

BOURDON'S CONTINUOUS CIRCULATOR.

In most cabinets of physics there are to be seen certain glass apparatus that are called "circulating fountains." These apparatus, while they demonstrate the ingenious application of a little known law of hydrodynamics, are also at the same time objects that please one's eyesight, in that they produce a genuine illusion when we watch the contours of the glass tube in which are circulating drops of colored alcohol, separated by bubbles of air; for, although the tortuous glass tube is entirely immovable, it seems, on the contrary, to be possessed of a rotary motion.

In this sort of fountain, a specimen of which is shown in Fig. 1, the circulatory motion of the drops of colored alcohol is obtained by utilizing the motive power of a column of liquid back of the apparatus for raising and keeping in motion another column; this latter being notably lighter because it consists of drops of alcohol separated by bubbles of air, while the former consists of liquid only. The means employed for obtaining such a regular alternation of a drop of alcohol, followed by a bubble of air, is very simple. The straight, vertical tube, which we shall style the motive column, is bent at its base into the shape of a U, enters the lower reservoir, with which it is united, and terminates in an ajutage of small diameter which allows a jet of liquid to spurt out very near the origin of the tortuous tube. About half of the colored liquid furnished by the ajutage rises drop by drop into this tube, while the other half runs slowly down along the sides of the lower reservoir and forces a volume of air equal to its own to interpose itself between the drops of alcohol in measure as these rise in the tortuous tube.

But, gradually, the upper reservoir becomes empty, while the lower gets full; and, after an operation of fifteen or twenty minutes, all motion ceases; so, in order to start the

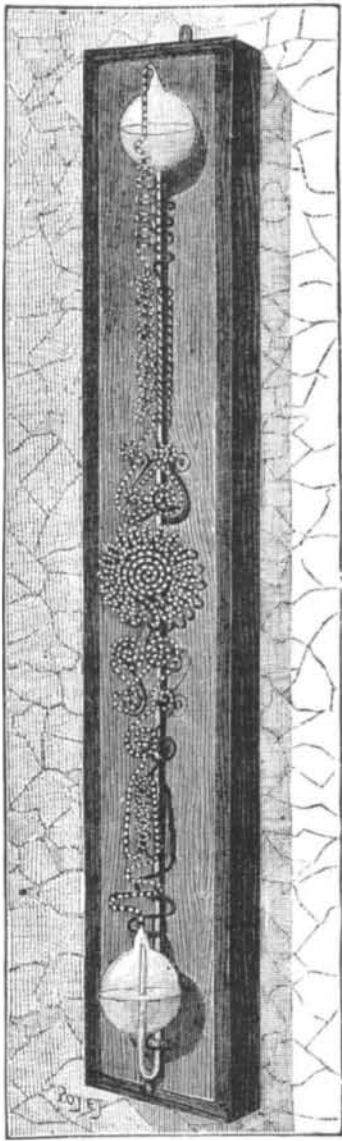


FIG. 1.—CIRCULATING FOUNTAIN.

apparatus again, it becomes necessary to invert it and keep it in that position for a certain length of time, in order that the liquid, passing again in the form of a continuous vein through the inverted tube, may fill the reservoir which supplies the motive column.

If, after this, the fountain be placed back in its first position again, it will begin to operate, but only for a length of time that scarcely exceeds twenty minutes.

The continuous circulator shown in Fig. 2 does not require any such maneuver as that just described, but operates uninterruptedly.

This apparatus, which is the invention of Mr. E. Bourdon, is arranged as follows:

A reservoir, capable of holding three or four liters of water, is kept at a constant level by means of a float cock attached to a water pipe. Beneath this reservoir there is adjusted a small suction tromp provided at the side with an exhaust pipe terminating in the bulb situated above the circulator.

A straight glass tube, 1.5 meters in length by 4 millimeters in diameter, is connected with the tromp by a small rubber sleeve, and dips at its lower extremity into a discharge vessel which is provided with a waste pipe that carries off the water discharged by the vertical tube.

This arrangement constitutes the motive apparatus, properly so called.

The circulator consists of five parts, all of glass, as follows: The inverted bulb, with neck, placed at the top of the apparatus; the tortuous tube, forming designs that may be varied in hundreds of ways; the return tube, placed to the left of the latter; the receptacle containing the colored liquid, and the distributing tromp with its regulating cock and its U shaped tube, connected by a sleeve with the tortuous tube (Fig. 3).

