Physiology. — *"Exaggeration of Deep Reflexes."* By Prof. J. K. A. WERTHEIM SALOMONSON.

(Communicated in the meeting of November 28, 1914).

The graphic method of recording pathologically exaggerated deep reflexes sometimes offers interesting results.

In the literature we find mentioned that exaggeration may show itself in different ways. A very slight tap on the tendon produces an unusually brisk contraction: the threshold-value of the stimulus is lowered. But we also read that the latency is shortened, that the duration, velocity and height of the contraction are increased; that a simple jerk may be changed into a tonic or clonic contraction. But even with this knowledge we are not quite prepared for the multiformity of the curves which may be recorded.

I have tried to record the shortening, or more generally the thickening of a muscle, following a tap on its tendon. Of course I found more or less of the changes mentioned before. But the curves seemed to be so absolutely different that I could not be content with the simple statement, that some patients showed one form of curve, some other patients quite another curve. We should like to know at least something about the mechanism of these different forms.

A priori the idea of a change in the form caused simply by exaggeration of a reflex is rather difficult to conceive. We can readily understand that the reflex irritability is increased when an extremely slight tap on the tensor produces a very strong contraction. And this is conformed by clinical examination. But it is now generally understood, — and I think I too have contributed to this opinion -- that the deep reflexes must be considered from a physiological point of view as simple contractions, preceded by one double-phased current of action. As physiological variations in simple muscle-twitches we only know slight changes in height, duration and slope of the curves, caused by fatigue, by temperature etc., if we abstract from the changes caused by direct poisoning. But we do not know of an increased shortening, of a notable change in the latency or of a highly increased duration as long as we consider only simple muscle-twitches.

If the simple muscle-twitch of the quadriceps known as knee jerk be recorded, we find under physiological conditions that the duration of the twitch is very nearly 0.20 second.

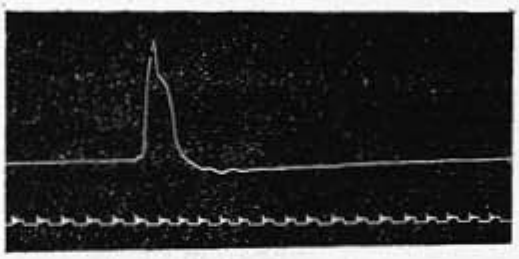

Fig. 1.

In many cases of undoubted exaggeration of the knee-jerk we also find very nearly 0.20 second. Fig. 1 shows such a curve in which the time marks, as in all the other curves in this paper represent 0.1 second. This record mnst be considered as an instance of the simplest form of an exaggerated deep reflex. I can add that this simplest form is rather a rare one and that more complicated forms are more usually met with. All the more complicated forms are characterised by the occurrence of more than one top in the graphical record. Amongst these we must consider in the first place the *simple clonic reflex*, where the simple twitch is entirely absent and replaced by a small series of clonic contractions (fig. 2). These

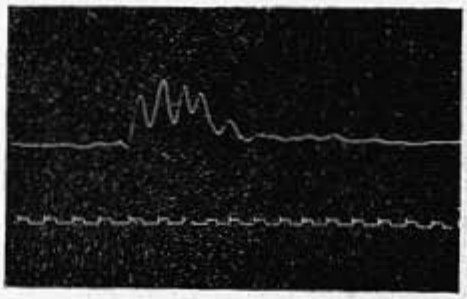

Fig 2.

are generally rather limited in number and we find perhaps only 4—7 contractions in all. But in a few cases quite a long series of clonic contractions may be seen (fig. 3). Curves of this kind may be found in patients where the mechanical and physiological conditions for permanent clonus are present. This means that the reflex irritability as well as the muscle tonus are greatly increased; also that the leg of the patient must be kept in such a position that nothing prevents the occurrence of clonus. Clinically we can find this in patients with organic as well as functional diseases of the nervous system. In functional disorders even the tonic rigidity of the muscles need not be present as a state of active muscle contraction may provide the mechanical condition for a clonus as well as a tonic spasm does.

