Boston *Evening Traveller* by Mr. D. W. Baker. The articles were originally addressed to the general public, and may therefore be regarded as a popular description of the work accomplished at the Harvard College Observatory during the first fifty years of its existence (1840–90). Prof. Pickering has had this material reprinted in pamphlet form. Reproductions have also been made of some of the illustrations. The large amount of important work done at this Observatory renders the pamphlet of great interest to astronomers, while the many facts brought to light for the first time give it a high value.

The results of observations made with the meridian photometer during the years 1882–88 by Prof. Pickering and Mr. Oliver Wendell, have also just been issued. The principal work done by means of this instrument is "the determination of the magnitudes of a sufficient number of stars contained in the *Durchmusterung*, and distributed with approximate uniformity, to serve for future estimates or measures of magnitude, and to enable previous estimates to be reduced to the photometric scale."

The number of stars of which observations are recorded is 20,125; so that, when the stars enumerated in vol. xxiii. of the Annals of this Observatory are reckoned, the total number of stars observed with the meridian photometer reaches 20,982. Measures have also been made of 166 variable stars, and of several planets and satellites. To comment upon the importance of these observations would be superfluous. The authors are to be congratulated that the comparison is completed.

DR. KOCH'S REMEDY FOR TUBERCULOSIS.

THE following is a translation (sent to England on Friday last through Reuter's Agency) of an article by Dr. Koch in the *Deutsche Medizinische Wochenschrift*, January 15:—

"Since the publication, two months ago, of the results of my experiments with the new remedy for tuberculosis, many physicians have received the preparation and have been enabled to make themselves acquainted with its properties through their own experiments. As far as I have been able to review the statements which have been published and the communications I have received by letter, my indications have been fully and completely confirmed. There is a general consensus of opinion that the remedy has a specific effect upon tubercular tissues, and is therefore applicable as a very delicate and sure reagent for the finding out of latent and to diagnose doubtful tuberculous processes. As regards also the curative effects of the remedy, most reports agree in stating that, notwithstanding the comparatively short duration of the application of the treatment, many of the patients subjected to it have shown a more or less pronounced improvement, and it has been affirmed that in not a few cases even a cure has been established. Standing quite by itself is the assertion that the remedy may not only be dangerous in cases which have advanced too far—a fact which may at once be conceded—but also that it actually promotes the tuberculous process, and is therefore injurious. During the past six weeks I myself have had the opportunity to bring together further experiences touching the curative effects and diagnostic application of the remedy in the cases of about one hundred and fifty sufferers from tuberculosis of the most varied types in the City and Moabit Hospitals; and I can only say that everything that I have latterly seen accords with my previous observations, and that there is nothing to modify in what I before reported. So long as it was only a question of proving the accuracy of my indications, there was no need for anyone to know what the remedy contains, or whence it is derived. On the contrary, the subsequent testing would necessarily be the more unbiassed the less people knew of the remedy itself. But now that this confirmatory testing has been, as it appears to me, sufficiently carried out, and has proved the importance of the remedy, the next task is to extend the study of the remedy beyond the field of its heretofore application, and, if possible, to apply the principles underlying the discovery to other diseases also. This task naturally demands a full knowledge of the remedy, and I therefore consider the time to have come when the requisite indications in this direction should be made; and this is done in what follows.

"Before I go into the remedy itself, I deem it necessary, for the better understanding of its mode of operation, to state briefly the way by which I arrived at the discovery. If a healthy guinea-pig is inoculated with the pure cultivation (*Kultur*) of the tubercle bacilli, the inoculation wound mostly closes over with sticky matter, and appears in the early days to heal. It is only after ten to fourteen days that a hard nodule presents itself, which, soon breaking, forms an ulcerating sore until the death of the animal. Quite a different condition of things occurs when a guinea-pig which is already suffering from tuberculosis is inoculated. The best adapted for this purpose are animals which have been successfully inoculated four to six weeks before. In such an animal the small inoculation assumes the same sticky covering at the beginning, but no nodule forms. On the contrary, on the following, or on the second day, the place of inoculation shows a strange change. It becomes hard, and assumes a darker colouring, which is not confined to the inoculation spot, but spreads to the neighbouring parts until it attains a diameter of 0·5 to 1 centimetre. In the course of the next few days it becomes more and more manifest that the skin thus changed is necrotic, and it finally falls off, leaving a flat ulceration, which usually heals rapidly and permanently, without any cutting into the adjacent lymphatic glands. Thus the injected tubercular bacilli have a quite different effect upon the skin of a healthy guinea-pig from that of one affected with tuberculosis. This effect is not exclusively produced with living tnbercular bacilli, but is also observed with dead bacilli, the result being the same whether, as I discovered by experiments at the outset, they are killed by somewhat prolonged application of low temperatures or boiling heat, or by means of certain chemicals. This peculiar fact I followed up in all directions, and this further result was obtained—that killed pure cultivations of tubercular bacilli, after being diluted in water, might be injected in great quantities under the skin of a healthy guinea-pig without anything occurring beyond local suppuration. (Professor Koch here interpolates a note to the effect that such injections belong to the simplest and surest means of producing suppuration free from living bacteria.) Tuberculous guinea-pigs, on the other hand, are killed by the injection of very small quantities of such diluted cultivations; in fact, within six to forty-eight hours, according to the strength of the dose. An injection which does not suffice to produce the death of the animal may cause extended necrosis of the skin in the vicinity of the place of injection. If the dilution is still further diluted so that it is scarcely visibly clouded, the animals inoculated remain alive. There soon supervenes a noticeable improvement in their condition. If the injections are continued at intervals of one to two days, the ulcerating inoculation wound becomes smaller, and finally scars over, which otherwise is never the case. Further, the swollen lymphatic glands are reduced in size, the body becomes better nourished, and the morbid process comes to a standstill, unless it has gone too far, and the animal perishes from exhaustion.

