practitioner to examine every part of the entire surface of a patient's body, but not to do it is a lack of employment of our knowledge, and we do not do our whole duty to our patient if we neglect it.

I know that I myself have been guilty of such neglect. I will state the facts that have led me to these remarks. I have found that irritation of certain parts of the body in epileptics will often and in some cases always produce an attack of the disease. I have not dared in many cases to produce an attack by such means, but in a few I have. I never wish intentionally to produce an attack, but it is important in some cases to ascertain whether we have to deal with epilepsy due to organic disease of the brain or to some other cause.

In this way we bring the attack to be like those that are preceded by an *aura* appreciable to the patient. If there be an *aura*, and the place where it starts from is determined, then the application of a variety of means of counter-irritation has a great power of curing the attack. So if you produce an attack of convulsions in this way, the patient is well repaid, as counter-irritation applied to the part may produce a cure of his disease.

This spot may be situated in any part of the body, so that an irritation applied to the back of the head, or neck, under the ear, or under the jaw, at the level of the origin of the vaso-motor nerves, the first or second dorsal nerves, the knees or other parts of the limbs, in some cases the breast, and so on, may be the means of curing the epileptic seizures. Abercrombie and Bright had cases like these. Reeves Clark had a most important case in which a touch on the breast produced an attack. In these cases counter-irritation applied to these points may effect a cure.

The *aura* may vary greatly. It may consist in a peculiar movement or in a sensation; the movement may occur anywhere in the body.

I had a case in London in which there was such a violent contraction of the bladder that the urine was forced out with great rapidity. This occurred two or three hours before the attack. Any muscle in the body may contract in this way. The organs of the abdomen or chest may be affected in like manner. Any muscle of the limbs or trunk may contract in the same way as did the muscles of my patient's bladder. As you well know, there are muscular fibers surrounding the blood-vessels. On this account you will get a pallor of the part in which the contraction occurs. It may be in the face or elsewhere. There is likewise a diminution of the temperature of the part.

There is, therefore, a kind of *aura* which consists in muscular contractions in various parts of the body. The bronchi, the diaphragm, the intestines, in fact any part may be subject to this contraction. The important point, for the sake of applying means of treatment, is to determine whether such a place exists, and if it is a constant place, and if the *aura* frequently occurs there previous to an attack. If such a place can be found, you have a great chance of doing a good deal for the patient by applying means of counter-irritation.

Another kind of *aura* is one of sensation. It is variable, but it generally consists of an indefinable sensation. The patient cannot tell what it is like. Its peculiarity is that it is like itself and nothing else; in fact it cannot be accurately described. It belongs only to that peculiar state. Some physicians think that the term *aura* should be limited to this peculiar sensation, but the term should apply to everything that takes place before the beginning of the actual attack.

In those cases in which the *aura* appears long before the attack, we have great chances of staving it off.

I pass now to the consideration of loss of consciousness. In 1857, in this country, in a work on epilepsy I tried to show, what is now admitted by physiologists and physicians, that the loss of consciousness is the result of the contractions of the blood-vessels in the cerebral lobes.

I am sorry indeed that my ideas were followed, for I now believe that it is only partly true, if true at all. I am quite certain that the blood-vessels contract, for I have seen it many times, and the fact is beyond dispute, but, just as in the case of sleep as shown by Dr. Hammond, the contraction is not essential. To say a few words about sleep, the contraction of the blood-vessels is so little essential to that phenomenon that in animals in whom both sympathetics have been divided, and where there can be no contraction, but on the contrary a state of congestion exists, sleep takes place just as well as if the blood-vessels of the brain were contracted.

It is clear, therefore, that contraction of the blood-vessels of the brain is only something that takes place during sleep, and is not the cause of sleep; so that a remedy that produces contraction, given in order to produce sleep, is wrong. The contraction of the blood-vessels is not essential; it may be accidental. I will consider in the next lecture the cause of loss of consciousness in epileptic attacks.

SNAKE POISON.

