Physics. — *"The Influence of Rotation on the Sensitiveness and the Accuracy of a Pressure Balance."* (Twelfth communication of results obtained in researches made by the aid of the VAN DER WAALS fund). By A. MICHELS. (Communicated by Prof. P. ZEEMAN).

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For the accurate measurement of great pressures methods are now of general application, based on the use of the so-called Amagat cylinder. In all these methods the force is studied exerted by a liquid under pressure on a piston of known diameter. The elaboration of this fundamental idea has given rise to different types of pressure balances, as those of WAGNER, STÜCKRADT, SCHÄFFER und BUDENBERG, and HOLBORN [1]).

In order to reach an accuracy as great as possible it is necessary to reduce the frictional forces between the piston and the wall of the hole to a minimum. In this respect WIEBE already obtained good results by tapping the wall of his apparatus with a hammer. Of late a rotation of the piston has pretty generally been applied, though HOLBORN [2]) considers a movement to and fro preferable.

The causes why these operations have such an influence, are only imperfectly known as yet. KLEIN (loc. cit.) tries, indeed, to give a solution of the effect of rotation, but does not succeed.

The purpose of this investigation is to find a solution, and at the same time to determine the circumstances under which the greatest effect is reached.

As there is no room here for an extensive discussion of our results, we shall restrict ourselves in what follows to a brief communication, referring for a fuller treatment to "Annalen der Physik" Bd. 72, 1923, p. 285—320.

It was tried to work theoretically in the direction indicated by the recent theory of bearings lubricated all round [3]). For when the piston revolves in a cylindrical hole, liquid being continually supplied from below, there must certainly be an analogy between the influences of friction to which our piston is subjected and those exerted on an ordinary axle resting in a bearing block.

[1]) I refer for the different types to KLEIN. G. Untersuchung und Kritik von Hochdruckmesser Diss. Berlin 1909.

[2]) Ann. d. Physik 1915, p. 1087.

[3]) SOMMERFELD. Zeitschr. für Math. und Physik 1904, GÜMBEL. Das problem der Lagerreibung Jahresb. d. Schiffbautechn. Gesellsch. 1917.

Undoubtedly there are also points of difference, which must be chiefly owing to this that in our case the so-called bearing-pressure is wanting on account of the vertical position of the piston. Application of the theory taught that if the peripherical speed is sufficient, a liquid layer will be formed everywhere between piston and hole-wall. The number of revolutions at which this takes place, will be called the critical value of the revolutions ω_k. It is dependent on the viscosity of the liquid chosen. In the absence of any metal contact also the axial friction would be a liquid friction above this value of revolutions.

In order to test the validity of this theory the pressure balance of the VAN DER WAALS fund which was at our disposal, was modified in such a way that it had a driving apparatus that could be regulated mechanically.

This alteration was made by the instrument-maker of the laboratory, Mr. J. WASSENAAR.

Characteristic of a liquid friction is its proportionality with the velocity. When a definite initial value of revolutions Ω is given to the piston, after which the motor is cut out, the motion will be retarded, and the angle $\varkappa$ passed over in the time t, will get a value of

$$\varkappa = \frac{\Omega}{A}\left(1-e^{-At}\right)$$

in which A is a constant. As soon, as the value of revolutions descends below the critical value however, there is metal contact, and the image of the motion changes.

In this way the course is examined all over the measuring scope of the pressure balance, and agreement was found between experiment and theory. As was to be expected, the critical value of the revolutions then appeared to be dependent on the temperature, as this influences the viscosity, but independent of the load.

An electrical determination shows the validity of the suppositions still more clearly. For, when the electrical resistance between axle and wall was measured, it appeared to be about 700 Ohms above a definite number of revolutions, being reduced pretty suddenly to 0.2 Ohm on diminution of the velocity. In these values the resistance of the conducting wires is included.

Conclusion. For a favourable use of the pressure balance experiments should always be made above the critical value of revolutions. This value can be determined experimentally for every liquid and temperature.