to nearly all chemical solvents. It is an excellent electric insulator, is capable of taking a high degree of polish, can be produced in almost every color, and is well adapted to the many purposes and uses for which hard rubber and hard rubber compounds are, at present, almost exclusively employed.

It possesses the great advantage over hard rubber of not being subject to oxidation, of not softening on the application of heat and of not being attacked by oils and bodies of a similar nature.

Any and all materials, organic as well as inorganic, may be incorporated with protal-bakelite, thus giving rise to a great number of compounds which possess very different qualities and properties and which are adapted to a great variety of uses.

Protal-Bakelite compounds have, as before said, great dielectric strength, ranging from about ten thousand volts to about twenty-six thousand volts per millimeter.

It would be practically impossible to specify all of the uses to which this new plastic may be put. It need only be borne in mind that this is a plastic which can be fashioned into any shape, which can be molded and pressed, which is capable of taking a high polish, which is not affected by water—cold or boiling—which is resistant to practically all chemical solvents, which can be tooled and machined with ease and which is produced in both flexible and rigid form.

In cost, this material compares very favorably with rubber and every day witnesses its introduction into new fields of industry.

The manufacture of protal and protal-bakelite is in the hands of a New York concern, Protal Company, the works being located at Bridgeport, Conn., and at Yonkers, N. Y.

#### THE STUDY OF MATERIALS AS A SUBJECT IN A COURSE OF CHEMICAL ENGINEERING.

By CHAS. F. MCKENNA.

Dr. McKenna calls attention to the fundamental importance of a thorough knowledge of all the properties, both physical and chemical, of the materials available for human use. The

extraordinary number of substances used in the arts is surprising. A careful list of those used by one company comprised no less than 850 definite and distinct classes or grades of materials.

The chemical engineer must study the properties of these materials because it is he who must transform the raw properties of nature into products possessing properties which make them of use to mankind.

A careful classification of the tests, both physical and chemical, to be applied is given. No material, even the most common, has as yet been fully investigated and all of its properties discovered. The adoption of the so-called standard or uniform methods of analysis are apt to discourage rather than encourage the investigation of the properties of materials.

#### CHANGES IN INDUSTRIAL CHEMISTRY CAUSED BY ELECTRICITY.

By EDWARD R. TAYLOR, Penn Yan, N. Y.

This paper calls attention to the advantages to be derived from the use of electricity with the object of stimulating the development of water powers.

The great advances already made in a number of industries especially metallurgical, and in the production of alkali and bleach, is reviewed. It is shown that these industries could be carried on commercially only after water power is developed. The electric separations and determinations of metals now carried on only in the quantitative laboratory indicate what may be accomplished on an industrial scale in the near future. The manufacture of chlorine and ozone in small units indicate how many small industries can install their own plant for using chlorine and ozone for bleaching, cleaning, disinfecting, etc.

Among the new uses for electricity was mentioned the very marked increase in the quality and quantity of yield of various agricultural products when electricity was allowed to leak into the soil.

Twenty-four electric furnaces for the smelting and refining of iron and steel are at present in operation.

The large amount of water power which is allowed to go to waste at present was deplored.

#### THE DEVELOPMENT OF CHEMISTRY INDUSTRY IN CANADA.

By JUDSON A. DECEW, Montreal, Can.

This paper treats of the various industries of a chemical nature that are established in Canada, and show where statistics or dates are available, the rapid development that has taken place in this field within the last 5 or 10 years.

An attempt is made to give the location of the various works and, where possible, the approximate capacity at the present time.

The industries mentioned, and concerning each of which some facts are given, are as follows:

Sulphuric Acid and Alkali. Coal Tar and Ammonia. Explosives. Fine Chemicals. Wool Distillation Products. Petroleum, Salt, Milk, Sugar, Starch, Rubber, Glue. Paints, Fertilizers, Glass, Beverages, Soap and Glycerine. Calcium Carbide and Electrochemical Products. Wood Cellulose Products. Portland Cements.

Reference is also made to several new projects that are still in the stage of development, but which may soon be classed among the established industries.

#### NOTE ON THE CORROSION OF IRON AND STEEL AND ITS PREVENTION.

By GUSTAVE W. THOMPSON, Brooklyn, N. Y.

This paper gives a most excellent summary of the facts which have been discovered with reference to the cause and prevention of the corrosion of iron and steel. The author leaves it to the reader to interpret these facts in the terms of any theory

with which he may be familiar. The general conditions conducive to the formation of rust are first given. The opinion is given that facts do not warrant the conclusion that the tendency of iron to corrode is dependent on the composition of the metal and that the use of a purer and more expensive metal as against a more impure and cheaper metal is not justified by the facts.

Practical suggestions with reference to the prevention of corrosion of iron and steel are given, among which the following may be mentioned: The action of acids, moisture and oxygen. Cement prevents corrosion because it is alkaline. Protective coatings exclude moisture and oxygen. The cleaning of iron and steel before painting is of great importance. Specific rules for the cleaning of steel and iron are given as well as the value of the various methods in common use.