"By this means the basis of the curative process against tuberculosis was established. Against the practical application of such dilutions of dead tubercle bacilli there presented itself the fact that the tubercle bacilli are not absorbed at the inoculation points nor do they disappear in other way, but for a long time remain unchanged and engender greater or smaller suppurative foci. Anything, therefore, that was to exercise a healing effect on the tuberculous process must be a soluble substance which would be lixiviated to a certain extent by the fluids of the body floating round the tubercle bacilli, and be transferred fairly rapidly to the juices of the body, while the substance which produces suppuration apparently remains behind in the tubercular bacilli, or in any case dissolves but very slowly. The only important point, therefore, was to bring about outside the body the process which goes on inside, and, if possible, to extract from the tubercular bacilli alone the curative substance. This demanded much time and toil until I succeeded at last, with the aid of a 40 to 50 per cent. solution of glycerine, in obtaining the effective substance from the tubercular bacilli. With the fluids so obtained I made further experiments on animals, and finally on human beings. These fluids were given to other physicians in order that they might repeat the experiments. The remedy with which the new treatment against tuberculosis is practised is thus a glycerine extract from pure cultivations of the tubercle bacilli. Into the simple extracts there naturally passes from the tubercular bacilli, besides the effective substance, all the other matter soluble in 50 per cent. glycerine. Consequently there are in it a certain quantity of mineral salts, colouring substances, and other unknown extractive matter. Some of these substances can be removed from it tolerably easily. The effective substance is, namely, insoluble in absolute alcohol and can be precipitated by it, not indeed in

a pure condition, but still combined with the other extractive matter which is likewise insoluble in alcohol. The colouring matter may also be removed, so that it is possible to obtain from the extract a colourless dry substance which contains the effective principle in a much more concentrated form than the original glycerine solution.

"For application in practice, however, this purification of the glycerine extract offers no advantage, because substances so eliminated are unessential for the human organism, and the process of purification would make the cost of the remedy unnecessarily high. As regards the constitution of the more effective substance, only surmises may for the present be expressed. It appears to me to be a derivative from albuminous bodies, and to have a close affinity to them. It does not belong to the group of so-called tox-albumens, because it bears high temperatures, and in the dialyser goes easily and quickly through the membrane. The proportion of the substance in the extract is to all appearance very small. I estimate it at fractions of 1 per cent. If my assumption is correct, we should therefore have to do with a matter the effect of which upon organisms attacked with tuberculosis goes far beyond what is known to us of the strongest drugs. Regarding the manner in which the specific action of the remedy on tuberculous tissue is to be represented, various hypotheses may naturally be put forward. Without wishing to affirm that my view affords the best explanation, I represent the process to myself in the following manner. The tubercle bacilli produce, when growing in living tissues, just as artificial cultivations do, certain substances which variously and notably unfavourably influence the living elements in their vicinity—namely, the cells. Among these is a substance which in a certain degree of concentration kills the living protoplasm and so alters it that it passes into the condition described by Weigert as coagulation necrosis. In the tissue which has thus become necrotic the bacillus finds such unfavourable conditions of nourishment that it can grow no more and sometimes finally dies. This is how I explain the remarkable phenomenon that in organs which are newly attacked with tuberculosis, as, for instance, in the spleen and liver of a guinea-pig which is covered with gray nodules, numbers of bacilli are found, whereas they are rare or wholly absent when an enormously enlarged spleen consists almost entirely of a whitish substance in a condition of coagulation necrosis, as is often found in cases of natural death in tuberculous guinea-pigs. The single bacillus cannot, therefore, bring about necrosis at a great distance, for as soon as the necrosis has attained a certain extension the growth of the bacillus subsides, and therewith the production of the necrotizing substance. There thus occurs a kind of reciprocal compensation, which causes the vegetation of isolated bacilli to remain so extraordinarily restricted, as, for instance, in lupus, scrofulous glands, &c. In such a case the necrosis generally extends only to a part of the cells, which then, with further growth, assumes the peculiar form of the *Riesenzelle*, or giant cell. Thus, in this interpretation, I follow the first explanation given by Weigert of the production of giant cells.