EVERY now and again the British public is horrified by accounts of the famines which periodically carry off myriads of our fellow-subjects in India, but comparatively few have the least idea of the enormous destruction of human life which occurs there from the ravages of wild animals and venomous snakes. In a most interesting lecture recently delivered at a meeting of the Society of Arts by Sir Joseph Fayrer, the lecturer estimated the loss of life at no less than 20,000 human beings and 50,000 head of cattle annually. Wild animals destroy most of the cattle, but venomous snakes kill more human beings than all the wild animals put together. The bites of these reptiles caused the death of 17,000 persons and over 3,000 cattle in the year 1875, and these figures very probably understate the facts, as the returns upon which they are based are incomplete. The desirability of obtaining an antidote to snake poison is thus evident, and many attempts have been already made to discover one. Another has been added to the already numerous investigations on this subject by Mr. Pedler, who has lately published the results of his research in a paper read before the Royal Society. Before proceeding to seek for the antidote, he endeavored to analyze the poison chemically, and thus discovered several facts of great interest. The venom of snakes seems to contain very much the same proportion of solids at all times, even under such different climatic conditions as during the wet and dry seasons. It may be kept for two or three months without alteration, but if preserved for a year or eighteen months, it becomes insoluble, and, to a great extent, loses its poisonous qualities. Its composition is very like that of albumen, and, indeed, the dried poison, which looks very like gum arabic, contains about sixty per cent. of albumen, and only forty per cent. at most of the poisonous principle. By the use of solvents, Mr. Pedler endeavored to separate a crystalline principle,

such as Lucien Bonaparte affirmed to be present in the poison of the rattlesnake. His attempts were unsuccessful, and he therefore tried to obtain it by dialyzing the poison through parchment paper. Part of the poison dialyzed, and part did not. On evaporating the fluid inside the dialyzer, the residue formed a gummy mass, with a poisonous action. The water outside the dialyzer also gave a similar result, but in it a few crystals could be detected. It was, if anything, rather more poisonous than the ordinary virus. He did not succeed, however, in obtaining any very definite crystalline substance. Ammonia, which has lately been highly recommended as an antidote in snake poisoning, he found, as did Fontana two hundred years ago, to be useless, and indeed its addition to the poison before injection seemed really to hasten death.

Some organic poisons may have their physiological action greatly altered by changing their chemical constitution. Thus strychnia has its action completely altered by combination with iodide of methyl, so that instead of producing convulsions it causes complete paralysis, like curara. At the same time its deadly power is greatly diminished, and it occurred to Mr. Pedler that the poisonous properties of cobra virus might be diminished in a similar way. On testing this supposition he found it to be correct, as the poison, after digesting with ethylic iodide, took five times as long to kill an animal as fresh cobra poison would have done. Hydrochloric acid also diminished the activity of the virus, and platinum chloride had a still more powerful action. This salt seems to combine with the poisonous principle of cobra virus, forming with it a yellow amorphous precipitate, which is very insoluble in water, and which has little or no poisonous action. This result of the action of platinum chloride on cobra virus out of the body is most satisfactory; but this apparent antidote has not the same power when the poison has once entered the system. When the poison is injected under the skin and the platinum chloride is injected shortly afterward into the same spot, death appears to occur even more quickly than when no antidote whatever is used, the second injection seeming to drive the poison before it and to cause it to act more rapidly. When the platinum chloride, however, is injected at the same point but somewhat more deeply than the virus, so that in passing inward the poison might come in contact with the platinum, life is considerably prolonged. If a short time elapses between the injection of the poison and that of the platinum, death ensues, even though the interval be only one or two minutes. It would thus seem that when the platinum chloride is brought directly into contact with the poisonous principle of the cobra venom it renders it insoluble and prevents its poisonous action, but that it is not a physiological antidote, and will not counteract the deadly action of the virus after it has once entered the circulation. It may be useful as a local application, but cannot be regarded as an antidote. Every means hitherto tried of counteracting the effects of cobra venom has thus proved ineffectual. Artificial respiration, proposed by Sir Joseph Fayrer and Dr. Lauder Brunton, gave fair promise of success, and by its use the heart may be kept beating for many hours. Indeed in one case an animal apparently dead for many hours has been partially revived by it, yet on no occasion has a fatal issue ever been averted by its use. The experiment just mentioned was performed by a commission appointed by the Indian Government, at Sir J. Fayrer's suggestion, to examine into the modes of preventing death from snake bite. A dog was bitten one afternoon by a water snake, and apparently died about three o'clock. Artificial respiration was at once commenced, and the heart continued to beat, but the animal seemed to be perfectly dead, and the limbs no longer responded to electrical stimuli. Early next morning, however, an alteration took place. The limbs again answered to electricity, voluntary movements occurred, and the eyelids closed not only when the eye was touched with the finger, but when the hand was simply brought near it. This showed that the animal could see the approaching hand, and closed its eyes in order to protect them from the expected touch. The dog seemed to be in a fair way to recovery, but about noon it began to get worse, and finally died at three o'clock on the second day, twenty-four hours after its first apparent death.