These five pieces are affixed to a wooden support, according to the arrangement shown in Fig. 2; but, although the tromp is here represented as being close to the circulator, it may, in fact, be placed at some meters distance, in a neigh-

boring apartment, so that the apparatus by means of which motion is kept up may be hidden from sight. The air exhaust tube which connects the tromp with the bulb has, in such a case, a greater length; but this in no wise interferes with the operation of the apparatus.

The circulator is set in operation as follows:

The small receptacle placed under the return tube is half filled with water which has been slightly colored with archil or aniline blue, care being taken to keep the regulating cock closed that connects this receptacle with the tromp. This done, water is allowed to enter the reservoir by opening the float cock, and its entrance into the suction tromp is moderated in such a way that the air carried along by it forms with it a sort of miniature cataract composed of regularly spaced drops of water and bubbles of air. The partial vacuum that this feeble fall of water keeps up in the bulb surmounting the apparatus has the effect of setting in motion the colored liquid supplied by the small receptacle at the base of the return tube, and of causing it to circulate from top to bottom. In order that the ascending motion of the colored liquid shall be continuously kept up in the designs formed by the tube of the circulator, it is necessary that the return column shall be heavier than that of the circulator, and that this necessary condition of the apparatus' operation shall be kept up in a constant and regular manner.

At first sight, this would seem a difficult thing to effect; for the column formed by the return tube is shorter than that formed by the circulator, whose length makes the travel greater, and, as a consequence, gives rise to an increase of resistant work. The means employed to obtain this difference in gravity consists in causing the circulation of a certain quantity of air between the drops of liquid contained in the circulator tube, and in admitting none into the return tube.

The first condition is effected by means of a small regu-

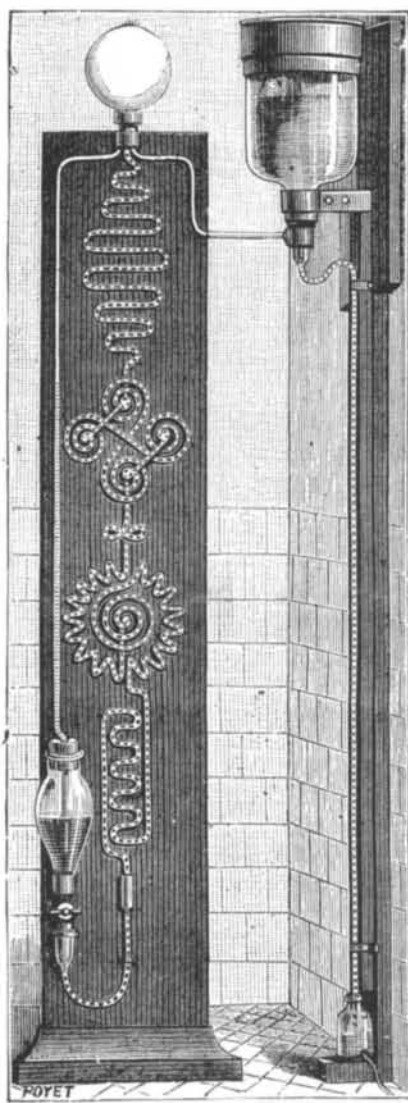


FIG. 2.—BOURDON'S CONTINUOUS CIRCULATOR.

lating cock, which is kept open in such a way that the liquid shall enter drop by drop only, and that there shall be left between the drops regularly spaced intervals of air. A hole formed in the stopper at the side of the small cock allows entrance into the tromp of the air that separates the drops of water on their entrance into the tortuous tube.

The second condition is effected by giving the return tube an internal diameter sufficiently large (about 8 millimeters) to allow the liquid descending from the bulb to run along the sides of the tube without ever imprisoning the air with it.

It is necessary, then, to bestow a little attention on the regulation of the small cock that supplies the colored liquid to the tromp of the circulator or distributing tromp; for, if it discharges too much, the column will not carry along sufficient air, and the motion will be checked; while if, on the contrary, it does not discharge enough, the opposite will be the case, the speed will be increased, and the drops of liquid will be spaced too far apart. But, when the apparatus is well regulated, the colored liquid, under the influence of atmospheric pressure, rises and forms a string of brilliant pearls extending up to the bulb that surmounts the apparatus, and then runs down through the return tube into the receptacle, giving up, as it does so, all the air that had been carried along; and the motion continues as long as the reservoir of the suction-tromp is supplied with water.