The principles which should guide in the selection or designing of the paint are given. Poor workmanship in the application of paint was given as responsible for most of the failures in the protection of iron and steel with paint. Linseed oil was condemned as a prime coat for iron and steel.

Nineteen different paints applied to the Havre de Grace Bridge of the Penn. R. R. all proved equally effective because they were properly applied. Oxygen cannot be excluded from iron by means of any protective coating. In the absence of moisture, oxygen does not produce corrosion.

#### THE MANUFACTURE AND INDUSTRIAL APPLICATIONS OF OZONE.

By DR. OSCAR LINDER, Western Electric Co., Chicago, Ill.

The properties and methods of formation of ozone were given. The amount present in pure air was given as about 1 part in 1,000,000. The commercial methods of manufacture of ozone are almost exclusively electrical, although ozone is formed by the ultraviolet light and heat. The successful operation of the electric ozonizers depends upon the rise of a high voltage (10,000-40,000 volts) and dry air maintaining a low temperature. Concentrations of ozone as high as 50 grams of ozone per cubic meter of air corresponding to 2 per cent. by volume have been obtained. Yields of 105 to 250 grams of ozone per kilowatt hour have been obtained.

Ozone has been used industrially for a great many purposes. The purification of the air of theatres, schools, restaurants, and public halls is quite common in Europe. Ozonizers made especially for ventilating purposes are now on the market and are made either of portable or stationary type. Large installations for water purification are in successful operation.

Ozone is well adapted for sterilizing and disinfecting purposes. It is being tested in the Quarantine Station in New York and at the Pittsburg Homeopathic Hospital. It is believed that ozone will ultimately supplant formaldehyde in disinfecting rooms and buildings. It has also been successful for the preservation of milk, cream, butter, eggs, fruits, meat, etc.

Ozone is also an excellent bleaching agent.

#### PLANT DESIGN.

By W. M. GROSVENOR, New York.

In this paper a number of very practical suggestions are made with reference to plant design. Illustrations are given showing the advantage of handling materials by the gravity system. The installation of complicated systems of conveyors is declared to be generally poor policy on account of the usual high cost of maintenance.

The importance of careful management of materials in construction is emphasized. A loss of \$10,000 worth of material was reported in one case on account of poor storage facilities during construction.

#### NITRIC ACID.

By SCHUYLER FRAZIER, Chicago, Ill.

This paper gives a few notes with reference to the manufacture of nitric acid. The various important advances which have been made in recent years are reviewed, and the advantages secured by each improvement is noted. Tables giving the yield and purity of acid obtained, as well as rate of distillation, are appended.

#### UNDERGROUND WATERS FOR MANUFACTURING PURPOSES.

By W. M. BOOTH, Syracuse, N. Y.

The paper gives reasons why underground water is or should be sought, also what preliminary steps should be taken in locating the wells, well surveys and records. The cost of drilling is discussed and the employment of a drilling company is considered. The importance of the chemist as an aid in well drilling and the quality of water to be expected from different strata is discussed. Examples are given showing methods and cost of pumping. The quality of water found in average wells at different depths and cost of treating well waters for manufacturing purposes is fully discussed.

#### COAL: ITS DETERIORATION IN STORAGE.

By A. BEMENT, Chicago, Ill.

Results of experiments given in this paper are the termination of a long period of study with the two coal seams of Illinois, which from the standpoint of production are the most important ones. The experiments show changes in heating power, in quality of the fuel, and disposition to slack down to smaller size during storage.

### RECENT INVENTIONS.

The following patents relating to Industrial and Engineering Chemistry are reported by C. L. Parker, Solicitor of Chemical Patents, McGill Building, 908 G St., N. W., Washington, D. C.

Only a few patents which are deemed of greatest importance are abstracted in this department.

Abstracts of all patents appear regularly in *Chemical Abstracts*, to which publication the reader is referred.

960,441. Production of Fine-metal Tungsten. ELIHU THOMSON, of Swampscott, Massachusetts. June 7, 1910.

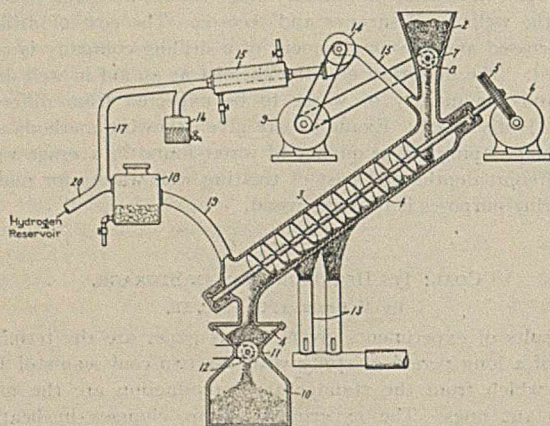
This invention relates to the reduction of metals by a gaseous reducing medium.

It is desirable for some purposes to obtain metals in a finely divided state, with the exclusion of all impurities. A very pure, finely divided metal can be best obtained by carefully purifying some reducible compound of the metal, as the oxid, and then effecting a reduction of the finely divided oxid with a pure reducing gas, as hydrogen. As finely divided metals are easily oxidized when heated, great care must be used to guard against the heated reduced metal coming in contact with air, or the watery vapor which results as a by-product in the reaction.