Whether a combination of artificial respiration with other appliances may yet enable us to prevent death altogether, is a question which can only be determined by a continuance of those experiments which led to the use of artificial respiration alone. But however valuable such a method as this may occasionally be in saving the lives of English officers, government officials, or persons living within reach of skilled assistance, and who might otherwise be doomed to certain death from the bite of a cobra, it is obvious that it is too complicated to be of much service to the numerous natives who are bitten in localities where no other assistance can be had than that of their comrades, equally ignorant with themselves. If any great diminution is to be effected in the frightful mortality annually resulting from the bites of venomous snakes in India, the remedies must either be so simple and easy of application that they can be used by the most ignorant, or the snakes must be destroyed. The best instructions yet given for the treatment of persons bitten by venomous snakes are contained in Sir Joseph Fayrer's magnificent work on "The Thanatophidia of India." He recommends that a tight ligature be applied to the limb above the bite, that the bitten part be cut out as quickly as possible, and that the wound thus left be cauterized with a hot coal or hot iron, or touched with nitric or carbolic acid, while brandy or ammonia should be administered internally. Even this treatment, simple though it be, requires knowledge, as well as instruments and skill, which the majority of the natives do not possess. Sir Joseph Fayrer therefore recommends that in every police station and public place plain directions should be printed and hung up, and that at all such places a supply of whipcord, a small knife, a cautery iron, and a bottle of carbolic or nitric acid should be kept, as well as a supply of liquor ammonia for internal administration. But, as Sir Joseph Fayrer says, although comparatively little is to be expected even from this rational mode of treatment, much may be anticipated from prevention, and it is to be effected by making known the nature and appearance of the venomous as distinct from the innocent snakes, and by offering rewards (to be judiciously distributed) for the destruction of the former. The differences between many of the non-venomous and the venomous snakes are not known to the natives, and it is important that a knowledge of such distinctions should be widely disseminated, not only that the venomous ones may be more easily recognized, and thus avoided or destroyed, but in order to prevent death or serious illness from sheer fright, which may frequently result from the bite of a non-venomous species. For this purpose it would be well if the pictures of the chief venomous snakes contained in Sir Joseph Fayrer's work, or cheaper but accurate lithographic copies of them, were displayed in

every police station and public place throughout India. Rewards should be paid for the destruction of venomous snakes only, and if these pictures were exhibited in the way suggested there would be little or no excuse for any mistake, either on the part of the natives who killed the snakes or the officers whose duty it would be to pay the reward. As to the amount of reward, and its mode of distribution, there should, he suggests, be a department, or branch of a department, with a responsible chief and subordinate agents, for whom certain rules should be laid down, to be observed steadily and without hindrance throughout the country, leaving much, as to detail, to the discretion of local authorities. If the destruction of venomous snakes and wild animals in India were intrusted to an officer such as controls the Thuggie and Dacoitee department, he considers that the result would in a few years be as good in the case of noxious animals as it has been in that of noxious men, Thugs and Dacoits. —*Nature*.

LABORATORY EXPERIENCES ON BOARD THE CHALLENGER.*

By J. Y. BUCHANAN.