In sum, it will be seen that four principal points characterize this continuous circulator, and make a new apparatus of it notably different from the old circulating fountain.

These points are:

- (1.) The mode of effecting the regular spacing of the drops of water in the tortuous tube.
- (2.) The mode of applying the partial vacuum that serves to keep in motion the liquid mixed with air which lends brilliancy to the designs of the circulator.
- (3.) The application of the principle of hydrodynamics by the aid of which there may be made to circulate for entire days the same quantity of liquid in a direction opposite

that which the laws of gravity would compel it to take, and that too without the possibility of the liquid that forms the motive power mingling with that whose role is to keep up the motion.

(4.) The prosperity that it possesses of being easily transformable into an apparatus of evident utility, and as a sure means of ascertaining the degree of purity of the air or gases, that it may be desired to submit to analysis.

This apparatus not only solves a problem in hydrodynamics which is interesting to study, and is not only an interesting object to please the eye, but it has a useful application in all that touches those microscopic observations that are so much employed at present for ascertaining the quantity and nature of the microbes that exist in the air that we inhale, and that have a greater influence than is generally supposed upon the hygienic conditions necessary to preserve the health of animate beings.

When the circulator is employed for this kind of observations, instead of a tube shaped in fancy designs like that shown in the figure, we simply adopt one or several straight tubes, adjusted on the one hand to the distributing tromp, and, on the other, to the bulb surmounting the apparatus.

We have seen that the small quantity of liquid which circulates uninterruptedly from the distributing tromp to the upper bulb never mixes with the water that supplies the suction tromp. It will be easily understood, then, how, under the influence of the partial vacuum caused by the suction tromp in the upper bulb, the water, on rising in the circulator tube, carries along with it as many bubbles of air as drops of water, and holds back in its passage all the microbes contained in the air whose purity is to be examined. It suffices, then, in order to know the number and the species of microbes contained in a given volume of air, to measure, by means of a gas-meter, the number of cubic meters that have been passed into the circulator, in contact with a small quantity of distilled water contained in the receptacle placed at the base of the apparatus.

To count the number of infinitely small animalcules contained in a small quantity of water is not an easy thing to do; yet, in the hands of observers used to this delicate sort of work, a highly magnifying microscope permits not only of counting these small living beings, but also of classifying them by species, which are often very different from one another.

Amateur physicists who are content to look at the apparatus from the standpoint of amusing experiment might arrange it in a still more original way than that shown in our cut. Instead of placing the circulator against a board, it might be fixed to a polished or silver-plated copper tube in which the suction-tube, as well as the water-return tube,

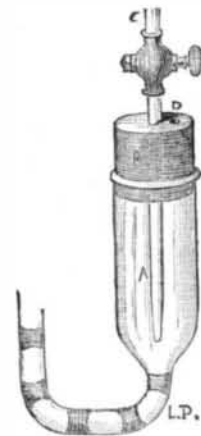


FIG. 3.—DISTRIBUTING TROMP.

etc., would be hidden. The apparatus, thus simplified and rendered more mysterious, might be placed in the angle formed by two mirrors, so as to show the object and its images, and thus constitute a sort of kaleidoscope.

Circulating fountains were formerly much in demand among physicists. Their effects may be varied in several ways. At the College of France there is one that contains a fluorescent liquid, which has a charming effect in darkness, after an insolation.

Finally, we think proper to mention, in conclusion, the largest circulating fountain that was ever constructed. This figured at the London Exhibition of 1862. It formed a true architectural structure, each of whose four sides was at least 2 meters in length and height, with colonnades, windows, porches, domes, etc., the whole made of glass tubes in which water circulated. The effect was of the most singular nature.—*La Nature*.

ANGULAR MOTION IN WIND STORMS.

By JAMES HOGG.

