ATMOSPHERIC POLLUTION AND FOGS

BY

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The interesting account in the *British Medical Journal* of February 14th (p. 277) of the investigations by Professors Nolf, Firket, and Leeuwen, into the causes of the Meuse fog disaster in December has prompted me to write this article. It appears that the disaster was caused by the ordinary products of combustion from the chimneys of factories and other industrial undertakings scattered about in the sparsely populated neighbourhood of the district near Liége where the disaster occurred ; and the possibility of a similar disaster happening in this country is a matter of great public interest. If a similar concentration of similar products of combustion were to occur in the air of any large town in this country, the deaths would be numbered not in tens but in thousands.

From the symptoms described, and the clinical and post-mortem evidence, the effects on men and animals were due mainly, if not entirely, to the sulphur acids (sulphuric and sulphurous acids) in the products of combustion, owing to the irritant action of these substances on the air passages. Symptoms and signs of nasal inflammation, laryngitis, and bronchitis were evident, but not of pneumonia. The sulphuric acid is present in the air as minute liquid droplets of dilute sulphuric acid condensed on solid nuclei, while the sulphurous acid is present as gas. It was suggested that hydrofluoric acid might also have been present in very small quantities, but my own experiments with this substance during the war did not seem to indicate that, in spite of its striking action on glass, it is more dangerous as a constituent of air than other mineral acids.

The dangers arising from atmospheric pollution by products of combustion were discussed in the inquiry in December last, before the Electricity Commissioners, as to the proposed very large electrical generating station (now sanctioned by them) to be erected at Fulham. Evidence as to possible risks to public health and safety was given, on behalf of the London County Council, by Dr. J. S. Owens, Dr. Daley, and myself, and as to possible damage to buildings by Sir Frank Baines. Assuming from the newspaper evidence that the fog disaster near Liége was due to ordinary products of combustion, I myself discussed the question why it is that though the products of combustion emitted per acre of ground are probably greater in amount in London than in the Liége district, nothing comparable to what occurred in the latter district last December, or in the winter of 1911, has ever occurred in London. I pointed out that in a town a very large amount of heat is emitted at or near the ground level. This warms the air sufficiently to cause convection currents which carry it upwards, and at the same time to evaporate to a considerable extent the liquid particles which constitute fog. These particles are evaporated to a much greater extent inside buildings, though acid nuclei still remain, and make the air inside just as irritating as that outside. Many of the Liége victims had never been outside at all.

The consequence of the products of combustion being carried upwards over a town is that, instead of their becoming concentrated near the ground level, and a fog being correspondingly more opaque there, they are distributed through a layer many hundreds of feet high, and a " black " overhead fog results, in place of a stifling fog at the breathing level, as near Liége. There, owing to the absence of the warming effect produced by inhabited houses, the products of combustion accumulated down below with disastrous results. It is now a common experience of motorists and others that though it is darker in a town than outside it, the air is much less opaque during a fog. In the town of Liége itself there was no trouble from breathing the fog.

Dark overhead fogs are now much more common in London and other large towns than the more opaque, equally dark, and also more irritating fogs which prevailed last century. I think that there can be no doubt that the reason for this is the immensely increased use of gas for heating and cooking, particularly among the working classes, who have to study economy. Gas supplies heat with hardly any emission of sulphurous fumes, and none whatever of smoke. The sulphur naturally present in gas is nearly all in the form of sulphuretted hydrogen, and every trace of this impurity must, by law, be removed from the gas, the public gas examiners appointed by local authorities seeing that this regulation is most strictly complied with, in accordance with the methods specified by the Gas Referees. Although only a very small proportion of the energy liberated as heat in a large town is distributed as electricity, the electrical undertakings have hitherto taken no share in improving the atmosphere, since all the sulphur in the coal burnt at the generating stations goes into the atmosphere, along with a good deal of smoke. If the system of combustion and purification adopted at the new large generating stations at Battersea and Fulham is made really effective, and the present smaller stations throughout London are abolished, it will be no longer possible to level this reproach against electrical supply undertakings.

In their decision, which was communicated to the newspapers, as well as to others concerned, about a fortnight ago, the Commissioners have not specified any definite standard of purification, beyond the general condition that the purification shall be the best that is " reasonably practicable," and that the Commissioners, the Board of Works, and the Minister of Health must be satisfied of this. Perhaps it was impossible, in view of the somewhat doubtful and imperfect chemical evidence available, to go further than this.

In one respect, however, the Commissioners decided in the teeth of the medical evidence submitted to them on behalf of the County Council. The scrubbing process in the scheme of purification proposed would involve cooling down the effluent gas to near the air temperature. Owing to its high percentage of carbon dioxide, this cooled gas would, in periods of air stagnation, including fog, drop at once, and with only (owing to its enormous volume) a comparatively small dilution, on a small area round the generating station. The representatives of the undertaking agreed to the necessity of the gas being sufficiently heated to make it rise high above the tops of the chimneys in still weather. The Commissioners decided, however, that it was not necessary for the effluent gas to be warm ; and it appeared that the basis of this decision was a memorandum (which they quote in full) from the chief representative of another Government department. This memorandum was not brought up at the inquiry. If it had been it would have been torn to pieces in the course of cross-examination and rebutting evidence. To pour down cold and heavy gas in immense volume on the people round the station and the mouths of the furnaces would be an invitation to a great disaster. The result would probably be, for one thing, a wholesale emission of carbon monoxide owing to imperfect combustion ; and hundreds of people might be poisoned in consequence. The County Council has taken, or is taking, energetic steps to bring the true facts of the case before the bodies which will be concerned in guarding the public interest in connexion with the new generating stations ; but it is perhaps well that,

through the columns of the *Journal*, the medical public should also know how matters stand.