THE laboratory was 10 feet long, 5 feet 8 inches broad, and 6 feet high, and although the dimensions seemed small, there was practically quite room enough for one worker. It was situated in the middle of the ship on the main deck, on the starboard, i. e., the right-hand side looking forward. A locker, 2 feet 6 inches high and 2 feet broad, ran across the whole of the front side. Supposing that the visitor takes his seat on this locker looking aft, the following description will convey a rough idea of the interior: Immediately on his left is a gun port which, in the absence of the gun, provides light and ventilation for the room. Some light is also obtained from windows in the deck. The locker contains the stores of glass and porcelain, a balance, microscopes, etc. On the right is the blowpipe table; a spirit lamp, formed of a wide mouth stoppered bottle and having a large wick, was found to yield the most convenient flame. A tallow lamp was abandoned on account of the trouble of melting the tallow. On the left-hand side, further aft, is seen the principal working bench, 3 feet 10 inches high, furnished with drawers containing the reagents, each bottle in a separate compartment. On the top of the bench battens are nailed, so that the bench presents the appearance of the frame of an ordinary door without the panels; into the places where the panels should be the drawers of reagents can be fitted while in use, and so are prevented from shaking down. Ordinary retort stands were found to be useless, and the following stands were used: A half-inch metal rod was taken and a long eye cut out at one end (like a needle). Into this eye fitted a staple driven into the joists forming the roof of the laboratory. By this arrangement the retort rod had a certain play up and down. The retort rings having been slipped on from the bottom, the rod was lifted and then pushed down into a hole made for the purpose in the teak bench. This plan was found very convenient, and when not in use the rods were turned up, the eyes forming a joint, and hooked along the roof. For evaporating, drying, etc., a cast-iron frame set in gimbals and fixed to the side of the laboratory was found quite sufficient, even during the most violent movements of the ship. In the further left-hand corner are the sink and the diluted water vessel. Along the further end are wooden shelves with holes for various pieces of glass apparatus. Many vessels, etc., were slung from and between the beams supporting the deck. On the right-hand side are seen the bottles of standard solutions with burettes; the latter were made like pipettes, and filled by sucking up the solutions from below. In this way barium hydrate solution was found to keep its quality for two to three months, though used every day. On the same side the specific-gravity apparatus, hydrometers, and piezometers were stowed away. In all ordinary weathers, and, in fact, as long as the port which lighted and ventilated the laboratory could be kept open, there was no difficulty in working on board ship.

It seemed very desirable to have some means of checking the depths, as indicated by the sounding line, and it was clear that some sort of barometric method must be used. Air had already been tried without success, and so water was finally adopted. The piezometer used consisted of a thermometer, the bulb having a capacity of about 9 c. c., the stem being 13 inches long and 1 mm. in diameter. The thermometer was inverted, after filling with water, in a little flask filled with mercury. The neck of the flask is connected to the stem by a short piece of India-rubber tubing, between which and the stem a piece of glass rod is inserted, so as to admit the external pressure to the surface of the mercury. By warming the bulb enough water is forced out to allow the mercury, on cooling the apparatus, to rise to a convenient height in the stem. In the stem is a little index similar to those used in Six's thermometer. The stem is divided into millimeters, and was carefully calibrated. If such an instrument be sunk with a sounding line, it is clear that the water will be compressed, and that the mercury with the index will rise, such rise being the sum of the decrease in temperature $\times$ the increase of pressure. If a thermometer, properly protected, be sunk at the same time, the temperature will be registered, and thus the increase of pressure can be found. Before starting it was thought that a gauge similar to those used with hydraulic pumps might be employed to determine the pressure, but, on examination, the gauge furnished was found unreliable, and, after all, the length of the sounding line furnished the best gauge of the pressure, provided that care was taken that no currents, bad weather, etc., interfered with the result. If there is a current, its existence is always rendered evident by the behavior of the sounding line as it goes up and down, so that, practically, there is no difficulty in saying when a sounding is good. There was some difficulty with the springs of the indices. As a mean, the compressibility of distilled water per 100 fathoms was found to be 0.0009, or per atmosphere 0.000049, Regnault finding 0.0000486. The results at various depths agreed well: thus, at 1,000 fathoms, 0.00008; at 2,000, 0.00007; at 3,000, 0.00008. The compressibility of sea-water was determined in precisely the same instrument, and was found to be, at 800 fathoms, 0.000077; at 1,000, 0.000078; at 1,500, 0.000073, per 100 fathoms. These experiments were all made by attaching the piezometer to the sounding line, the temperature being from 1° to 3° C. In order to determine the compressibility at higher temperatures, recourse was had to a hydraulic instrument; but as no reliable gauge was at hand, the only results possible were comparative between sea-water and distilled water. At 26.5° C., distilled water = 100, 93.6; 25.8°, 92.0; 22.1°, 92.8; 22.5°, 92.0; 13.7°, 92.6. A solution containing 4 per cent. sodium chloride gave results (distilled water = 100), 26.5°, 90.51; 25.8°, 88.13. 22.1°,

* A paper read before the Chemical Society, February 21st, 1878.

