other in the space. This result appears sufficiently important to warrant its early publication.

Undoubtedly there are still other influences which are caused by the structure of the nitrogen compounds, but in order to study these a great many more substances will have to be tested. The research will, therefore, be continued.

Microscopy. — Prof. J. W. MOLL describes: "*An apparatus for focussing the projecting-microscope from a distance.*"

In the new Botanical Laboratory of the University at Groningen the lecture-room is entirely arranged for the purpose of demonstration by means of projecting-apparatus. I intend to describe elsewhere the principal features of the general arrangements. Here I will only mention one special point. An important part of the projecting-apparatus is formed by the projecting-microscope, of which the magnifying power is 5000 diameters and more. With such highly magnified images it is of special importance that any part of the object can be brought to a sharp focus, which cannot be done by a person who is at some distance from the screen, so as to be unable to distinguish the finest details. Moreover the demonstrator who stands next to the screen must be able during his explanation continually to alter the adjustment of the fine motion-screw, for the same reason which necessitates this adjustement when working with the ordinary microscope.

If therefore high magnifications are often used in the projection, the sharp focussing cannot be left to the assistant at the apparatus, as is generally done in projecting photographic images. It is absolutely necessary that the lecturer himself has a complete control over the adjusting apparatus. In the laboratory at Groningen the distance between the screen and the projecting-apparatus is 6 M., while moreover the latter is placed in a separate small room adjoining the lecture-room.

The idea, which naturally first presents itself, is that of an arrangement by which the adjusting-screw of the microscope can, from the position of the lecturer, be moved at will in either direction. This could be done either by electrical transfer of power [1]), or

[1]) At the Dutch scientific and medical congress held at Rotterdam in April 1901 an apparatus constructed on this principle was used by Dr. W. EINTHOVEN, of which however I have not seen the details.

mechanically by a connecting rod or by means of so called "flexible tubing", such as is used in boring apparatus of different kinds, e. g. by dental surgeons.

In the present case however there is an objection to such a solution of the problem, *viz.* the bad construction of the adjusting-screw of the projecting-microscope. The projecting apparatus used at Groningen was made by the well known firm NEWTON & CY., London. It is of excellent design [1]) and is, according to my experience, preferable to others. A great drawback however is that the workmanship of the metallic parts is not always of the highest standard. Thus especially the screw for the fine adjustment is far inferior in quality to what is generally found in modern microscopes.

In the case of high magnifications and with a distance of the screen of 6 M. extremely minute alterations of this distance correspond to large differences in focussing. No satisfactory result could thus be expected in this way. Also it proved to be very difficult to replace the bad screw by a better one.

Thus I was led to another solution of the problem which appears to me to be very simple and effective. It is well known that by changing the distance between the ocular- and objective-glasses in an ordinary microscope, different levels of the object can be brought to a sharp focus. In this way the same end is obtained as by turning the adjusting-screw, and even somewhat better, as a motion of the ocular is equivalent to a considerably smaller motion of the screw. Consequently in the ordinary microscope a more exact focussing can be effected by means of the ocular-glass than by the adjusting-screw.

RANVIER [2]) mentions that he has an arrangement fitted to his microscope by which a fine motion can be given to the ocular. This arrangement is used in delicate observations.

Naturally the same principle can be applied to the projecting-microscope, and some preliminary experiments at once gave very satisfactory results.

At first a wooden cross-beam was fixed before the microscope, and entirely free from it. The objective only was left on the microscope, the ocular being fixed on a wooden slide, or sledge, which was so connected to the cross-beam, that it could be moved through about