According to this invention there is employed a furnace which will accomplish a continuous reduction of metallic compounds, as tungsten oxid, at any desired rate, using for this purpose a reducing gas, such as hydrogen. As only a small part of the hydrogen is used up in the reaction when hydrogen gas is passed over a metallic oxid, I provide for the removal of the watery vapor, and return the hydrogen to the furnace to be again used in the reducing process.

The reducible tungsten compound, as tungstic oxid,  $WO_3$ , is conveyed into the tubular-inclined reducing chamber 1 from the hopper 2. The reducing chamber is provided with a rotatable Archimedean screw, 3, which serves to move the oxid along the reducing chamber at any desired rate. The reduced metal

falls into the receiving hopper 4. The Archimedean screw is rotated at any desired rate, and is connected by means of the gear 5 to any suitable source of power, such as the motor 6. The hydrogen enters at the opposite end of the reducing chamber and passes through the same. The streams of oxid and hydrogen, therefore, move in opposite directions. The reducible oxid is conveyed into the reducing chamber 1 from the hopper 2 by means of the rotatable member 7, which is provided with a slotted portion, 8. The rotatable member 7 is connected to any suitable source of power, as the motor 9, and in its revolution the slotted portion 8, in passing through the hopper containing the oxid, "picks up" a portion of oxid and transfers



it to the reducing chamber. By this arrangement the oxid is fed uniformly into the furnace and air is kept out of the reduction chamber. The reduced metal is conveyed out of the hopper 4 into a receiving vessel, 10, in a similar manner by means of the rotating member 11, which is likewise provided with a slotted portion, 12.

The reducing chamber is heated through a portion of its length by any suitable means, such as the gas burners 13. The temperature of this hot zone should be somewhere between 600-800° C. As the dry hydrogen gas meets the tungstic oxid in the hot zone, reduction takes place according to the following reaction:



As before stated, the stream of hydrogen and the tungstic oxid move in opposite directions, therefore the watery vapor resulting from the reaction is carried by the hydrogen away from the reduced metal, and re-oxidation is, therefore, avoided. The linear speed of this moving stream of hydrogen must be great enough to carry away the moisture at a rate which will exceed the rate of diffusion of the watery vapor in the opposite direction. The hydrogen, laden with watery vapor, is drawn from the reducing chamber by means of a pump, 14, through a tube, 15. The pump may be connected to any suitable source of power. As shown on the drawing, it is connected to the motor 9. The hydrogen is conveyed by the pump through a water-cooled condenser, 15, where a greater part of the watery vapor is condensed. The condensed moisture trickles down into a receiving vessel, 16. The unused hydrogen still containing a certain amount of uncondensed moisture is carried by means of the tube 17 to a vessel, 18, where it comes in contact with metallic alkali, such as sodium. The following reaction takes place:



As will be seen, the hydrogen is regenerated with the formation of sodium hydroxid. The unused hydrogen, together with this regenerated hydrogen, is carried back to the reducing chamber through a tube, 19, and is used again for the purpose of re-

duction. The vessel 18, instead of containing a metallic alkali for the purpose of regenerating hydrogen from the moisture, may contain a moisture-absorbing agent, such as sulphuric acid or calcium chlorid, and the moisture may thus be absorbed, the unused hydrogen, as before, being returned to the reducing chamber. In either case any losses of hydrogen are made good by the introduction of hydrogen from a hydrogen reservoir through a tube, 20.

960,542. Means for Recovering By-Products. PULASKI M. HAMLIN, of Pittston, Pennsylvania. June 7, 1910.

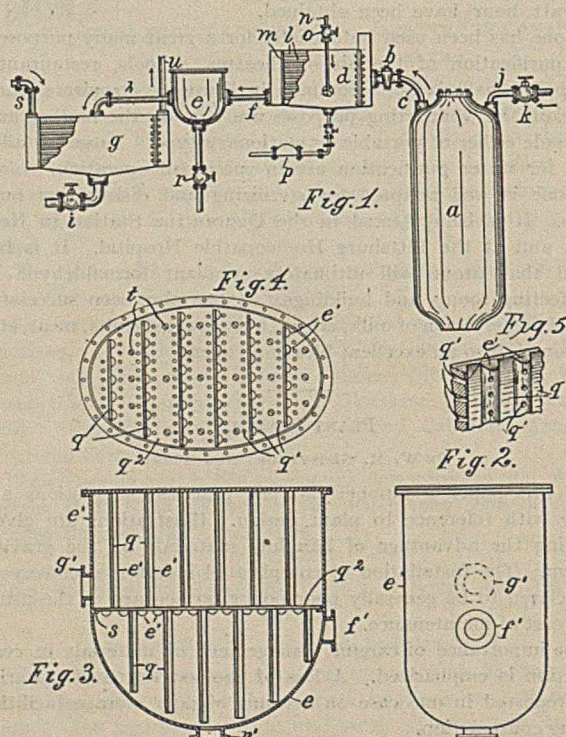
This invention relates to a means of recovering volatile by-products from the treatment of wood-fiber or other crude materials in a cooker, digester, or roaster in which the crude material is heated to change its constitution, and the by-products are incidentally vaporized.