It is evident that the importance of properly purifying the effluent gases from electrical generating stations and other large similar undertakings is becoming more and more recognized. With it will also be recognized the importance of emitting the gas at a suitable temperature. With reasonable purification, and the gas emitted warm, any such disaster as that near Liége could never have occurred, nor could the extensive damage to vegetation. It is more difficult to deal with the damage to buildings and other property, through the use of ordinary coal fires, and even coke or smokeless coal fires ; but by the substitution of gas fires for ordinary fires considerable progress has been made in this direction.

One interesting historical fact which occurs to me in relation to the great improvement in connexion with the composition of London fogs is as follows. The air was formerly so very unpleasant in the House of Commons, as well as outside, during fogs, that a large fog-filter of cotton-wool was designed by Dr. Percy, who at that time superintended the ventilation. This filter was like an immense mattress, and was placed in position whenever a bad fog occurred, so that the air supplied had to pass through it. I can remember it well, but it was abolished many years ago, partly because it was no longer necessary, partly owing to danger from fire, and partly because it obstructed the ventilation, and people had begun to trouble more about germs than about chemical constituents of the air.

Recent information as to the chemical composition of the air during fogs in towns or industrial districts is extremely scanty ; but Dr. Russell made, last century, a large number of determinations of the carbon dioxide in the air at St. Bartholomew's Hospital, and found that during one of the thick fogs then prevalent the percentage rose to as much as 0.14 per cent. Allowing for the probable error of the Pettenkofer method which he used, this indicated an excess of 0.1 per cent. It seems probable that in the fog which caused the disaster near Liége the excess may have been three or four times as great. It can hardly have been more, or symptoms of carbon monoxide poisoning would have pretty certainly occurred ; and the symptoms observed were not those of poisoning by this gas.

"UNIPOLAR AIR"

EXPERIMENTAL WORK AT FRANKFORT

[FROM A CORRESPONDENT]

The effects of certain climatic conditions—such as sunlight, temperature, humidity, and barometric pressure—upon the human organism have all been more or less studied in times past, but relatively little attention has been directed to the electrical charge present on particles in the atmosphere. The subjective symptoms experienced by certain individuals before or at the time of a thunderstorm or in association with certain seasonal winds in the South of France have been attributed to possible electrical effects, and the subject must be considered as removed from the realm of mere guesswork by the recent publication[1] of some remarkable experimental results obtained over a period of ten years at the "Institute for the Physical Foundations of Medicine" of the University of Frankfort-on-Maine, directed by Professor F. Dessauer. That they are only now available for the first time is due to a fear that premature publication might cause the work to be regarded as something in the nature of a "stunt."

Put briefly, the underlying assumption is that air contains normally both positively and negatively charged particles, which fluctuate in numbers and proportion according to climatic conditions. Normal air at ordinary altitude contains usually an excess of positively charged particles, but under certain weather conditions this surplus of positive articles may give place to an excess of negatively charged particles. The particles are roughly of two types: what are termed "light" particles, gaseous ions for the most part, and "heavy" particles, consisting of dust and water vapour. The experiments at Frankfort have been concerned with the effects on the body of air containing excess of particles of only one electrical sign. The production of ionized air with a positive or negative charge has been obtained in various ways, including the use of ultra-violet light, high-tension electrical apparatus, high-frequency apparatus, or by glowing alkalis or metals. The favourite method has been to heat a cartridge of magnesium oxide by means of a coil of platinum-iridium wire through which an electrical current is passed. Air is circulated over this and then through a grid, which is charged positively or negatively according to the "ions" it is wished to retain. After passing through the grid air containing a unipolar charge as high as 10,000 times the amount present in normal air was available for experimental purposes. The method of measuring the charge, the number of "ions" present, the loss by gaseous diffusion, electrical diffusion, and many other physical problems, have been gradually solved by various workers at the institute, and for the most part the experimental work has been carried out with "heavy" particles of medium size.

The use of this "unipolar air" for animal experiments and for the treatment of patients has been mostly employed by Dr. Happel, and he states quite frankly that many of the experiments produced negative results. Nevertheless some interesting effects were observed when patients breathed this specially prepared air, either obtaining it through a funnel or breathing in a chamber into which such air was passed. In certain cases of raised blood pressure, particularly when this was not due to renal disease, the inhalation of air with a negative charge produced definite reduction in blood pressure and alleviation of the principal subjective symptoms such as headache, tiredness, and giddiness, while, if the air breathed had a positive charge, distinctly unfavourable results and an aggravation of symptoms frequently resulted. Even where the blood pressure did not fall in cases of essential hypertension subjective symptoms were often relieved by negatively charged air, while similar symptoms were also sometimes relieved in patients with no rise in blood pressure, especially those peculiarly sensitive to climatic conditions. The usual periods of treatment were from half to one hour daily or at less frequent intervals, and the results mentioned above were carefully controlled so that patients did not know what variety of air they were breathing on any particular day. Care was also taken to make sure that the effects produced were in no way to be attributed to the minute amounts of platinum or magnesium inhaled, estimated at less than one-hundreth of a milligram in half an hour, or to any oxidation products of nitrogen. A definite amount of electrical charge appears to be "lost" in the body by this method of treatment, and it is tentatively suggested that the effects produced result from this electrical charge.

While the first ten years of work at Frankfort have been fully occupied with the scientific basis of this fascinating subject the application of results to treatment

[1] *Zehn Jahre Forschung auf dem physikalisch-medizinischen Grenzgebiet.* Edited by Professor Dr. Dessauer. Leipzig: Georg Thieme. 1931.