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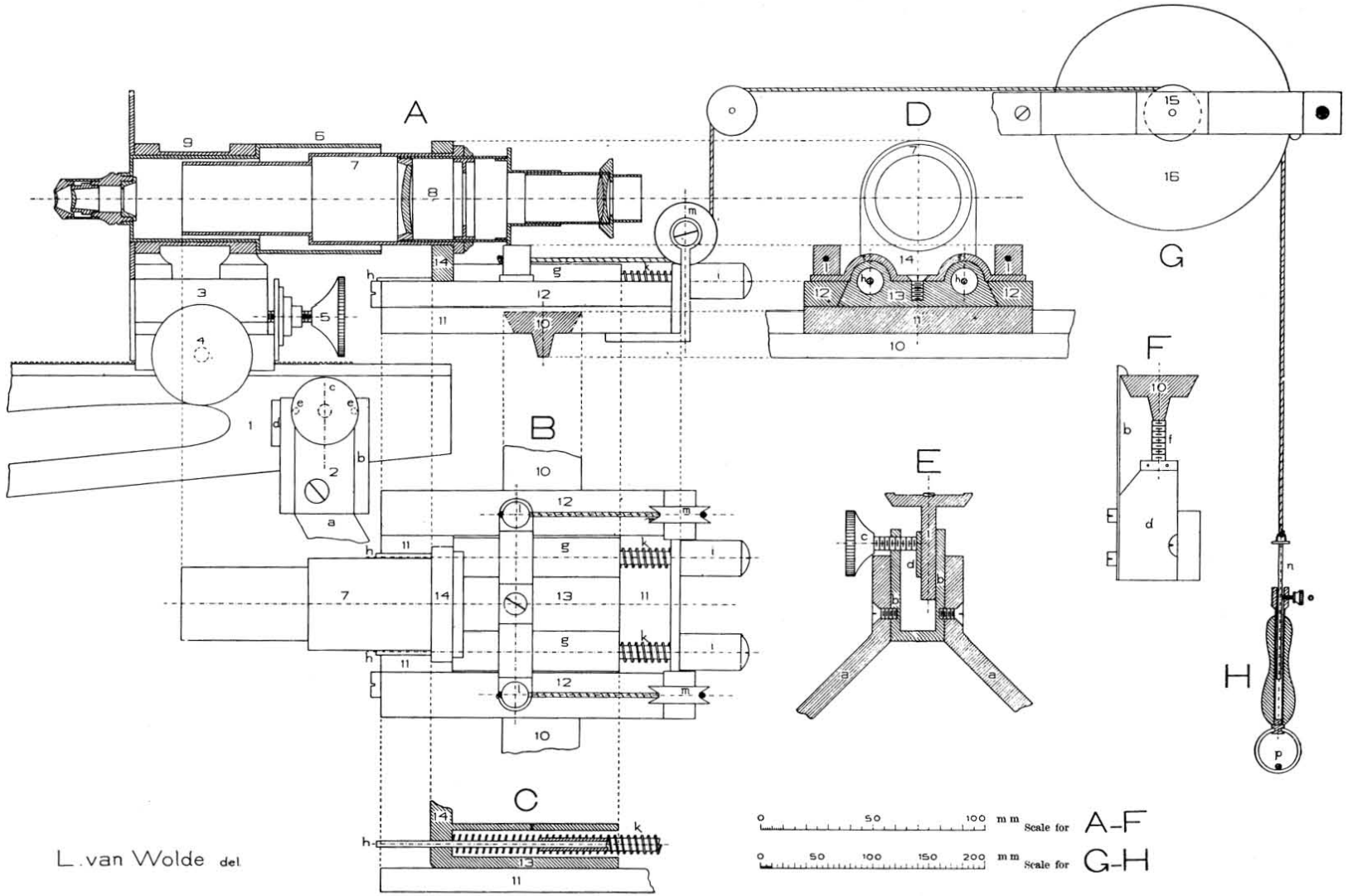
[1]) c. f. LEWIS WRIGHT. Optical Projection. London 1891. This I think is the best work which has been written about methods of projection. The author is also the designer of the microscope by NEWTON & CY.

[2]) RANVIER Technisches Lehrbuch.

Prof. J. W. MOLL. „An apparatus for focussing the projecting-microscope from a distance.



5 c. M. in a direction parallel to the axis of the microscope. The distance between the objective- and ocular-glasses could thus be altered by this amount. The motion of the slide towards the screen could be effected by a rope, the other end of which was held by the lecturer at the screen. When the rope was relaxed, the slide was pulled back towards the objective by a weight. The first experiments with this arrangement gave very satisfactory results. The focussing could be effected with at least the same sharpness as in the ordinary microscope, and it was found easy to retain the slide for a considerable length of time in any position, when it was necessary that one particular level should remain in focus for some time.

Thus the principal feature of the arrangement was arrived at, and it was decided to erect a definitive apparatus. In order to secure the necessary stability for the permanent centring of the lenses, this apparatus was made of metal. It is represented in the fig's *A*, *G*, *H* of the plate.

Of course it was also necessary to provide a light-tight but movable connection between the objective- and ocular-glasses, and also a few other details required attention. Firstly it was found possible by a simple device materially to increase the accuracy of the control over the motion of the slide.