When it is desired to maintain any pressure above the atmosphere during the treatment of the crude material, such pressure can be obtained and the by-products secured by discharging the vaporized by-products from the receptacle only as fast as they are generated, which is effected by any valve suitable for regulating and limiting the discharge flow.

The invention is partly adapted for the recovery of turpentine oils, resin, and wood alcohol from wood during the manufacture of pulp without interfering with the pulp-making, or increasing its cost. In such manufacture of wood-pulp, a charge of wood-chips is placed in a tightly closed digester and is heated by injecting steam into the digester at a temperature above the boiling point of the by-products, which are thus necessarily vaporized.

In digesting coniferous woods to produce pulp, ingredients of greatly different character and density, as wood alcohol and resin, are discharged as by-products, and the object of the present invention is to first separate the heavier ingredients from the vapor in order that they may not clog the water-cooled condenser which is required to liquefy the more volatile elements.

Resin and heavy oils if condensed upon a chilled surface adhere strongly thereto and are liable to accumulate and clog



up the vessel in which they are condensed so that its use cannot be continued without frequently opening it to remove these gummy substances. The patentee has discovered that an air-cooled trap suffices to separate such heavier elements from the vapor, while it does not chill them sufficiently to prevent their spontaneous flow from the trap. He forms the trap with perforated baffle-plates which afford an extended surface for the deposit of these gummy elements and the conveying of their heat to the atmosphere, the plates producing a deposit of these elements without preventing their flow and discharge from the trap at the temperature of the air which is always much below that of steam under pressure. That portion of the vapor which is uncondensed in the air-cooled trap is then treated in a surface condenser where tubes can safely be used as a cooling agent, because the elements condensed from the remaining vapor are of a fluid character and not liable to clog the passages between the pipes by adhesion thereto. The apparatus does not separate all the by-products from one another, but divides them into two very different classes which are adapted for very different subsequent treatment to dissociate them, as may be desired.

The discharge of vaporized by-products from the digesters during the cooking operation permits steam, watery vapor and crude materials to pass off with the vapor, and it is therefore found desirable to reheat this vapor at a temperature higher than that in the digesters so as to fully volatilize all the watery vapor and any of the crude materials that have not been vaporized.

The illustration shows the patentee's apparatus.

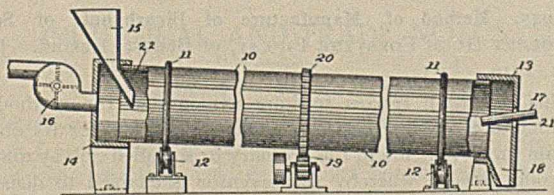
**961,121. Process for Cleaning Iron Ores.** EDWARD F. GOLTRA, of St. Louis, Missouri. June 14, 1910.

This invention relates to a process for cleaning iron ores and for preparing the same for the subsequent operations.

Some iron ores, as brown hematite, contain a large percentage of clay and sometimes silica as a gangue, and this gangue must be separated from the ore before it can be used in a blast furnace.

The apparatus illustrated consists of a runway upon which the ore is thrown. The ore on the runway is subjected to a strong blast so as to dry the gangue and render the earthy, the silicious and any other gangue easily separable from the ore. The ore is tumbled to shake loose the gangue from the ore, and the gangue is removed by the blast.

The runway is preferably in the form of a long inclined tube or drum, which is rotated about its longitudinal axis, and a hopper is located at one end of the drum for discharging the ore in the same. The ore in its passage downwardly is heated to dry out the ore and render the gangue brittle and easily separable from the ore, and the rotation of the drum will tumble and rattle



the ore as it dries and cause the gangue to be shaken loose from the ore and pulverized by the tumbling action. The strong blasts sweeps, cleans and washes the gangue from the ore and this gangue is withdrawn from the drum by the blast while the cleaned ore passes along the drum to the discharge end.

The ore as mined must be dried slowly especially if it contains much clay as a gangue since a rapid heating would cause this clay to be baked hard and burned to a brick and thus it would be impossible or exceedingly difficult to thereafter loosen it from the ore. For this purpose the hot blast enters the drum at the lower end, that is at the discharge end, and when it strikes

the fresh ore admitted from the hopper this hot blast is cooled down enough so that its temperature is sufficiently low to prevent the hard baking and burning of the gangue.