86°61'; 13°7', 86°84'. The compressibility of mercury was next determined, and found to be, per 100 fathoms, 0.0000271, and per atmosphere, 0.0000015. The apparent compressibilities of water and mercury having been thus determined, the next task was the practical one of applying the results to control the soundings as obtained by the line, and the temperatures as indicated by the thermometer. Two piezometers, one charged with water, the other with mercury, were sent down on the sounding line; now water is very sensitive to changes of pressure, but not to changes of temperature; mercury, on the other hand, is less affected by changes of pressure, but considerably more by variations in temperature. The true temperature and true depth were obtained from the readings of the two instruments, thus: The rough depth as given by the sounding line is applied to correct the temperature as indicated by the mercury piezometer; by this temperature the reading of the water instrument is corrected; thus the correct depth is obtained to within twenty-five fathoms. This is again applied to the mercurial instrument, and so, by correcting backward and forward, both the correct depth and the correct temperature are found. For great depths the piezometer above described is useless, a pressure above 3,000 fathoms forcing the mercury into the bulb. To obviate this difficulty a bulb was blown in the middle of the stem, and its size was so arranged that the contraction up to 1,500 fathoms was covered by this bulb, and so the stem was left to indicate greater pressures. The amounts of oxygen and nitrogen in sea-water were estimated; about 900—1,000 c. c. were used. The sample was collected in a brass cylinder furnished with stop-cocks having a 3/4-inch bore, and was transferred to the flask in which it was to be boiled with as little disturbance as possible. To the flask is fitted an India-rubber cork, through which a glass tube, having a large bulb attached to it, passes; the tube and bulb are filled with distilled water, the end of the tube in the flask being closed by a simple device. The bulb is now boiled for ten minutes, and the upper end of the tube closed. The lower end is now connected with the water in the flask, and the latter boiled for one and a half to two hours. The gases evolved are collected in the bulb and analyzed. The carbonic acid was determined by distilling about 1/4 liter of water to dryness, after the addition of 15 c. c. of barium chloride solution to prevent bumping. The steam was passed through a still, and the distillate with evolved gases collected in flasks and U-tubes containing standard baryta water. This, by titration with hydrochloric acid, rosolic acid being used as an indicator, gave the amount of carbonic acid. The following are the results of the analyses of about one-third of the gas samples obtained: Oxygen + nitrogen = 100. In surface water = 33.67; at 25 fathoms, 33.4; 50 fathoms, 32.3; 100 fathoms, 30.2; 200 fathoms, 23.4; 300 fathoms, 11.4; 400 fathoms, 15.5; 800 fathoms, 22.6; below 800 fathoms, 23.5. So that from the surface downward the oxygen decreases to 300 fathoms; below this depth it increases in amount; this increase is in all probability due to the decreasing amount of animal life at depths greater than 300 fathoms. Experiments with the tow net at various depths confirmed this view. As regards superficial distribution, the cold water at the Antarctic regions, both at the surface and below, is thoroughly aerated, the gases diminishing in quantity as we approach the equator, and increasing again as we proceed northward.

From many experiments it was found that the absorption of nitrogen by sea-water varies considerably from that by distilled water, especially at high temperatures. As regards density and depth of sea-water, two regions of maximum density exist north and south of the equator—the north maximum being 25° north of the equator, the south about 15° south. Toward the equator the density at the surface falls off, while toward the Arctic and Antarctic regions the density decreases rapidly.

These regions of maxima correspond to the regions frequented by the trade winds. It is known that the south trade blows much nearer the equator than the north, and so the maximum of density is nearer the equator on the south. As to vertical distribution, the maximum penetrates some depth, but at 350 fathoms a great tract of water of low density is found. At the equator we find first an increase as we go down, then a decrease, and, last of all, again an increase of density near the bottom. The densest water is found in the Atlantic. In the Pacific a certain imitation of the areas of dense water just described is found. Near ice very light water is found; again, near Hong Kong, just after the monsoons, the superficial water is very light, but during the dry season the water becomes more dense. The maxima of density lie in the North Hemisphere to the southwest, in the South Hemisphere to the northwest of the maxima of barometric pressure. It is at these latter spots that the cold dry winds descend from great altitudes and flow outward, taking up moisture from the sea in their course, and not becoming saturated until they are near the equator.

PARAFFINE.

