this asteroid had a magnitude of 11·3; and on August 31 Dr. Palisa recorded it as being of the eleventh magnitude; at 11h. 44m. (Vienna M.T.) on September 5, however, it had sunk to the twelfth.

The position of this body at 11h. 39·9m. (Königstuhl M.T.) on August 23 was R.A. = 22h. 37·9m., dec. = -7° 55′, and on September 5d. 11h. 4·4m. (Vienna M.T.) R.A. = 22h. 27m. 47·3s., dec. = -9° 5′ 45″.

INTERPRETATION OF SPECTROHELIOGRAPH PICTURES.—In No. 4044 of the *Astronomische Nachrichten*, M. N. Donitch discusses the results obtained by Messrs. Hale and Ellerman, regarding the different chromospheric layers shown on their spectroheliograph negatives, in a new light. He points out that in spectrograms of the chromosphere taken during total eclipses of the sun, the lower layers of the eruptions, *i.e.* those nearer to the moon's limb, appear to be the most extensive, but in Prof. Hale's photographs (plate v., No. 1, vol. xix., of the *Astrophysical Journal*) the opposite appears to be the case, the higher, less dense layers being more extensive than those near to the photosphere.

This discordance between the two results is, in the opinion of M. Donitch, only apparent, and may be explained by the suggestions he advances. He assumes that the inequalities on the surface of the photosphere are so small as to be incomparable with those in the layers of calcium vapour which overlay it. Where this vapour is thin it will only produce the ordinary narrow reversal, producing on the negative a calcium area which is at a low pressure, and, therefore, according to Messrs. Hale and Ellerman, is situated in the upper regions of the chromosphere. This same reversal is also shown by the vapours, which are, in reality, at a greater elevation, so that, using the monochromatic reversal, one obtains on the photograph the forms of the calcium clouds of which the temperature and pressure are relatively low, whatever may be their elevation above the photosphere. For this reason, as M. Donitch believes, the first photograph, which shows more extensive areas of calcium vapour, and according to the Yerkes observers represents simply the upper layers of the disturbed areas, really also represents the thinner extensive layers of vapour which are shown on eclipse spectrograms as the broad bases of the eruptions.

A second photograph taken with the secondary slit set on the *broadened* H reversal ($\lambda = 396{\cdot}2\ \mu\mu$) only registers those layers of calcium vapour which, being part of a thick layer, are subjected to a sufficient difference of temperature and pressure to produce the broadening; and these may, in many cases, be at a greater elevation than the thin layers shown as part of the "calcium" area on the first photograph.

Similarly in regard to the two photographs shown on plate viii. of Messrs. Hale and Ellerman's paper, M. Donitch believes that it is the second, taken with the secondary slit set at λ 3968·6, that reveals the general distribution of the vapours in projection, whereas the first only reproduces the higher agglomerations of the vapour which dominates the lower layer.

THE OBSERVATORY OF PARIS.—M. Lœwy's report for the year 1904 is far too lengthy to be reviewed as a whole in these columns, but one or two of the more important details may be mentioned. In his introduction, the director mentions the progress made during the year in the Eros campaign, and also indicates how the photographs of the moon, taken for the large atlas he is preparing, afford evidence that the moon, and, inferentially, the planets, solidified from the surface towards the centre.

M. Bigourdan has temporarily arrested his observations of nebulæ with the equatorial of the east tower in order that the dome and instrument may be prepared for the determination of the absolute constant of aberration by M. Lœwy's new method.

A study of the garden meridian circle showed that a difference of 0″·45 existed between the readings of the two circles. Various possible causes for this discrepancy were examined, and finally it was discovered that the method of illuminating the microscope wires was at fault. The microscopes have been replaced by others, and the difference thereby eliminated.

The astrophysical department is awaiting the arrival of apparatus before making celestial observations, but in the meantime M. Hamy has carried out several laboratory researches, the chief of which related to the constancy of wave-lengths in the solar spectrum. He found that when the temperature of cadmium vapour in a vacuum tube was raised about 15° C., in the neighbourhood of 300° C., the line at λ 508 diminished several units of the order of $1\ \mu \times 10^{-6}$, and he suggests that the variation of temperature in the solar atmosphere may produce similar results.

During 1904, 80 catalogue and 31 *carte* plates were obtained in connection with the *carte du ciel* operations, whilst 67 plates containing 16,656 star-images were measured.

AN ELECTRIC MICROMETER.[1]

THERE is no finality in experimental measurement. In physics it is a common experience for a present-day worker, with better appliances and a wider horizon than his forerunners, to surpass all previous experimental work in accuracy. As knowledge increases it becomes more minutely exact, and nowadays the physicist has often to measure lengths much less than anything visible in any microscope.