The ore as mined is crushed so as to reduce it to workable form. It is not necessary to pulverize it, but it is sufficient if it can pass through a two or two and one-half inch mesh. This crushed ore is placed in the hopper 15 and is discharged into the drum 10. The burner 17 furnishes the necessary heat and the temperature will be the greatest at the lower end of the drum, but at the upper end this temperature will be considerably reduced, so that the fresh wet ore will not be heated to a sufficient degree so as to hard bake the gangue. As the ore moves downwardly it will be tumbled and thrown around so as to knock loose all of the gangue which clings to it, this gangue becoming more and more heated and more and more loose, dried and pulverized as it proceeds toward the lower end of the drum. The ore is cleaned and washed of its gangue by the blast passing through the drum, the gangue being drawn off by the strong blast which is created by the suction fan 16. The drum is made long enough and the speed of rotation is governed so that at the time when the ore reaches the discharge 18 practically all of the gangue has been dried out and rendered separable, shaken off of the ore and drawn off by the blast. Since the temperature will gradually increase from the upper to the lower end of the drum, the ore is gradually dried and thus the gangue is rendered very brittle, and due to this gradual increase, the gangue on the ore as it is admitted will not be subjected to the high temperature as would be the case if the burner 17 were placed at the upper end of the drum.

It will be noted that the blast is passed through and above the ore while it is agitated. The rotation of the drum will cause the ore to rise with the sides of the drum and fall through the blast passing through the drum. In this way the strong blast sweeps the pulverized gangue clinging to and surrounding the ore with it, allowing the cleaned ore to pass down the drum to the discharge 18.

**961,350. Process of Making Nitric Acid.** FRIEDRICH HAUSER, of Kaiserslautern, Germany. June 14, 1910.

It is known that at high temperatures nitrogen and oxygen combined directly with each other so as to form oxid of nitrogen which at ordinary temperature further combines with oxygen so as to form dioxid of nitrogen, which will produce nitric acid when dissolved in hot water. This method of producing nitric acid has been carried out on a commercial scale in North America, especially at the Niagara Falls where the oxidation of the nitrogen has been effected by means of the electric arc. It is, however, expensive to produce in this manner the high temperatures required for manufacturing nitric acid and it has been found that in order to obviate said inconveniences the oxidation of nitrogen can be effected in a more economical way by means of explosive combustion, that is to say, by heating or burning a mixture of nitrogen gas and oxygen gas for instance in an explosive engine, together with a suitable fuel, as coal-gas, benzene-vapor or the like, and preferably after the said gas mixture has been compressed, prior to ignition, adiabatically, as far as possible as the gain in oxid of nitrogen very quickly increases in proportion to the rise of temperature. The formation of oxid of nitrogen being a reversible reaction it is necessary, in order to avoid any decomposition of the oxids of nitrogen formed, to suddenly chill the gas mixture at the moment of maximum temperature. Evidently the gas mixture must be cooled down to a degree where the reaction speed is so low that a decomposition of the oxid of nitrogen practically cannot take place, that is to say, to 1600° C. or lower. But as the gas mixture still exerts a high pressure at this temperature, it is profitable to allow the gas mixture to expand, after having been cooled, in a well-known manner.

The gain in oxid of nitrogen depends on both the explosion temperature and the proportion of nitrogen and free oxygen in the gases resulting from the explosion, that is, exhaust gases. The gain, therefore, can be increased by adding oxygen to the air used for the explosive mixture.

The most favorable proportion of oxygen and free nitrogen producing the greatest amount of nitric acid exists, if the mixture after the explosion contains the same amount of oxygen and nitrogen. This result may be obtained by adding artificial oxygen to the atmospheric air. The simplest way is, however, to use ordinary atmospheric air, in which case 100 parts of the

FIG. 1.

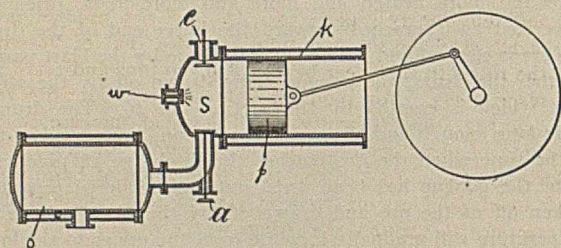
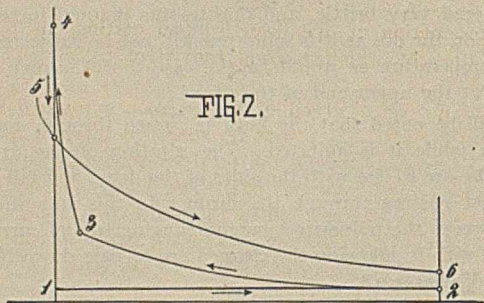


FIG. 2.



initial fresh gas mixture contain about 68 parts nitrogen, 18 parts oxygen, and 14 parts hydrocarbon vapors in the form of lighting gas. The composition of the mixture varies with the quality of the lighting gas. If the quality is good, less gas is added, and *vice versa*. The mixture having the proportions above stated is a gas having a heating value of 5,000 calories.

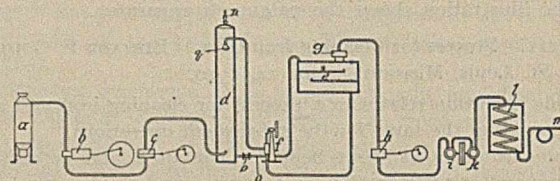
The temperature which is indicated by the point 4 in Fig. 2 should be as high as possible, because the production of nitric acid increases very much with the increasing temperature. The temperature should be preferably no less than 1900 to 2,000° C. Such temperatures can be easily obtained by a sufficiently high compression of the combustible mixture prior to its ignition and by the use of gases of great heating quality, as for instance lighting gas mixed with air.