But under such conditions the clonus generally is not quite as regular as in organic disorders, as is well known. The very short cloni, as in fig. 2, were only seen in organic diseases of the central nervous system.

The complicated forms of deep reflexes, which are now to be considered, offer the peculiarity that after an initial simple twitch, the muscle does not entirely relax, but a state of hardening of the muscle substance persists for a longer or shorter time. This hardening may be caused in at least three different ways.

Fig. 4 represents a record obtained in a patient with chorea minor and shows one of the changes described by GORDON, HEY a. o. as occurring in chorea minor. After the initial simple twitch we observe a second contraction which may be as high or even higher than the first. It begins either at the end of the simple twitch or even a little earlier. In this special case the second contraction showed the short duration of a single twitch, but I have also seen more tonic contractions in the same patient as well as in others with the same disease. The latency of this second contraction is of the order of 0.15—0.20 second and agrees with the latency for a central reaction on a stimulus applied to the peripheral organs of sense. As the probable seat of the lesions in chorea is the cerebrum, we must at least consider the possibility of a central reaction. It seems to me that this supposition is not entirely unfounded. I even think it rather probable, that the deep reflexes are also, at least partially represented at a higher nervous level than the spinal cord. In peculiar circumstances, as in chorea minor, this cerebral part may sometimes appear. I think that this cerebral part of the reflex is answerable too for the so-called pseudo-kneejerk of WESTFAHL, which in rare cases of tabes appears with a latency of about 0.2 second after tapping the knee-tendon or the skin above it. In more than a few cases of functional neurosis I have also seen reflexes as in fig. 4. I have never been able to record those reflexes, which as a matter of fact occurred only the first time that the knee-jerk was elicited; if the reflex was obtained a second time or at a later examination, the cerebral restraining impulse was sufficiently intense to prevent the action of the higher centrum. In chorea this restraining influence has entirely disappeared as well as the faculty of suppressing involuntary choreatic movements.

Records closely resembling those of fig. 4 can be obtained sometimes under totally different circumstances. Fig. 5 was recorded in a case of multiple sclerosis, the patient being nearly paralysed. He is just able to make a few slow movements with his extremely rigid

lower limbs. The kneejerk shows a simple twitch followed by a second and even a third short contraction; immediately afterwards a second kneejerk showed a contraction of half a second's duration following the initial twitch.

In cases like this we scarcely need consider a central origin for the

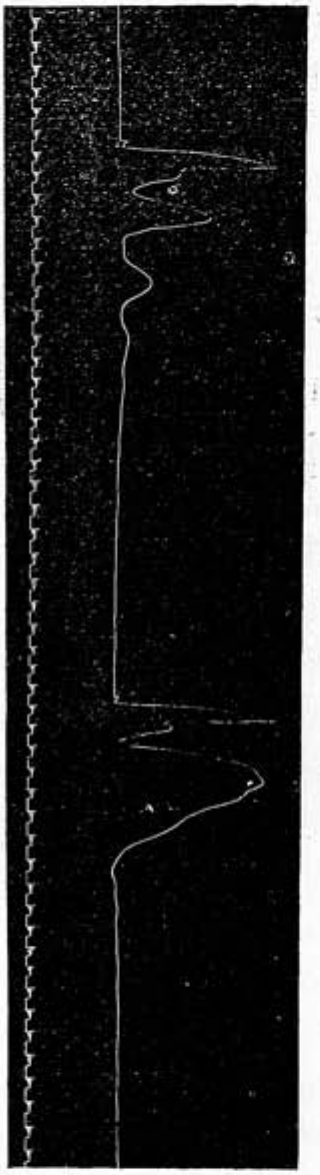

Fig. 5.