THE raw material of this branch of mineral industry, which is of comparatively recent origin, is a variety of earthy lignite occurring within a small portion of the Saxon Thuringian brown-coal formation between Weissenfels and Zeitz. This contains a fusible hydrocarbon, the so-called Pyropisite of Kengott, which, in the purest condition, yields by distillation as much as 66 per cent. of tar containing paraffine. The pure mineral is, however, only found in nests and patches in the lignite, the average of the coal worked giving 10 per cent. as a maximum of condensable products, but often less. Freshly-raised coal containing a large proportion of water is found to yield more than that which has been dried by exposure to the air. Thus a series of comparative experiments showed that—

Coal containing 68 per cent. of water gave 40 lbs. of tar and 16 lbs. of gas per tub (of about 3 cwts.).
Coal containing 40 per cent. of water gave 33 lbs. of tar and 44 lbs. of gas per tub.
Compressed coal containing 26 per cent. of water gave 24 lbs. of tar and 36 lbs. of gas per tub.

The increased quantity of permanent gases in the drier coals is obtained at the expense of the tar, a result which is to be attributed partly to the higher temperature prevailing during the distillation and partly to the absence of the direct action of hydrogen on carbon. This is owing to the want of water, which, as is well known, is decomposed at a low heat by carbonaceous substances producing hydrocarbons and carbonic oxide.

The retorts used are of two kinds, horizontal and vertical. The former, which are confined to the older works, are of cast iron, 8 1/4 feet long, and of an elliptical section, 14 inches high and 28 inches broad. These are either set in pairs, each pair being fired separately, or in batteries of from twelve to twenty, laid across the direction of the grate flame. The

former plan is generally preferred, as it allows the retorts to be more uniformly heated. The fire-grate extends along the bottom of one of the retorts, the flames pass by a side flue under the second and return over the tops of both. The fronts of the retorts are connected by goose necks of oval section, with a collecting main running along the front of the furnaces which conduct the volatile products to the condensers. These are made of vertical pipes like those ordinarily used in gasworks. A stop-valve is placed on the connection of each retort with the main to prevent the admission of air to the latter during the time of charging. The average amount of coal carbonized in the twenty-four hours is from 6 to 7 cwts., three charges being worked during that time. The coal is spread over the surface in a layer about 4 inches thick; the residual coke when sufficiently good is used in part for heating the retorts, but otherwise it is thrown away or employed for road-making. The coal required for heating the retorts is from 80 to 100 per cent. by volume of that distilled.

The yield of tar varies greatly with the temperature and with the manipulation, the proportion of condensing surface being also of considerable importance. From 250 to 300 square feet is required for each retort, but a notable improvement in yield has been obtained by increasing it to 400 or 500 square feet.

The vertical form of retort which is adopted in all the newer works is a cast-iron tube 16 feet long, from 4 to 6 feet in diameter at the top, and somewhat less at the bottom, to which is adapted a conical discharging piece and a cylinder of about 2 cubic feet capacity, closed by two slide valves for drawing the coke. The center of the retort contains a system of thirty conical rings overlapping each other in the manner of Venetian blinds, built up into a column round a central rod; the apertures between the rings form the passages for the volatile products given off by the coal which is contained in the annular space between the rings and the cast-iron shell. Two large mouthpieces lead the gases from the central column to the condenser. The heating is effected by an external grate fire, the retort being closely surrounded by an external casing of fire-bricks. The work goes on continuously, the charge of 82 bushels of coal requiring about thirty-six hours for complete distillation. The coke is drawn at intervals of an hour to an hour and a quarter, each portion as it leaves the retort being allowed to cool between the slides of the coke-box before being discharged into the air. Latterly cylindrical retorts with fire-brick instead of cast-iron shells have been tried, with fair results. The vertical form of retort, being continuous in action, does five times the work of a horizontal one; at the same time the process is more regularly conducted, and the yield of tar is larger. The average of five years' working showed the produce to be 70 per cent. of the theoretical yield of the coal with vertical, as against 66 per cent. with horizontal retorts.

The best results are obtained when the temperature is such that the gases leave the retorts at 302° or 392° Fahr.; above this point there is a greatly increased production of permanent gases, while at a lower heat the products are principally water and coke.

Another method which has only been tried experimentally is that of distilling in an atmosphere of superheated steam. This was found to give a higher yield both in regard to quantity and quality of the tar, but it has not been adopted in practice.