**960,788. Process for Manufacturing Carbonic Acid.** ERNST AUGUST BEHRENS, of Bremen, Germany. June 7, 1910.

This process is carried out in the apparatus shown in the accompanying illustration. The gas is led from the generator *a* to the power cylinder *b* of an explosive gas engine, where it is exploded in the presence of sufficient air to convert the CO in the gas to CO<sub>2</sub>. It has been found in practice that such employment of an explosive engine furnishes almost the entire power necessary in the subsequent portions of the operation, and that the cylinder-cooling water of the explosive engine can be employed for maintaining the saline solution at the required temperature. The exhaust gases from the explosive cylinder *b* are forced by a compressor, *c*, under suitable pressure into the lower portion of a reservoir, *d*. The compressor *c* may be belted to the explosive engine, or driven in any other desired manner. The reservoir *d* is partially filled with a solution of potassium

carbonate, which is maintained at about 100° C., and the exhaust gases are forced therein by the compressor *c* at a pressure sufficient above that of the atmosphere to cause a chemical union of the CO<sub>2</sub> with the potassium-carbonate at such temperature, the upper portion of the reservoir *d* being provided with a relief valve, *n*, to permit escape of the nitrogen of the exhaust gases which accumulates in the upper portion of said reservoir. A pipe, *o*, leading from the lower portion of the reservoir *d*, conducts the solution to a tank, *e*, where it flows over baffle-plates, and, owing to the reduction of pressure, gives up the CO<sub>2</sub> in a gaseous form, a valve, *p*, being provided in the pipe *o* for regulating the rate of flow therethrough. A pump, *f*, is employed for withdrawing the solution from the tank *e* and returning it under pressure through a spray nozzle, *g*, to the upper portion of the reservoir *d*, thus establishing a continuous circulation of the solution between the reservoir *d* and the tank *e*. An aspirator and compressor, *h*, is employed for drawing the CO<sub>2</sub> from the tank *e* and forcing it under suitable pressure through the nipple *m* to retorts or other receptacles, a series of purifiers and coolers, *i*, *k* and *l*, being interposed between the compressor *h* and said nipple.

This method of absorption and setting free of the carbonic acid by pressure and relief of pressure without changing the temperature allows of a considerable saving being realized in the manufacture; it must still be added that according to the physical conditions whereupon the present process is based,



the absorption speed is considerably higher than in the known process, and owing to this fact it is possible to work with considerably less lye. It follows therefrom that the dimensions of the installation are considerably reduced in comparison with the known installations.

It has been proposed to produce carbonic acid through the influence of a partial vacuum with or without a saline solution. Experiments show that at low temperatures the separation of carbonic acid from a solution of bicarbonate of potassium, even under a high vacuum, is too slow to be of any industrial value. If the separation of the carbonic acid is produced by heating the saline solution, the latter must be cooled down before it can be again used for absorbing the carbonic acid.

**961,945. Method of Manufacture of Bicarbonate of Soda.** ROBERT HUGH FORSYTHE FINLAY, of Belfast, Ireland. June 21, 1910.

This invention relates to improvements in the method of manufacture of bicarbonate of soda, and it has for its object certain improvements in the ordinary or so-called Solvay ammonia-soda process, whereby the inventor is enabled to dispense with the necessity for distilling the liquid from which the bicarbonate of soda has been precipitated (hereinafter called the mother liquor); avoid the use of lime, and the loss of ammonia and undecomposed salt contained in the discharge from the stills after distillation—the disposal of which discharge constitutes rather a troublesome feature of the ammonia-soda process as now carried out.

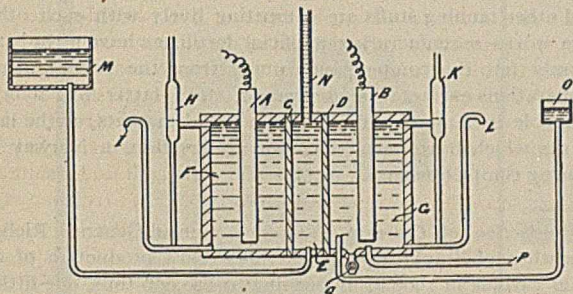
The present invention, moreover, presents the advantage that the user is enabled to recover the chlorine of the salt acted upon, in the form of chlorine gas, instead of as heretofore permitting it to pass away with the discharge above mentioned in the comparatively worthless form of calcium chloride.

In carrying the invention into effect the earlier steps of the



well-known ammonia soda process is followed up to the point at which the mother liquor has to be dealt with; that is to say, the user treats the brine with ammonia and carbonic anhydrid so as to obtain a precipitate of bicarbonate of soda, ammonium chlorid being left in solution as well as some undecomposed sodium chlorid and some ammonia and carbonic anhydrid, chiefly in the form of bicarbonate of ammonia.