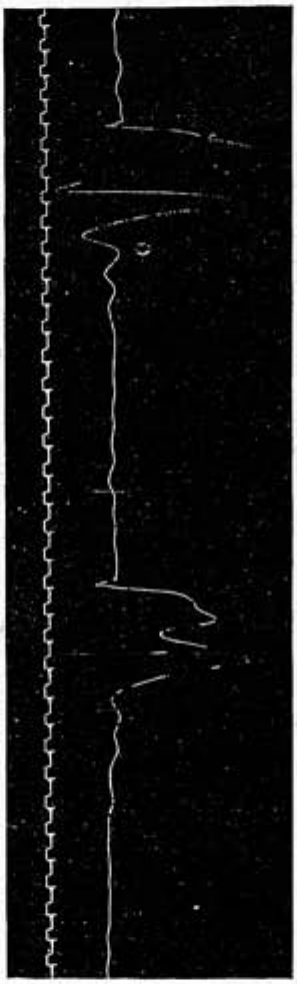

Fig. 4.

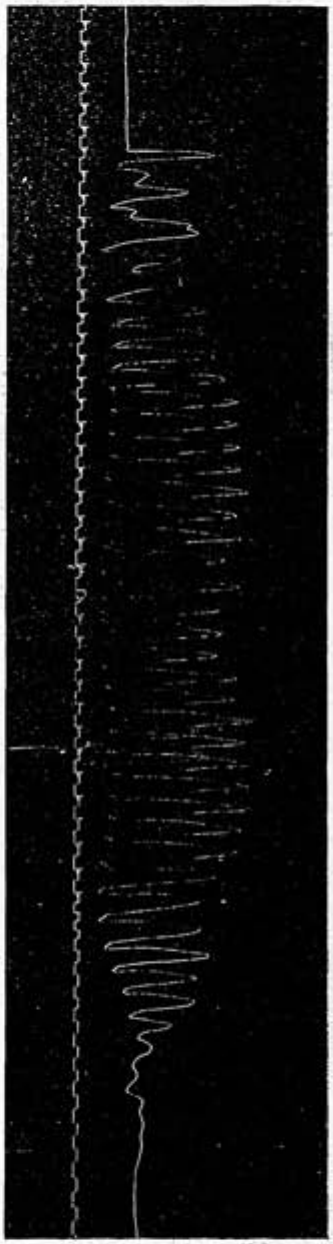

Fig. 3.

second contraction especially as contractions of this kind are sometimes found in completely paralysed patients. In some cases of myelitis or tumor of the spinal cord with complete paralysis we may often see involuntary movements in the paralysed limb. These movements set in after a slight peripheral stimulus, such as a simple touch, or the influence of the lower temperature of the air, or even without appreciable cause; they cannot be prevented or modified by the patient. They may be considered as a spinal automatism. Generally they appear in the form of an adduction or a flexion of the lower limbs, more rarely as an extension movement. But a tap in the neighbourhood of the knee often produces a stretching movement of the leg.

In some records it is not easy to distinguish between a clonus strictiori sensu and an automatism. The oscillations in the curve of

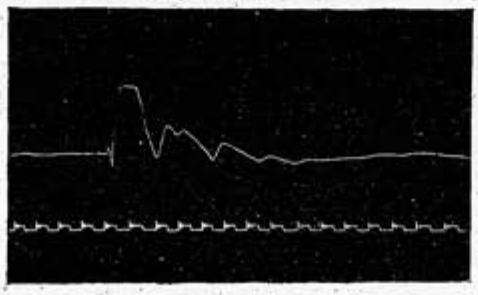

Fig. 6.

fig. 6 are rather slow for a true clonus, the rhythm being not quite 5 per second. For an automatism the rhythm is rather fast. Perhaps we might consider it as an intermediate form: clonus and automatism are sufficiently closely related to render this admissible.