BEING at sea recently in one of the violent storms of wind and snow which of late have visited our coast, we became greatly interested in observing the varied action of the wind upon the water, and the difference of effect which it produced in the size and motion of the waves as we proceeded on our course. The wind being very strong and nearly dead ahead, we progressed but slowly, and this gave us the more opportunity to observe its effects. It blew steadily and continuously, or very nearly so, from the same point of the compass; and apparently with the same velocity and force. The engines of the ship were slowed down, and worked with the regularity of a watch, so that there was no apparent increase of velocity or force of the wind due to increased speed of the ship. We propose to note some of the observations we made and the deductions we made therefrom, although in so doing we intend that they shall be merely suggestive, and given to draw the attention of others who have made meteorology a special study.

We noticed that at the height of the topmasts the snow did not come down perpendicularly through the air, but descended at an angle of about thirty degrees, and that when it came near the surface of the sea, it was thrown upward at a nearly corresponding angle, producing a kind of undulatory motion following the lines of the waves. That in the hollows of the waves very little snow fell into the water, and that what did fall was caught by the crests of the waves as it was driven forward horizontally by the wind. We also noticed that the angle of the waves on their windward side was

not far from a right angle to that at which the snow appeared to be descending from above, and that the waves assumed on their windward side the form of a cyma recta, and on the leeward side a form approaching the cavetto, if we may be allowed to use architectural terms to express these forms. Now these are very nearly the forms which a force pressing at an angle of forty-five degrees upon the horizontal surface of a mobile substance or fluid would cause such surface to assume.

The generally received idea of wind storms is, that they are masses or bodies of air moving, either horizontally forward, or revolving upon the axis of the body of air, and that this revolving body may also move forward in a direct line. That if these masses of air were visible to us, in either case we should see them lying in horizontal strata of different densities. Wind gauges for testing the pressure of the wind are therefore placed vertically, those for testing its velocity are placed horizontally.

From what we have stated of the snow falling at an angle it occurred to us that the air in descending from the higher regions of the atmosphere, whether it moves horizontally or in rotating columns, comes down at varying angles, and in the latter case visible to us, the various strata of which it is composed would somewhat resemble the lines made by wind-ing a ribbon diagonally round a cylinder. If then it strikes the water, it must do so with much greater force and power of throwing it into waves than if it passed over it horizontally, or came down upon it vertically, and this power would be in proportion to the angle of descent and the velocity with which it rotated. A revolving or gyrating storm will also travel in a circle, or some form approaching thereto; this also will add to its power of disturbing the surface of the water, and will produce a more broken sea.

The wind often blows horizontally without rotating in columns, as can frequently be seen during an ocean voyage, especially in the summer season, when a brisk wind will often occur which will scarcely produce any sea at all. This occurs in the monsoons and trade winds, which, blowing for weeks and months together from the same point of the compass, and at a regular rate of velocity, have but little effect upon the surface of the sea.

The soil also blows down vertically with or without a gyratory motion, and instances are not wanting of perpendicular columns of air descending and spreading out on the surface of the water, the gyratory motion being continued in the horizontal portion. In an article written by Capt. Horsburgh in Nicholson's *Journal of Natural Philosophy*, he says: "I have several times, in calm weather, seen a cloud generate and diffuse a breeze on the surface of the sea, which spread in different directions from the place of descent. A remarkable instance of this occurred in Malacca Strait, during a calm day, when a fleet was in company; a breeze commenced suddenly from a dense cloud; its center of action seemed to be in the middle of the fleet, which was much scattered. The breeze spread in every direction from a center, and produced a singular appearance in the fleet, for every ship hauled close to the wind as the breeze reached her, and, when it became general, exhibited to view the different ships sailing completely round in a circle, although all were close hauled to the wind." It is not uncommon to hear sailors speak of a wind that blows the sea down; a horizontal wind will do this, but it is often produced by vertical winds, especially when accompanied with rain. We have seen this effect produced in a thunder storm at sea; when sailing over a somewhat rough sea, with a favorable stiff breeze, such a storm was encountered, crossing our course at right angles to the breeze by which we were sailing. The wind and rain came down perpendicularly, or nearly so, from the clouds overhead, and in a short time there was not a wave to be seen, and the ship lay as motionless as she would do in a dead calm. In a couple of hours the storm had passed away, and we were again accompanied by the previous wind, and soon afterward by the rough sea, as before the storm.