The precipitated bicarbonate of soda being removed and treated in the usual manner the mother liquor is passed directly, or after treatment with carbonic anhydrid, into the cathode chamber of an electrolytic cell, or battery of cells, brine being



supplied at the same time into the other chamber or chambers. The ammonium chlorid in the mother liquor is here electrolyzed, and ammonia is set free at the cathode and combines with carbonic anhydrid, if present, chlorin being also set free at the anode.

After electrolysis the liquids and gases are removed from the cathode chambers. The hydrogen formed at the same time as the ammonia is readily eliminated, being insoluble. Water also may be eliminated from the liquid by evaporation at this stage. The liquid which now contains some common salt and the ammonium chlorid which has not been decomposed by electrolysis may be used instead of brine in the first reaction of the process in which meeting with the ammonia liberated by electrolysis and carbonic anhydrid, bicarbonate of soda is again precipitated and the mother liquor again treated as described.

If salt be added to the mother liquor before, and carbonic anhydrid be injected during electrolysis, bicarbonate of soda may be formed in the cathode chamber of the cell. In this case the chamber should be made larger than would otherwise be necessary and be furnished with suitable means for removing the precipitate.

The accompanying illustration shows the apparatus in which the process is carried out.

## INDUSTRIAL AND TRADE NOTES.

(Concluded from July No., p. 336.)

**Potassium Cyanid Manufacture (Continued).**—The ceilings are 23 feet high to the cornice. In building construction the use of wood has been avoided wherever possible, and owing to the poisonous nature of the product every precaution has been taken to prevent the escape of gas into the buildings.

From the centrifugal machinery up to where the cakes of potassium cyanid are pressed and packed workmen are obliged to wear respirators and specially made gloves. On arrival at the factory workmen must change their clothing, lockers being arranged, and before leaving the works they must bathe, shower and plunge baths being provided. There is also a dining-room in an adjoining building. It is necessary to run night and day; 130 men work on each shift; no boys or women are employed. Many workmen walk three to four miles from surrounding villages. They work 11 hours, quitting at 6 A.M. or 6 P.M., according to shifts, and have one hour for meals. The common

laborers receive 41 cents and the skilled workmen 91 cents to \$1.02 per day. The trust controlling the manufacture of potassium cyanid from molasses pays \$1.52 to \$1.62 for each 220 pounds of raw material. Before the discovery of this new process the molasses was considered worthless, while there are now several more by-products of commercial value after producing the potassium cyanid.

**Production of Steel.**—The American Iron and Steel Association has just compiled its statistics for the production of open-hearth steel ingots and open-hearth castings in 1909. They show that the total was 14,493,936 gross tons, against 7,836,729 tons in 1908, an increase of 6,657,207 tons, or 85 per cent. The production in 1909 was much the largest in the history of the industry and exceeded that of 1907, the next largest year, by 2,944,200 tons, or 25.4 per cent. In 1908 the production of open-hearth steel for the first time exceeded that of Bessemer steel, the totals in that year being 7,836,729 tons and 6,116,755 tons, respectively. For 1909 the figures were 14,493,936 tons and 9,330,783 tons, respectively. The rapid increase in the production of basic open-hearth steel accounts for the record-breaking figures in 1909. The total production of basic open-hearth ingots and castings was 13,417,472 tons, while that of acid open-hearth ingots and castings was 1,076,464 tons. This last figure has been exceeded in five preceding years—namely, 1907, 1906, 1905, 1903 and 1902.

The production of open-hearth steel castings in 1909 was 601,040 tons, of which 306,005 tons were basic and 295,035 tons acid steel.

The production of crucible steel in 1909 amounted to 107,355 tons, against 63,631 tons in 1908, an increase of 43,724 tons, or 68.7 per cent. Of the total for 1909, 94,672 tons were ingots and 12,683 tons castings. The high point in crucible steel production was reached in 1907 at 131,234 tons; in 1906 the total was 127,513 tons. Last year's total was over 5,000 tons less than that of a year as far back as 1902.

The production of steel in 1909 by various minor processes, including the electric process, amounted to 22,947 tons, against 6,132 tons in 1908. Of the total last year, 14,242 tons were ingots and 87,005 tons castings.

The production of all kinds of steel ingots and castings in 1909 amounted to 23,955,021 tons, against 14,023,247 tons in 1908, an increase of 9,931,774 tons, 70.8 per cent. The production of the various kinds of steel in the past three years is as follows in gross tons:

	Bessemer.	Open-hearth.	Crucible and all other.	Total ingots and castings.
1909.....	9,330,783	14,493,936	130,302	23,955,021
1908.....	6,116,755	7,836,729	69,763	14,023,247
1907.....	11,667,549	11,549,736	145,309	23,362,594

Included in the 23,955,021 tons of steel ingots and castings made in 1909 were about 182,000 tons of alloyed steel, of which 159,000 tons were ingots and 23,000 tons castings. Of the total of 182,000 tons approximately 42,000 tons were made in Bessemer converters, 120,000 tons in open-hearth furnaces and 20,000 tons in crucible, electric or special furnaces.—From "Iron Age," May 26, 1910.