There is still a third possible genesis for the after-contraction. In a former communication on "shortening reflexes" I pointed out, that these are always accompanied by a tonus-reflex, by which the muscle adapts itself to its new condition. As soon as a movement is necessary the muscle tonus is automatically regulated so as to put the muscle in the best condition for doing its work. Therefore we may a priori expect a tonus-reflex at the same time as the deep reflex. As a matter of fact we find that in records of simple deep reflexes, the simple twitch is generally followed by a slight elevation of the curve, indicating that immediately after the real muscle twitch tonus is increased for somewhat less than a second. The beginning of the tonus reflex is not sharply defined, as it starts before the end of the simple twitch. In favourable circumstances this after-contraction

shows a smooth curve; more often we find a clonical after-contraction (fig. 7). Records of this kind are obtained in cases where

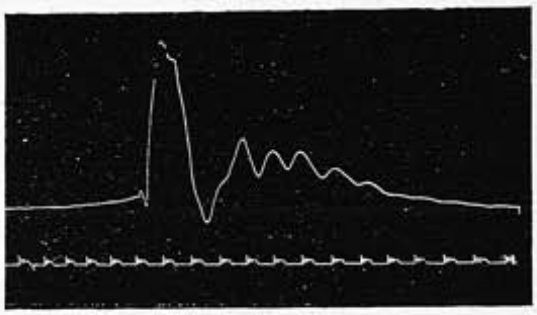

Fig. 7.

in ordinary conditions the tonus is not quite high enough to permit of a clonus. But as soon as a tap on the tendon elicits the muscle twitch and the tonus reflex, the tonus sufficiently increases to render a short clonus possible. This last disappears as soon as the tonus reflex in finished. If we can in some way diminish the tonus before the reflex is obtained, the increase of tonus caused by the reflex may be insufficient for a clonus. In such a case we should be able to provoke either a tonic or a clonic after-contraction, only by lowering or increasing the tonus beforehand. Resting the foot, slight active bending of the knee diminishes the tonus in the quadriceps; supporting the knee and slight passive bending increases it.

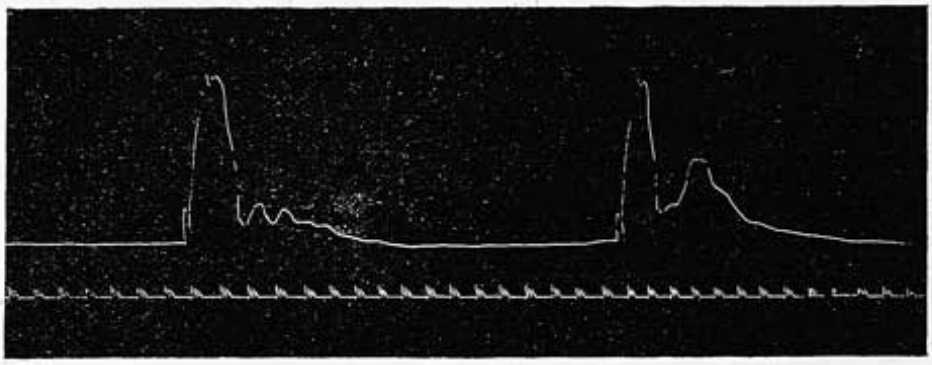

Fig. 8.

Fig. 8 gives a record on which the first reflex shows a clonic, the second one a tonic aftercontraction, which were obtained in this way. With all patients of this kind the tonus is not quite sufficient to admit of a persisting clonus. Only under the most favourable circumstances, as after prolonged exposure to a low temperature, and much care in arranging the most favourable

positions of the lower limbs, we may be able to produce a damped clonus or perhaps even a permanent clonus.

We have now to consider another group of records in which the after-contraction forms the most important and conspicuous part in the whole reflex.

