while the terms of higher order accord pretty fairly on the whole with Schuster's hypothesis, this is not true of the principal terms of lower order. The natural inference is that the hypothesis is, at best, not a complete explanation of the phenomena. To the second question the answer obtained is that the forces causing the diurnal variation do *not* possess a potential; part, but only part, of the diurnal variation may be derived from a potential. Besides the main data mentioned above, data from a number of other stations are utilised, and there is, besides, a good deal of mathematical theory. While the publication makes most direct appeal to theorists, it contains much valuable information as to facts not otherwise readily accessible.

GALVANOMETRIC RECORDS OF EMOTIVITY.

IN the correspondence columns of the issue of the *Lancet* for February 23, Dr. A. D. Waller described some very interesting results which he had obtained by the study of the "emotive response" or "psycho-galvanic reflex" on various individuals. If, by means of electrodes applied to the dorsum and palm of the hand, a subject be connected in series with two Leclanché cells and a galvanometer, an emotive response is shown by the deflection of the latter, not only to physical stimuli such as burning, unexpected noise, smell (*e.g.* a poison gas), but also to psychical stimuli such as apprehension, questions, and thoughts, pleasant or unpleasant. The

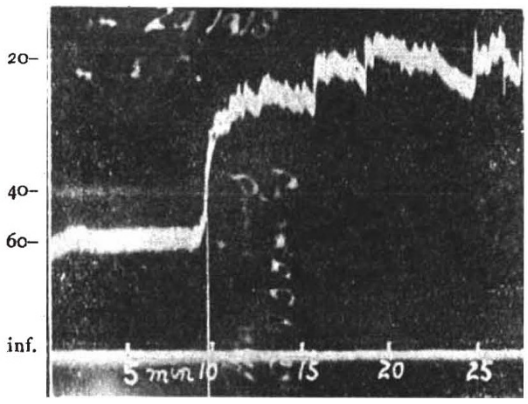

FIG. 1.—Galvanometric record of Miss G. De D. during the air raid of January 29, 1918. At the tenth minute of observation the noise of maroons, immediately followed by that of aeroplanes and guns, broke out, and the resistance, which was approximately 60,000 ohms during the first ten minutes before the disturbance, fell to approximately 20,000 ohms during the next fifteen minutes. (On the left hand is given the resistance in thousands of ohms.)

normal resistance between the back and the palm of the hand is between 10,000 and 40,000 ohms.

From many experiments made on different subjects, besides the big variation in actual resistance there is a marked difference in emotive response; also in the change of resistance which takes place during an experiment, and in the response of the subject to the same stimulus at different stages of the experiment. In some individuals a greater physiological change may be caused by an imaginary than by a real excitation. This is especially the case in imaginative subjects, such as members of the literary, artistic, and scientific professions. A very interesting record (Fig. 1) is given of the response of a subject taken during an air raid.

Comparative records are also given of two officers, one of high and the other of normal emotivity. It would be of extreme interest to know the nature of response in a series of subjects who have successfully withstood many nerve-trying ordeals—as, for example, the response of the experienced and successful fighting air-pilot. It is possible that this test would be of value in special cases in the selection of air-pilots, and also invaluable to the military authorities as an adjunct to the ordinary medical examination in classifying doubtful "nerve" cases, *e.g.* shell-shock, neurasthenia, and malingering.

ATMOSPHERIC POLLUTION.

AN examination of the third report of the Advisory Committee on Atmospheric Pollution, published as a supplement to the *Lancet* of March 23, shows that the total deposit for 1916–17 has increased in the (six) summer months over that of the previous year, which was greater than that of 1914–15, so that there has been a steady increase in most of the stations during the past three years. On the other hand, in the (six) winter months a diminution in 1916–17 is recorded. No very definite conclusions can be drawn from these results, as the stations have in some cases been changed; but in London, where the same stations have been in steady operation during this period, there is a distinct improvement in the winter months, and the same is true of Glasgow.

Among the towns exhibiting the highest deposits of atmospheric impurities St. Helens and Glasgow stand out most prominently, whilst Malvern and Exeter, as might be expected, exhibit the lowest figures.

A comparison of deposits during wet and dry weather indicates that, whereas insoluble matter is little affected by rainfall, soluble matter is brought down in much larger amount. The highest and lowest deposits, based on the average of eighteen stations, correspond, nevertheless, in no instance with the highest and lowest rainfall.

Some kind of automatic recorder for the rapid registration of atmospheric pollution, to replace the cumbersome and tedious method at present used, has always been a great desideratum. Dr. J. S. Owens describes in the present report a simple form of such an apparatus, whereby a known volume of air (2 litres) is drawn at a fixed rate through an aperture ($\frac{1}{8}$ in.) into which a piece of filter paper is inserted. The stain produced by the arrested dust particles gives a measure of the amount of suspended impurity, and by calibration with weighed quantities, which have been determined by Mr. J. G. Clark, the depth of deposit can be expressed quantitatively. The method appears to give trustworthy results, and each determination is complete in ten minutes. It does not, of course, touch the gaseous impurities, but as these run to a great extent parallel with the solid impurities, and as the latter are the more injurious, the results should give a fair record of the changes taking place in atmospheric pollution at different centres. As the method involves simple apparatus and but little attention, it is to be hoped that a larger number of observers will be induced to enrol themselves under the present committee. J. B. C.

LUBRICATING OILS.

IN a paper read by Drs. A. E. Dunstan and F. B. Thole before the Institution of Petroleum Technologists on April 16, the authors, in reviewing the work of previous observers, point out that little knowledge exists as to the chemical composition of lubricating oils and the relation between their chemical character and lubricating properties. These oils probably consist (though nothing very definite is known) of

saturated and unsaturated hydrocarbons of the naphthenic or polynuclear type, and, to a limited extent, of paraffins and aromatic hydrocarbons.