"If now one were to increase artificially in the vicinity of the bacillus the amount of necrotizing substance in the tissue, the necrosis would spread to a greater distance, and thereby the conditions of nourishment for the bacillus would become much more unfavourable than usual. In the first place, the tissue which had become necrotic over a larger extent would decay, detach itself, and, where such were possible, carry off the enclosed bacilli and eject them outwardly; and in the second place, the bacilli would be so far disturbed in their vegetation that they would much more speedily be killed than under ordinary circumstances. It is just in the evoking of such changes that the effect of the remedy appears to me to consist. It contains a certain quantity of necrotizing substance, a corresponding large dose of which injures certain tissue elements even in a healthy person, and, perhaps, the white blood corpuscles or the cells adjacent thereto, and consequently produces fever and a quite remarkable complication of symptoms. With tuberculous patients, on the other hand, a much smaller quantity suffices to induce at certain places—namely, where the tubercle bacilli are vegetating and have already impregnated the adjacent region with the same necrotizing matter—more or less extensive necrosis of the cells, together with the phenomena in the whole organism which result from and are connected with it. In this way, for the present at least, it is possible to explain the specific influence which the remedy, in accurately defined doses, exercises upon tuberculous tissue, and further, the possibility of increasing these doses with such remarkable rapidity, and the remedial effects which have been unquestionably produced under not too favourable circumstances."

Regarding the duration of the remedy, Prof. Koch observes in a note that, of the consumptive patients who were described by him as temporarily cured, two have been again received into the Moabit Hospital for further observation, that no bacilli have appeared in the sputum for three months past, and that the physical symptoms have also gradually but completely disappeared.

GASEOUS ILLUMINANTS.[1]

III.

IT has been proposed to carburet and enrich poor coal gas by admixture with it of an oxy-oil gas, in which crude oils are cracked at a comparatively low temperature, and are then mixed with from 12 to 24 per cent. of oxygen gas. Oil gas made at low temperature is *per se* of little use as an illuminant, as it burns with a smoky flame, and does not travel well; but, when mixed with a certain amount of oxygen, it gives a very brilliant white light and no smoke, while, as far as experiments have at present gone, its travelling powers are much improved. At first sight it seems a dangerous experiment to mix a heavy hydrocarbon gas with oxygen; but it must be remembered that, although hydrogen and carbon monoxide only need to be mixed with but half of their own volume of oxygen to produce the most explosive compound, yet as the number of carbon and hydrogen atoms in the combustible gas increases, so does the amount of oxygen needed. So that coal gas requires rather more than its own volume, and ethylene three times its volume, to yield the maximum explosive results; while these mixtures begin to be explosive when 10 per cent. of oxygen is combined with hydrogen or water gas, 30 per cent. with coal gas, and more than 50 per cent. with oil gas of the character used. It is claimed that if this gas were used as an enricher of coal gas, 5 per cent. of it would increase the luminosity of 16-candle gas by about 40 per cent. Oxygen has been obtained for some time past from the air, on a commercial scale, by the Brin process; and it is now proposed to make oxygen by a process first introduced by Tessié du Motay, which consists of passing alternate currents of steam and air over sodic manganate heated to dull redness in an iron tube. The process has never been commercially successful, for the reason that the contents of the tube fused, and, flowing over the surface of the iron, rapidly destroyee the tubes or retorts; and also, as soon as fusion took place, the mass became so dense that it had little or no action on the air passing over it; but it is now claimed that this trouble can bs overcome. Cheap oxygen would be an enormous boon to the gal manager, as, by mixing 0·8 per cent. of oxygen with his coal gas before purification, he could not only utilize the method so successfully introduced by Mr. Valon at Ramsgate, but could also increase the illuminating value of his gas to a slight extent.

No ordinary gas flame is in contact with the burner from which it issues, this being due to the cooling effect of the burner; but as this only affects the bottom of the flame, with a small flame the total effect is very great; with a large flame almost *nil*. The first point, therefore, to attend to in making a good burner is that it should be made of a good non-conductor. In the next place, the flow of the gas must be regulated to the burner; as, if you have a pressure higher than that for which the burner is constructed, you at once obtain a roaring flame and a loss of illuminating power, as the too rapid rush of gas from the burner causes a mingling of gas and air, and a consequent cooling of the flame, while the form of the flame becomes distorted. The tap also which regulates the flame is better at a distance from the burner than close to it; as any constriction near the burner causes eddies in the flow of the gas, which gives an unsteady flame. These general principles govern all burners.

We will now take the ordinary forms in detail. In the flat-flame burner, given a good non-conducting material and a well-regulated gas supply, little more can be done, while burning it

[1] Continued from p. 260. Conclusion of the Cantor Lectures delivered at the Society of Arts by Prof. Lewes.