There are various means of measuring small distances. We will take them in order, commencing with the least sensitive:—(1) The unaided eye cannot perceive much less than 1/10 millimetre. (2) With the aid of the microscope the eye can see as little as 1/5000 millimetre. (3) The measuring machine used for engineering gauges will detect differences of 1/8000 millimetre. (4) By using interference bands of light we can perceive movements of 1/100,000 millimetre. (5) In the optical lever a beam of light falls on a pivoted mirror; if a body push the mirror at a point very near the axis of the pivot the beam of light is deflected by a large angle. By this means a movement of the body by 1/400,000 millimetre may be detected. (6) The most modern and sensitive method, the electric micrometer, is due to Dr. P. E. Shaw, who produced it in 1900, and has improved it until he can now measure less than 1/2,000,000 millimetre. The nucleus of the apparatus is shown in the figure. A fine screw M has a graduated head N. The screw in rising pushes up the long arm of a lever pivoted at B. The short arm of the lever falls, and in so doing lets down the long arm of a second lever. This process is carried on through six levers, which all rest under their own weight on the blocks shown. The last lever carries a measuring point P, just above which is a measuring surface Q. If the joint leverage of the lever system be 2000/1, an upward movement of the screw point M by 1/1000 millimetre produces an upward movement of P by 1/2,000,000 millimetre.

As a simple example, suppose we wish to find the thermal coefficient of expansion of the rod R, we proceed thus:—Bring P and Q into contact. The screw M is worked up, while a telephone (Tel.), in the electric circuit shown, is on the observer's head. When P touches Q a circuit is completed, and the telephone sounds. Read the graduated disc N. Now lower the temperature of R by any desired amount, taking care that little or no heat reaches the pillars F′ or any part but R. R contracts, and by working screw M up the observer causes P to touch Q again; the telephone sounds, and N is again read. The expansibility can thus be found, when we know the movement of P and the change in temperature.

The screw, the levers, and the frame F′ are all carried by a massive girder I. The whole is surrounded by a box thickly wrapped in felt to minimise temperature changes, and is suspended by long rubber cords from the ceiling, to insulate the measuring apparatus from vibration.

The screw M is not touched by hand, but is worked by a pulley cord of rubber which passes from a hand pulley round pulley O. This is done to avoid the comparatively rough touch and tremor of the hand. There are many precautions as to shape, size, cleanliness, and other matters which must be observed.

[1] Based upon a paper by Dr. P. E. Shaw read before the Royal Society.

The smallest measurements ever yet made, viz. 1/2,000,000 millimetre, were in connection with the movements of a telephone diaphragm. The problem was to find what movement of the diaphragm produces a sound which is only just audible.

This is done as follows:—Place a telephone to the ear and pass through it a steady current. On stopping the current a sharp sound is heard in the telephone. Alter the strength of the current until when it is stopped the sound can only just be heard. Observe on a galvanometer the strength of that current (c). Next put the telephone in the electric micrometer in place of the rod R, pass the current (c), and measure the movement of the diaphragm in the usual way. This movement then produces a sound in the telephone which is just audible.

Another use of the instrument is to measure the sparking distance between two surfaces, the potential difference of which is known. The surfaces used are P, Q in the figure. Suppose the potential difference between these surfaces is very small, say 1/1000 volt. Find the contact position as above, and draw P away from Q. Now make the potential difference between P and Q equal to 1 volt. On making P approach Q the contact position has changed by an amount D. Thus the sparking distance for 1 volt is D (supposing the spark distance for 1/1000 volt is negligible). This is found to be about 1/100,000 mm.

In problems on the constitution and molecular properties of matter there are obvious possibilities before this apparatus, for by it we can bring two surfaces of any hard metal to molecular distance (or less) from one another, and keep them there while any desired physical change is produced in the surfaces or in the medium surrounding them.

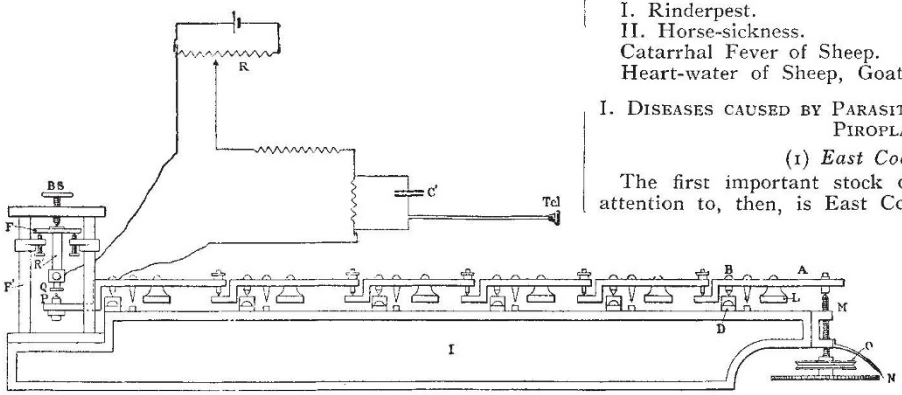

FIG. 1.—The Electric Micrometer.