The rope runs from the projecting-apparatus upwards, and then along the ceiling of the lecture-room to a place above and beside the screen. There it is fixed to the circumference of a small wooden disc (15 in the figure) of which the diameter in 4,2 c.M. If this disc turns on its axis in such a direction that the rope is wound upon it, the slide consequently is drawn away from the objective. This disc is fixed concentrically to another larger disc (16) of 19,4 c.M. diameter, to the circumference of which the descending rope is so fixed that, when it is pulled, the rope of the smaller disc is wound up[1]). When the rope is relaxed by the demonstrator, the slide is pushed back towards the objective by a pair of strong springs, which replace the weight of the first arrangement. As a consequence of the introduction if this second (large) disc, very little force is required for moving the slide, notwithstanding the very strong counteraction of the steel springs. At the same time the range of motion of the slide, which in the definitive apparatus is 5.5 c.M., is increased

[1]) Of course it is by no means necessary to place the disc-system exactly above and beside the screen. It can be placed anywhere in the course of the rope, according to local circumstances.

to a range of ± 26 c. M. [1]) for the motion of the hand. Thus a very fine adjustment of the focus is made possible, and it is easy, while pulling the rope, to bring the slide to rest at 20 or more different positions during its motion in one direction. The relative accuracy of focussing is thus here considerably greater than with the ordinary microscope.

Before proceeding to the description of the details of the apparatus I will still call attention to another point.

In the ordinary microscope, before the beginning of the observations, the adjusting screw must occupy a mean position, in order to enable lower as well as higher levels of the object to be brought to focus. Similarly here the slide must occupy a mean position when not in use. The assistant at the microscope focusses on the middle level of the object by means of the adjusting screw, and the demonstrator must then be able by means of the rope to move the slide in either direction. For this purpose there is fixed to the end of the rope a handle (fig. *H*) with a ring, which can be passed on a pin, which has been driven in the wall at a convenient height. The length of the rope must be so adjusted that the slide is in the required mean position when the ring is on the pin. As the discs are high up in the room, the rope in the hand of the demonstrator is long, and he is free to move before the whole of the screen while holding it, in order to point out special details of the image.

It will be seen that the arrangement is very simple and effective. There is however one drawback. When the ocular-glass is moved, the magnification and the illumination of the field are altered, however so slightly that it causes no inconvenience to the audience. As the ocular moves away from the objective the magnification is increased and the illumination is reduced.

Also the changes of level, which are produced by a definite change of position of the ocular, decrease as the ocular moves away from the objective. For this reason the correct optical mean position is not the middle point of the range of motion of the slide, but a point nearer to the objective. The best mean position of the slide has been found by experience to be such that a motion of 2.2 c.M. towards the objective and of 3.3 c.M. towards the screen is possible. In this position of the slide the distance between the objective-

[1]) Actually the range is somewhat larger (29 c. M.) probably owing to the extensibility of the ropes.

and ocular-glasses is equal to the length of the microscope-tube, which originally belonged to the microscope, *viz.* 15.5 c.M. The design of the lenses did not allow to bring the whole slide with the ocular nearer to the objective, with a view to increasing the illumination.

Having thus explained the principal features I proceed to a detailed description of the apparatus as erected in my laboratory.

As has been said above, the figures *A*, *G*, *H* of the plate represent a side-view of the whole apparatus and a section of some parts of it. On the left-hand side of the figure the front part of the projecting-microscope, is also shown The ocular (8) is entirely free from the microscope and is mounted on the slide, which rests on a metallic cross-beam (10). This cross-beam is fixed before the microscope to two projecting rafters of the wall of the small room in which the projecting-apparatus is placed. The part of the rope from *A* to *G* is high up in the lecture-room. The two discs are shown at *G*, and *H* represents the handle with the ring, which is kept in its place by the pin *p*.

The slide is shown separately, without the ocular, in fig. *B*, seen from above, and in *C* a part of it is shown in longitudinal section. *D* is a cross-section of the slide together with the cross-beam (10) on which the slide rests and the ring (14), which carries the ocular-tube (7).

Figures *E* and *F* represent some other parts, which will be mentioned further on.

Proceeding now to a more detailed description of the figures, I begin at the left hand side of fig. *A*, which shows that part of the microscope carrying the objective. At 1 we see the head of the bar of the projecting-microscope [1]), which originally carried the whole apparatus. This bar is in my laboratory fixed in a kind of fork (2) of which fig. *E* gives a cross-section. The obliquely descending metal plates (*a*) are firmly connected to the wall of the room. They carry a bent piece of metal (*b*) in which the microscope-bar is fixed by the screw *c* and the plate *d*. In fig. *A* the two adjustable pins (*e*, *e*) are shown, by which the plate *d* is kept in position. This rigid mounting of the microscope has been found

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[1]) The projecting-apparatus of the laboratory at Groningen is NEWTON's new patent triple rotating electric lantern (N°. 5345 of the catalogue), which is furnished with the patent electric lantern microscope and micro-polariscope N°. 5350, and a BROCKIE-PELL arc-lamp of 40 Ampères. The lantern is placed on an easily movable stand.

necessary independently of the focussing-apparatus described in this communication. During the microscopic projection the automatic centring of the lamp must now and then be corrected by hand and this causes vibrations of the microscope, which are very troublesome.