**Air Nitrate Fertilizers.**—Consul-General Frank H. Mason, of Paris, writing of the production of nitrogen from the atmosphere and its use for economic purposes, especially as a fertilizer in agriculture, says that as thus far developed in Europe it is a direct sequel to the manufacture of calcium carbid by the application of electric heat to lime and carbon. He continues:

"When this process was discovered some years ago it was assumed that acetylene gas, generated from calcium carbid, would largely supplant coal gas and revolutionize the existing system of artificial lighting. The first essential requisite for carbid production was abundant and cheap electric current, and extensive

plants were erected along water courses of Europe and preparations made to supply a large and steadily increasing demand.

"But it was soon found that acetylene gas was a difficult and, under certain conditions, a dangerous element to manage; its use became restricted to certain locations and conditions, and experience proved that the combined carbide factories had a capacity of about 100,000 tons in excess of the normal demand for that material.

"About this time Frank and Caro, two German chemists, invented a process through which, by combining nitrogen gas with calcium carbide at a temperature of  $1,000^{\circ}\text{C}$ ., they could produce a combination of lime, carbon, and nitrogen—in other words, a synthetic nitrate of lime—to which they gave the name of cyanamid of calcium, now commonly known as cyanamid, which contains from 15 to 20 per cent. of nitrogen, 60 per cent. of lime, and has qualities as a fertilizer similar to sodium nitrate, or Chilean saltpeter. This process was patented in all countries and became the property of a corporate company, with headquarters at Rome, and known as 'La Société Italiana per la Fabrication de Prodotti Azotati.'

"The calcium carbide therefore was ready, the process for converting it into cyanamid by combination with nitrogen was perfected, and it only remained to provide an adequate supply of atmospheric nitrogen at a moderate cost. This requirement was met by a process invented by Dr. Carl von Linde, of Munich, which was patented in both France and the United States. By this process atmospheric air, having been first liquefied by compression, is subjected, by subsequent expansion under pressure, to a process of fractional distillation, by which the nitrogen is separated, leaving as a by-product oxygen of 50 to 60 per cent. purity, which can be used by burning in the electric arc (sparking) for the manufacture of nitrates and nitric acid. [A copy of the French patent for the Linde process is on file in the Bureau of Manufactures.]

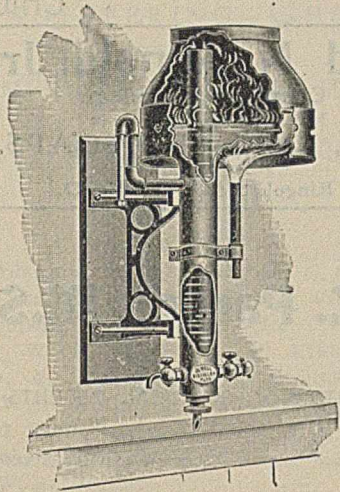
"The cycle was now complete, and it is through the combination of these two processes—the Linde method for recovering atmospheric nitrogen and the Frank-Caro method of combining nitrogen with calcium carbide for the production of cyanamid of calcium—that European progress hopes to provide for the future an adequate supply of nitrate fertilizer for agricultural purposes."

*Activity of German Chemical Factories.*—Deputy Consul-General Simon W. Hanauer, of Frankfort, notes that Germany's chemical industries have in the first four months of this year increased their exports by about 25 per cent., compared with the corresponding period of last year, the values being \$55,700,000 against \$43,800,000. In spite of the higher tariff rates under the new law, the exports to the United States have not diminished. So far, the profits exceed those of last year, while stocks of goods are lower. The new chemical factory at Heyden is competing strongly with the Badische Aniline and Soda Works in the sale of synthetic indigo; the factories producing tannin and other tanning stuffs are competing lively with each other. The works manufacturing artificial fertilizers have already adversely felt the competition coming from the sale of nitrate preparations extracted from the air. The latter will soon be available in large quantities for the world markets, as the large plants which have been in course of erection in Norway are nearing completion.

*Production of Calcium Carbide.*—Consul-General Richard Guenther, of Frankfort, reports the world's production of calcium carbide in 1908 as amounting to 200,000 tons, one-fifth of which was produced in the United States and Canada. The production in the other countries was as follows, in tons: Italy, 32,002; France, 27,000; Norway, 25,000; Switzerland and Austria-Hungary, 20,000 each; Sweden, 12,000; Germany, 9,000; England, 800. There were 70 factories employed in the manufacture of the article. The production has increased very much in recent years.

Consul-General Richard Guenther writes from Frankfort that the Deutsche Gold and Silber Scheide Anstalt, capital, 10,000,000 marks (mark = 23.8 cents), reports 5,803,500 marks net profits for its fiscal year 1909-'10, of which 36 per cent. was paid in dividends. The company's Frankfort factories produce ceramic colors, synthetic indigo, and other chemicals, and its new cyanide and electrochemical works have yielded good results. Its enterprises in the United States, the Roessler & Hasslacher Chemical Company and Niagara Electro-Chemical Company, increased their profits, while its chemical works at Perth Amboy, N. J., earned less, owing to competition.

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