In another instance, when sailing with a fair wind and smooth sea, we noticed at five or six miles distance a great disturbance on the surface of the water, it rising into great waves; sail was immediately taken in, but before this could be fully accomplished this breeze crossed our path, and came near taking the masts out of the ship; and as it passed away from us it left a line or path of high waves on the smooth sea, presenting a singular appearance. In this case no clouds were visible, and from the action of this column of wind on the ship and sea, it was apparent to us that, besides its rotary motion, it also had the screw motion we have already spoken of. In whirlwinds and waterspouts we often see this motion, but it is an ascending instead of a descending line.

Something more would therefore be necessary in calculating the force of an approaching storm than merely ascertaining its horizontal force by the wind gauge, and the velocity with which it travels over a certain extent of land or sea. It would appear to be also necessary to ascertain the angle at which the particles of air were making in their course to the base of the column, in order to know what would be its ultimate effect upon such obstructions as it might meet with on land, or in producing waves upon the ocean. It would not appear to be very difficult to devise and construct an instrument to do this. If it were done, it might be the means of adding somewhat to our knowledge of the formation and action of storms, and also be of use in giving vessels an indication whether the approaching off-land storms were likely or not to produce dangerously high seas.

PERCEPTION OF COLORS IN DARKNESS.

M. CHARPENTIER has communicated to the *Comptes Rendus* an account of experiments carried out by him with the object of investigating the perception of white and of various colors by the human eye. He thinks that the idea of color may be physiologically considered as a perception of difference of brilliancy between the colored object and a white ground. He has therefore constructed scales showing the degree of brilliancy to which a color must be raised in order to enable it to be distinguished from the ground. Practically the ground was in complete darkness, and the observations therefore resolved the question of deciding the amount of intrinsic brilliancy that would enable colored objects to be distinguished in the darkness against an obscure background. Neglecting the measurements given by M. Charpentier it may be gathered that he finds yellow and red—or, as he calls them, the warm colors—more visible than white under these circumstances; while the cold colors, green and blue, are less visible than white. This fact is constant in all M. Charpentier's experiments; and shows once more that the visibility of a given source of light in enveloping obscurity greatly depends upon the proportion of yellow and red rays contained in it.

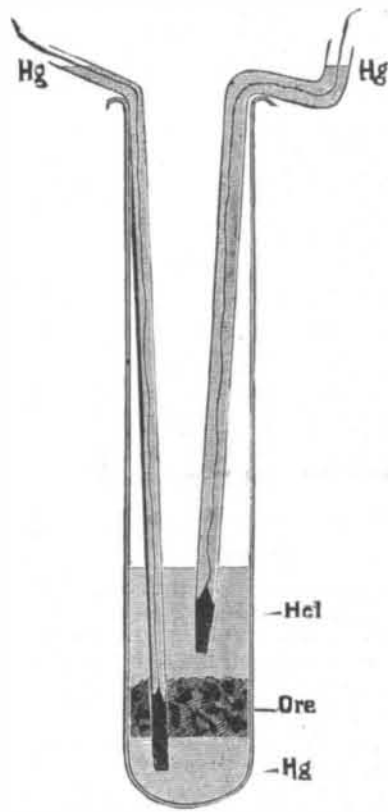
DETERMINATION OF LEAD FROM ITS ORE BY ELECTROLYSIS.*

By AD. SOMMER, Ph.G., of the University of California.

WHILE engaged in experimenting on the determination of lead by means of zinc amalgam, a full account of which will appear shortly, it became very desirable to me to have a simple and correct method of determining lead quantitatively, for the purpose of checking my results. Of the methods most commonly employed, the crucible assay is by far too unreliable, the unavoidable loss of metal reaching often six per cent., while the determination of lead as sulphate is rather tedious, and, like the former method, though to a less extent, liable to give low results. I, therefore, investigated the accounts given by various authors in regard to the electrolysis of lead-salts, and finding the uniform statement that by the action of the galvanic current, metallic lead is deposited on the negative, and peroxide of lead on the positive pole, it occurred to me that the reduction of the salt to metallic lead must be the first reaction, and the presence of peroxide only due to the oxidation of this metallic lead, and that, therefore, if it should be possible to prevent this oxidation by amalgamating the lead the moment it is liberated, the amount of lead contained in the sample might be found by deducting the amount of mercury employed in amalgamating.