THE BRITISH ASSOCIATION.

SECTION I.

PHYSIOLOGY.

OPENING ADDRESS BY COLONEL D. BRUCE, M.B., F.R.S., C.B., PRESIDENT OF THE SECTION.

The Advance in our Knowledge of the Causation and Methods of Prevention of Stock Diseases in South Africa during the last ten years.

TEN years ago, when I first came to South Africa, I was led to take an interest in the various great stock diseases which do so much damage and so retard the progress of South Africa as a stock-raising country. I thought, therefore, that a good subject for my address, in the centre of the foremost stock-raising Colony of South Africa, would be a review of the work done in advancing our knowledge, during the last ten years, of the causation and methods of prevention of stock diseases in South Africa. South Africa is particularly rich in animal diseases, every species of domestic animal seemingly having one or more specially adapted for its destruction. Now it is evident that, in an address of this kind, it will be impossible to take up every stock disease, but I think you will agree with me that those shown on this table are among the most important:—

East Coast Fever; ordinary Redwater or Texas Fever; Biliary Fever of Horses; Malignant Jaundice of Dogs; Nagana or Tsetse-fly Disease; Trypanosomiasis of Cattle; Rinderpest; Horse-sickness; Catarrhal Fever in Sheep; Heart-water of Sheep, Goats, and Cattle.

Now we may group these diseases in various ways; for example, as below, where they are divided into two main divisions: *A* division, in which the parasite is known; and *B* division, in which the parasite is unknown.

A. Parasite known.

I. Diseases caused by parasites belonging to the genus Piroplasma:—

(1) East Coast Fever (Koch), *P. parvum.*

(2) Redwater or Texas Fever, *P. bigeminum* (Theiler).

(3) Biliary Fever of Horses, Mules, and Donkeys, *P. equi.*

(4) Malignant Jaundice of Dogs, *P. canis.*

II. Diseases caused by parasites belonging to the genus Trypanosoma:—

(1) Nagana or Tsetse-fly Disease, *T. brucei* (Bradford and Plimmer).

(2) Trypanosomiasis of Cattle, *T. theileri* (Bruce).

B. Parasite unknown.

I. Rinderpest.

II. Horse-sickness.

Catarrhal Fever of Sheep.

Heart-water of Sheep, Goats and Cattle.

I. DISEASES CAUSED BY PARASITES BELONGING TO THE GENUS PIROPLASMA.

(1) *East Coast Fever.*

The first important stock disease I would direct your attention to, then, is East Coast Fever. This name was given to it by Prof. Robert Koch, of Berlin. In the Transvaal the disease is usually called Rhodesian Redwater. This term is not a good one, since the disease is not restricted to Rhodesia, nor did it arise there, nor is this a disease similar to the ordinary Redwater. Ten years ago, East Coast Fever was unknown in the Transvaal. The first known outbreak occurred only some three and a half years ago, when it broke out at Koomati and Neilspruit, in the Barberton district, and in the east of the Colony. The disease had broken out some time previously in Rhodesia, and the outbreaks in both Colonies were due to infection from Portuguese territory. Although this disease has only been introduced to the country during the last few years, it has already produced an enormous amount of damage among stock, and is probably the most dangerous disease that the people of the Transvaal have to cope with at the present time, and for some years to come.

In the Annual Report of the Transvaal Department of Agriculture there is a most excellent report by Mr. Stockman, the then Principal Veterinary Surgeon, on the work of the veterinary division for the year 1903–1904. A large part of this report is given up to East Coast Fever, and I must here express my indebtedness to Mr. Stockman for much of the following account of this disease. In the same Annual Report there is also an account by Dr. Theiler, the Veterinary Bacteriologist, of the experimental work. Messrs. Stockman and Theiler evidently worked together, and I must congratulate them on the immense amount of good, useful work done by them, and I would also congratulate the Government on having had the services of two such accomplished and energetic gentlemen during the late troublesome times. Unfortunately for the Transvaal, Mr. Stockman has accepted the post of Veterinary Adviser to the Board of Agriculture in England,