The block 3 can be moved along the bar 1 by means of a toothed wheel (4). This block 3 originally carried the whole microscope-tube, but now it only supports the tube 9 in which the objective is fitted by means of the tube 6. The rough focussing is done by turning the head 4, while the finer adjustment is effected by means of the screw 5. Every thing that has been described so far belonged to the original apparatus, with the only exception of the objective tube 6 in which the ocular tube 7 can slide in and out, without even at the most outward position admitting any troubling rays of light. Both the objective- and the ocular-tubes have a wider and a narrower part. This is not essential; it was only found necessary to make them thus, in order to be able to use the existing ocular and the existing tube 9, into which originally the whole microscope was fitted. When constructing a new apparatus, it would be better to make both tubes of a uniform width throughout.

I now proceed to describe the details of the new part of the apparatus. The ocular-slide is carried by the cross-beam (10) of cast iron. As it is often necessary in the course of one and the same lecture to use alternately projection of microscopic preparations and other forms of projection, the whole apparatus must be easily removable. For this reason the cross-beam is hinged at one extremity, so that it can be lifted up with the whole apparatus connected with it. In this position the beam is held by a hook, so that the space before the lantern comes free for another front. The other extremity of the beam is in the working position kept down by a catching arrangement, of which a section is shown in fig. *F*. The block *d* is fixed to a projecting rafter of the wall, and carries a catch-spring *b* which keeps the beam in its horizontal position. By the adjustable screw *f* any play which might exist between the beam and the spring, can be abolished. In order to prevent the handle *H* from sliding away from the pin *p* when the beam is lifted up, a rather heavy weight is fixed to the rope immediately above the projecting-apparatus.

The sliding-apparatus itself consists of a base-plate (11) which is cast in one piece with the cross-beam 10. This plate carries two ridges (12) forming a dovetail-guiding for the slide 13, which carries the ocular. This slide carries a ring (14) in which the ocular-

tube 7 is fixed, which again carries the ocular 8. The slide 13 has two projections of half-cylindrical form (*g*), each containing a cylindrical hole. Two rods (*h*) occupy the central lines of these holes. These rods are fixed to the base-plate at *i*, *i*. Their other extremities project through openings in the slide, which can thus move freely in either direction. Round these rods are two spiral springs which are compressed when the slide is moved towards the right, and therefore push it back towards the objective when the rope is relaxed. Round the part of each rod, which comes outside the hollow pieces *g*, is a brass tube which guides the spring and prevents it from bending. This detail is well shown in fig. C.

On the slide is fixed a metal cross-piece which carries at its ends two cylindrical blocks *l* in which the ropes are fixed. These ropes run over the pulleys *m*, *m* and are joined together at a short distance above the apparatus. The combined rope then runs upwards and through the lecture-room to the disc 15 of fig. *G*, of which the diameter is 4 2 c. M. The diameter of the larger disc (16) is 19.4 c.M. The rope is made of twisted metallic wire [1]) of 2.1 m. M. diameter, which is very strong and inextensible. This is necessary with a view to the strong counteraction of the springs of the slide.

In fig. *H* the handle for the demonstrator is shown. The required mean position of the slide can be arrived at, as already explained, by adjusting the length of the rope and the height of the pin *p*. But it may naturally be necessary afterwards to alter that adjustment, either because the rope may have been stretched, or if in a special case it is desired to use another mean position than usually. For this reason the handle is made hollow. The rod *n* can be slid in and out, and can be fixed at any required position by the screw *o*.

During the course of lectures given in 1899—1900 the original wooden arrangement was used, and in 1900—1901 the metal apparatus here described. Experience has led me during this time to consider the apparatus as an indispensable auxiliary for the projecting-microscope.

The apparatus was made according to my plans by the firm P. J. KIPP & SONS, J. W. GILTAY Opvolger at Delft; the rigid mounting for the microscope bar, the double disc and the adjustable handle were constructed by the amanuensis of the botanical laboratory, Mr. J. VEENHOFF.

Groningen, 1901 June 22.

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[1]) „Verzinktes Drahtseil" of C. F. ROCHLITZ, Berlin.