A number of trials proved the correctness of my theory. Without recounting the successive experiments that led me to the adoption of the apparatus now in use, I shall confine myself to simply describe the latter:

In one end of a narrow glass tube is fastened, by means of a small piece of rubber tubing, a round stick of graphite, which may protrude about one-half inch beyond the tube. The upper end of the glass tube is bent in such a way that when hung on the edge of a large test tube, in which the electrolysis of the ore is to take place, the lowest point of the graphite will be from one or two inches from the bottom of the test tube. Into another glass tube of the same caliber is fastened, in a like manner, a piece of carbon, such as is used in electric lamps; but this carbon-pencil should not protrude more than one-quarter of an inch, and must touch the bottom of the test tube. After the tightness of the fit-



ting has been ascertained, the tubes are nearly filled with mercury and placed into the test tube. A weighed amount of pure mercury (from twenty to forty grammes) is then poured into the test tube, and sufficient chlorhydric acid added (acid containing from 15 to 20 per cent. HCl has generally been employed) to just cover the graphite pencil. A small quantity (about one gramme) of powdered lead ore (for instance, galena) is now accurately weighed out on a small piece of paper, wrapped up, and thrown into the test tube. The whole apparatus is placed over a water-bath or a small coal oil stove, in order to keep it at a temperature of about 70° C., and connected with a battery consisting of about four Meidinger or Daniell cells, or instead of these two Bunsen or Grove cells. The connections are made by plunging a copper wire attached to the negative (zinc) poles into the tube holding the carbon pencil, while the positive (copper) poles are connected by means of another wire with the other tube holding the graphite pencil. The moment the circuit is closed, the electrolysis within the test tube commences: hydrogen, and, in presence of lead, hydrogen sulphide and lead are eliminated on the surface of the mercury, which represents the negative pole of the battery, while oxygen, and through it chlorine, hypochlorous acid, and—while hydrogen sulphide is present—even sulphuric acid are generated the graphite pencil representing the positive pole of the battery.

About five hours are required to thus entirely decompose about one gramme of galena. When the smell of hypochlorous acid becomes very distinct, the connections may be broken, the mercury, now containing all of the lead, poured into a shallow glass or porcelain vessel, carefully washed with distilled water, in order to remove the silica and other insoluble constituents of the ore, dried, and weighed.

The increase in weight is the quantity of lead contained in the ore.

The employment of carbon in two of its allotropic forms as a conductor of the galvanic current was decided upon for the following reasons:

Metals, even platinum, cannot be employed, since they are either acted upon by the acid or amalgamated by the mercury; and when the graphite and carbon pencils are reversed, or either form is employed on both poles, it is found that the graphite is soon disintegrated by the nascent hydrogen, while the carbon pencil meets the same fate from the nascent oxygen. Why this is so, I must leave to some one else to explain.

*A paper read at the California Pharmaceutical Association meeting.

SEPARATION OF NICKEL FROM COBALT.

By G. VORTMANN.

THE author, after pointing out the defect of all the ordinary methods of separating these metals, suggests the following process, depending on the oxidation of cobalt salts in ammoniacal solution by sodium hypochlorite. When such a cobalt solution mixed with sal-ammoniac is treated with this reagent, complete oxidation takes place, even at ordinary temperature, the liquid assuming a red color. The reaction is accelerated by boiling, the solution in a few minutes assuming a deep reddish-yellow color and then containing the cobalt chiefly in the form of a luteo-cobaltic salt. On diluting with water after cooling, and adding a small quantity of potash-solution, the liquid, if it contain nothing but cobalt, will remain clear even after standing for several hours, but nickel if also present will be deposited in a short time as hydroxide. In this manner, mere traces of nickel may be detected in a cobalt solution, and likewise a very small quantity of cobalt in presence of nickel. A blue ammoniacal solution of nickel containing a very small quantity of cobalt usually exhibits, after treatment in the cold with sodium hypochlorite, a distinct red violet color; but even if the quantity of cobalt present is too small to produce this effect, the liquid, after dilution with water, addition of potash lye, and filtration from precipitated nickel hydroxide, will exhibit a faint yellow color; and if the quantity of cobalt be too small to produce even this faint coloration, its presence may be detected by the black precipitate formed on addition of ammonium sulphide. If the quantity of cobalt present is sufficient to give the solution a strong red color, the cobalt-ammonium compound contained in it will be decomposed on boiling, with separation of brown cobaltic hydroxide. As nickel hydroxide is dissolved in small quantity by ammonia, even in presence of potash or soda, care must be taken in the first stage of the process not to add too large an excess of ammonia, as it would then become necessary, in precipitating with potash, to dilute the liquid to a considerable extent, which would interfere with the subsequent operations.