The product of the first operation is a dark-colored (yellowish brown to black) mass of the consistency of butter, varying in specific gravity from 0.82 to 0.935, fusible at 59° to 86° Fahr. to a brown fluid with dark green fluorescence. The best product is that of a medium density from 0.84 to 0.87, the average yield by rectification being 35 per cent. of benzine and various illuminating oils, 15 per cent. of gas or lubricating oils, 16 per cent. of paraffine, and 10 per cent. of creosote and pitch.

The rectification is conducted according to three different methods:

1. Distillation of the tar; purification of the resulting crude paraffine by caustic soda and sulphuric acid, or by the latter alone, and redistillation of the purified product.
2. Treatment of the tar with sulphuric acid, washing with water, and rectification with slaked lime.
3. Preliminary distillation with 1/4 per cent. of lime; treatment of the paraffine distillate with sulphuric acid.

The first of these is the oldest, and in many respects the safest, being adopted for all classes of material, but is attended with considerable loss of paraffine from decomposition during the distillation; the second is only adopted for the treatment of tar of low density; and the third is, in the author's opinion, the most advantageous, giving 16 per cent. of paraffine as against 12 or 15 per cent. by the other methods.

The operation is conducted in large stills containing from 35 to 50 cwts. of tar, the product being divided into two parts known as crude oil and crude paraffine mass, the latter distinction being made when the distillate solidifies when received upon a cold surface. The proportion is usually 40 per cent. of the former to 54 per cent. of the latter. The distillation is pushed to dryness, a residue of porous coke remaining in the still. Twelve hours are required to work off a charge of 40 cwts., after which the still is allowed to cool during the night so as to be ready for filling early in the morning.

Treatment of the Crude Oil.—This is first cleared from creosote by mixing with caustic soda lye and settling; then treated with sulphuric acid to remove resin, ammonia, and other organic bases; next washed with water until completely freed from acid, and finally rectified by fractional distillation into various products, which are known by the following names:

Benzine, specific gravity 0.790, boiling point 194° Fahr.
Photogene, specific gravity 0.800 to 0.805, boiling point 284° to 302° Fahr.

The oils obtained from the crude paraffine are solar oils, with a specific gravity between 0.825 and 0.845, and boiling point between 347° and 392° Fahr. They are of a yellow color, and form an illuminating material of very high class at an exceedingly low price.

Paraffine oils are those above 0.86 specific gravity, and boiling points between 500° and 518° Fahr. They are usually yellow and somewhat viscid, and are used for lubricating machinery. Notwithstanding the name, it is essential that these oils should be free from paraffine; and their lubricating value is improved by subjecting them to extreme cold in winter in order to freeze out the last traces of that substance.

The crude paraffine, after separation of the associated oils, is crystallized in blocks of 40 lbs. weight, the crystals being separated from the liquid oils by hydraulic presses, centrif-

ugal or other machines. The usual method is to effect a first separation in a chambered filter press, which gives a mass of crystalline scales that is subsequently squeezed in a hydraulic press to cakes under a pressure of 200 atmospheres. The brown coloring matter is removed by melting the crude press cake with 10 to 15 per cent. of benzine, and subjecting it to a second pressing. This is repeated with a further addition of benzine, and after finally washing with water and a little sulphuric acid the paraffine is set aside to crystallize. When so purified its melting point is 116° to 118° Fahr.

The composition of brown-coal paraffine differs from that made from the older coals and shales. The latter is nearly of the theoretical percentage composition, carbon 86, hydrogen 14, while the former contains oxygen, the following analysis being that of one of the best samples made in the district of Weissenfels: Carbon 82.41, hydrogen 14.16, oxygen 3.43.

There are at the present time fourteen mineral oil and paraffine factories at work in the district, consuming about 36,000 tons of tar, 5,500 tons of caustic soda, and 2,900 tons of sulphuric acid, the products being—

12,500 tons benzine, photogene, petroleum, solar and clear paraffine oils.
6,000 tons gas and lubricating oils.
5,000 tons hard and soft paraffine.
3,600 tons creosote, pitch, asphalt, and other accessory products.
27,100 tons, equal to 75 per cent. of the weight of tar treated.

The remaining 25 per cent. representing the loss due chiefly to the production of gas and carbonization by repeated distillations. About 3,500 tons of paraffine are converted into candles in the different manufactories.—*L. Grotowsky.*

THE APPLICATION OF AMMONIUM SULPHOCYANIDE IN VOLUMETRIC ANALYSIS.