The authors have made careful determinations of viscosity by a modified form of Ostwald apparatus, and discuss lubricating value in terms of this property and chemical composition. The desideratum for a lubricant appears to be low viscosity and good lubricating power, as the lubricant is concerned in the transformation of solid into liquid friction. On the other hand, the mysterious property known as "body"—that is, the power of maintaining a film (or film strength) between shaft and bearings—is a vital factor. This property of body seems to depend on surface tension, and is not necessarily dependent on viscosity, but appears to be connected with molecular weight. The possible iso-colloid nature of heavy oils in explaining high viscosity is considered, and the view is put forward that if this is the true nature of such oils, the film strength may depend upon the relation of the two phases present in the oil.

The following are some of the authors' general conclusions:—Paraffinoid oils, though highly stable, have little lubricating value, and the smaller the hydrogen content, the greater the viscosity and durability; it is the polynuclear naphthenes, especially the unsaturated components, which confer viscosity and film strength; the higher fractions of petroleum contain such unsaturated members, which, when removed, exhibit lower density, lower viscosity, higher molecular weight, and, generally, lower lubricating value.

It appears, then, that the true lubricant is an unsaturated compound possessing the characteristic attributes of such compounds, and this applies not only to hydrocarbons, but also to fatty oils, such as rape, castor, and olive oil; in other words, unsaturation is a feature of chemical activity which, in addition to colour, taste, smell, and physiological properties, manifests itself in lubricating value. Moreover, the colloidal condition of a good lubricant may also have to be taken into consideration.

The whole subject of liquid lubricants is an important one, and in the above brief summary the authors have brought forward a contribution of a highly suggestive character, which emphasises very clearly the necessity for further comprehensive and detailed study.

STATISTICAL METHODS APPLIED TO PRACTICAL PROBLEMS.

WE have received a copy of the presidential address delivered before the Indian Science Congress at Lahore in January last by Sir G. T. Walker, Director-General of Observatories, India (Calcutta: Thacker, Spink, and Co.). The bulk of the address is devoted to illustrating the application to important practical problems of statistical methods. Illustrations are given of the use of coefficients of correlation in connection with crop prediction, and also to show the extent of co-variation between the fever rate, population, cost of rice, cultivated area, and rainfall, so far as this can be determined by a first-degree regression equation computed from the data of twenty-five years.

An interesting point is the apparently close association between an increase of population and an increase of fever. Sir G. T. Walker observes that this "is so directly opposed to widely accepted medical ideas that for some months I did not treat it seriously. But on my informing Major McKendrick, of Kasauli, of it he urged me not to reject it lightly, and directed my attention to some analysis of his which would suggest an explanation. I have therefore examined the corresponding relationship for all the ten provinces of India for which sufficient data are available, and have not found a single negative coefficient. The average value is +0·5. For those of you who are interested in sanitary matters I may briefly explain that the spread of malaria among men depends upon the meeting of healthy men with infected mosquitoes, and the spread among mosquitoes on the encounters between infected men and healthy mosquitoes; hence the relations are symmetrical from the mathematical, if not the æsthetic, point of view, and an increase in the number of men has essentially the same bad effect as an increase in the number of mosquitoes."

In view of the work which has been done upon the method of variate difference correlation during recent years, it would be of interest further to explore the association by the new method. Statisticians in this country will appreciate the concluding passage of Sir G. T. Walker's address:—"I hope that statistical methods may before long be recognised as essential for efficiency for the following reasons. First, a table of data covering, say, fifty years gives any intelligent man the same advantage as if he had carefully watched the conditions for fifty years and had a perfect memory; secondly, employing a draughtsman to plot these data will suggest relationships in a manner which would otherwise require profound study of the figures; and thirdly, employing a clerk to work out the correlation coefficients and regression equation will give him without effort trustworthy information about their relationships which will distinguish direct from indirect effects, and could be got in no other way."

METHODS OF GAS WARFARE.

THE issue of the Journal of the Washington Academy of Sciences for February 4 last includes a report of a lecture by Prof. S. J. M. Auld, of the British Military Mission, on "Methods of Gas Warfare," delivered before the Academy. Naturally in the lecture, which is here summarised, attention is confined to a description of what the Germans have been doing; nothing is said of the activities of the Entente Powers in this direction.

The first gas attack was made by the Germans in April, 1915, and the whole method of the war was changed. The attack was made, of course, against men who were entirely unprepared—absolutely unprotected. The Germans expected no immediate retaliation, as they had provided no protection for their own men. A clear and unobstructed gap in the lines was made, which was only closed by the Canadians, who rallied on the left and advanced, in part through the gas-cloud itself.

The method first used by the Germans is simple, but requires great preparation beforehand. A hole is dug in the bottom of the trench close underneath the parapet, and a gas cylinder is buried in the hole. It is then covered first with a quilt of moss containing potassium carbonate solution, and then with sand-bags. When the attack is to be made the sand-bags are taken off the cylinder, and each cylinder is connected with a lead pipe which is bent over the top of the parapet. A sand-bag is laid on the nozzle to prevent the back "kick" of the outrushing gas from throwing the pipe back into the trench.

The attackers must know the direction and velocity of the wind with certainty. Favourable conditions are limited practically to wind velocities between twelve and four miles an hour. A wind of more than twelve miles an hour disperses the gas-cloud very rapidly. An upward current of air is the worst foe of gas. If the trench line is very irregular it is likely that gas will flow into a portion of one's own trenches. The