The author gives the details of a number of experiments made by this method, showing that in many cases it gives results more exact than those which are obtained by the use of potassium nitrite or potassium cyanide.—*Monatsh. Chem.*

ANTHRACENE FROM PETROLEUM RESIDUE.

THE conversion of the hydrocarbons of the marsh gas and ethylene series, observes M. Delahaye in the *Revue Industrielle*, into hydrocarbons of the aromatic series, was considered impracticable before the recent researches of Burg and Liebermann upon the distillation of peat tar, and those of Beilstein and Kurbatow upon Caucasian petroleum. These chemists have established that the hydrocarbons of these latter substances do not belong to the series of marsh gas and ethylene. Berthelot has shown that, in the distillation of coal, ethylene and its analogous constituents of tar are derived from acetylene. Letny has obtained benzol, phenol, naphthalene, anthracene, etc., by distilling petroleum residue. Liebermann and Burg have prepared these bodies by distilling peat tar. MM. Nobel Brothers are developing this industry at Baku; and the anthracene which they extract from naphtha refuse is obtained in a green mass containing from 25 to 35 per cent. of pure anthracene. In order to prove that this crude anthracene is suitable for the production of alizarine, a sample of alizarine oil of good quality was made from it at Ludwigshafen, and was exhibited last year at Moscow. The naphthalene was quite pure; but the benzols, although boiling at between 80° and 85°, contained a great proportion of foreign carburets, and were not suitable for making nitrobenzene. However, it has since been found possible to purify these benzols by lowering the temperature to -14°, which is easily done in Russia. The naphtha residuum of Baku is utilized in making heating and lighting gas, and from this a tar is obtained which is afterward distilled in the same manner as coal tar. Every 1000 kilos. of naphtha residue will yield about 500 cubic meters of gas, 300 kilos. of tar containing 0.6 per cent. of crude anthracene and 17 per cent. of crude benzols boiling at 120°, and giving from 4 to 5 per cent. of benzol and toluol. The house of Nobel Brothers last year had 200,000 tons of petroleum residue to dispose of, and of this only 900 tons were treated by distillation. From this was procured 1500 kilos. of crude anthracene and 15 tons of 80 per cent. benzol. This year the firm expect to make 42 tons of crude anthracene and 500 tons of benzol. Seeing that the European production of alizarine requires from 4000 to 5000 tons of crude anthracene yearly, M. Delahaye opines that it will be long before the competition from the Caucasus will become formidable. The great difficulty at Baku is, moreover, to find capital for establishing factories capable of working up the 250,000 tons of residuum actually disposable.

OXALIC ACID.

OXALIC acid required for the production of oxalate of potash in modern times is always prepared commercially by an ingenious process, which, in brief, consists of the heating together of sawdust and caustic alkali, usually soda and potash combined. The acid is produced in large quantity by the conversion of the vegetable matter, and is afterward separated and purified by a series of processes. Lately, another means of producing the acid has been invented—this time by a process almost the reverse of the one just described, the vegetable matter being replaced by animal and the alkali by acid. Waste leather from saddlers' or shoemakers' shops, and even woolen rags, horn, hair, etc., have been laid under contribution. These waste materials are heated with one part of sulphuric acid and four of water, and the mass thus obtained is treated, at a temperature of 176° Fahr., with nitric acid one part and water three parts. Oxalic acid is then obtained by digestion of the product.—*Br. Jour. of Photo.*

A NEW method of producing invisible ink, says the *Photo. News*, has been discovered by Herr C. Wiedemann. It is made by mixing together:

Linseed oil	1 part.
Liquor ammonia	20 parts.
Water	100 "

The mixture is well shaken before the pen is dipped into it, as otherwise the little oil which separates causes an oily mark on the paper. To render the writing legible, the paper is dipped into water, the characters again disappearing when the paper dries.