By J. VOLHARD.

DETERMINATION OF SILVER.

In a nitric solution of silver to which a soluble ferric salt has been added a permanent redness does not appear on the gradual addition of a dilute solution of ammonium or potassium sulphocyanide until all the silver has been thrown down as a sulphocyanide. If we know how much of the sulphocyanide solution is required to precipitate a known weight of silver we can determine volumetrically the quantity of silver present in any acid argentic solution, the ferric salt serving as an indicator. For the preparation of the standard solution the author uses ammonium sulphocyanide, though Lindemann prefers the potassium salt; both, in dilute solution, are permanent. But the ammonium salt is less frequently contaminated with chlorides, which interfere greatly if present in more than mere traces. The solution may be conveniently made of such a strength that 1 c.c. indicates 1 centigram. of silver. The weighed quantity of the salt is dissolved in water, and diluted in a graduated flask so far that 7.5 grms. (or 8 grms. if the salt appears very damp) may be contained in each liter. For the precipitation of 1 gm. of silver 0.704 gm. of pure ammonium sulphocyanide is requisite; 0.5 gm. of chemically pure silver is then weighed out, dissolved in 8 to 10 c.c. of pure nitric acid of sp. gr. 1.20, and, after the complete solution of the metal, the nitrous acid is expelled by boiling or prolonged heating on the sand-bath, and the solution is allowed to cool. It is then diluted with 200 c.c. of water, and 5 c.c. of a cold saturated solution of ammonia-iron alum are added. If the color of the ferric salt is perceptible, a little pure colorless nitric acid is added till it disappears. The sulphocyanide solution is then added from a burette. At first a white precipitate is produced, which remains suspended in the liquid like silver chloride, rendering it milky. On the further addition of sulphocyanide each drop produces a blood-red cloud, which quickly disappears on agitation. As the point of saturation is reached the silver sulphocyanide collects in flocks, and the liquid grows clearer without becoming perfectly limpid as long as a trace of silver remains in solution. As soon as all the silver is precipitated the flocculent precipitate quickly deposits and the supernatant liquid becomes quite clear. The sulphocyanide solution is added by drops till this point is attained, and till a very faint light brown color appears in the liquid, which does not vanish on repeated agitation. The color is most easily perceived if the liquid is held, not up to the light, but against a white wall turned away from the window.

For a repetition of the experiment it is convenient to use a silver solution of known strength. For this purpose 10 grms. of pure silver are dissolved in nitric acid in a liter flask, the nitrous acid is expelled, the liquid is allowed to cool, and diluted up to the volume. For use 50 c.c. are taken with a pipette. If the above-mentioned proportions are preserved for 0.5 gm. silver or 50 c.c. of the silver solution, somewhat less than 50 c.c. of the sulphocyanide solution will be required, whence the careful dilution can be calculated. If 48.5 c.c. sulphocyanide have been used, then to every 48.5 c.c. of the solution 15 c.c. of water must be added.

The solution is perfectly permanent, even on being kept for two years. The silver solution must have a decidedly acid reaction from free nitric acid, which it is quite unnecessary to neutralize. Nor is it important that the proportion of acid in different experiments should be approximately equal. It is, however, essential for the constancy of the results that the ferric salt should be in large excess, and should be used approximately in one and the same proportion to the total volume of the fluid. It must also be remembered that the color of ferric sulphocyanide is destroyed by nitrous acid at common temperatures, and by nitric acid on the application of heat. Hence follows the necessity of completely expelling all nitrous acid, and of allowing the liquid to become cold before the operation is begun. The nitric acid used in this process should be kept in the dark.

TITRATION OF SILVER IN PRESENCE OF OTHER METALS.

Copper.—The proportion of copper in an alloy may reach 70 per cent. without in the least affecting the accuracy of the process. Beyond this limit the recognition of the final reaction is somewhat doubtful, since after the precipitation of the silver the liquid is rendered opaque and discolored by the formation of black copper sulphocyanide. The only remedy in such cases is to add a known weight of pure silver to the alloy so as to reduce the proportion of copper below 70 per cent., as is done in Gay-Lussac's process.

Mercury.—In presence of this metal silver cannot be titrated with sulphocyanide solution. This defect is of little consequence, as mercury is readily expelled.