Fig. 9 gives an exceedingly protracted after-contraction of nearly 5 second's duration. Clinical observation shows that this is not a case of spinal automatism. In testing the knee-jerk we find that the leg is extended in the ordinary way, or perhaps a trifle longer, and falls down as in a normal reflex. But we see and feel, that the tendon remains in a state of maximal tension and that the muscle itself retains its condition of increased tonus. Then the tonus disappears slowly and gradually and only after several seconds the original condition has returned. That we have indeed a tonus variation of excessive magnitude before us and not a contraction strictiori sensu, may be seen from fig. 10. This record was obtained from the same patient suffering from diplegia cerebralis pseudobulbaris and shows two knee-jerks in succession, the second being elicited before the first had entirely subsided. The second jerk shows, in exactly the same way as the first a maximal simple twitch, whereas afterwards the tonus was still more exaggerated. As the second jerk gives a record which in this patient must be regarded as a customary one, a real contraction ought to be considered as highly improbable. Neither is the hypothesis of an automatism very alluring, as this patient did not show any other typical spinal automatic movement. Finally the clinical examination showed, that in the almost paralysed patient all changes of the muscle tonus disappeared very slowly, and agreed absolutely with the after-contractions of the knee-jerk.

In another patient with diplegia cerebralis the knee-jerk produced quite a series of interesting movements, as will be seen in the records of fig. 11—13. In fig. 11 we find that the initial twitch can be followed by a protracted tonic aftercontraction, on which either clonic movements with a rhythm of 8 per second are superposed or not. In other circumstances, principally determined by the position of the limb, and the way of supporting it during the examination, I could get a series of automatic movements with a rhythm of about $2^2/_3$ per second. At the same time the clonus of 8 per second remained more or less visible (fig. 12). By a slight change in the way of supporting the knee it was possible to obtain much longer duration of the automatic movements (fig. 13); the more rapid clonus disappeared completely after a few seconds

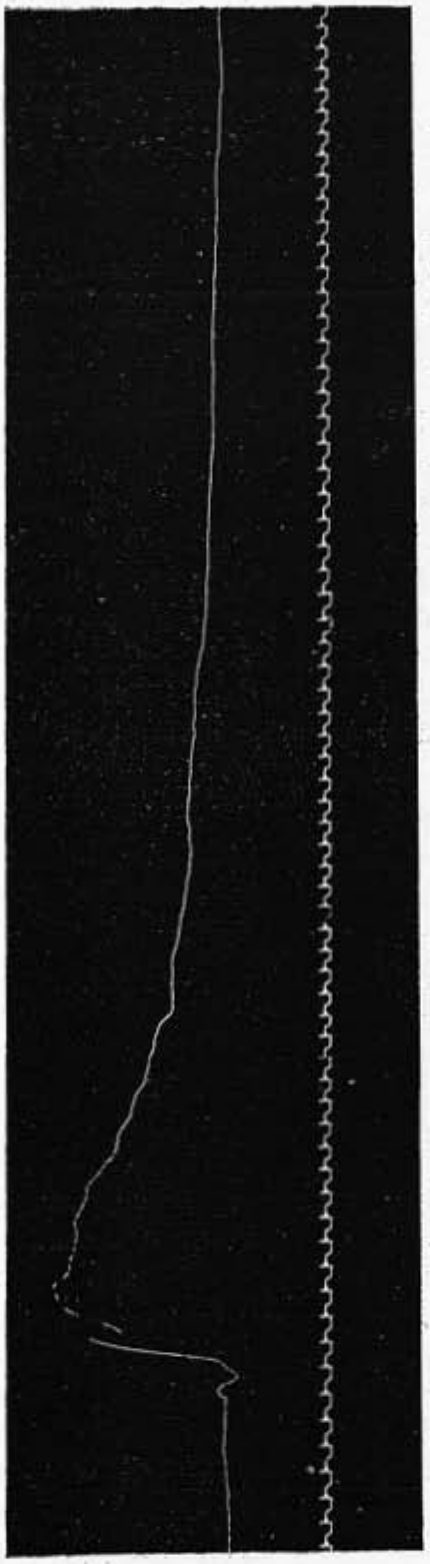

Fig. 9.

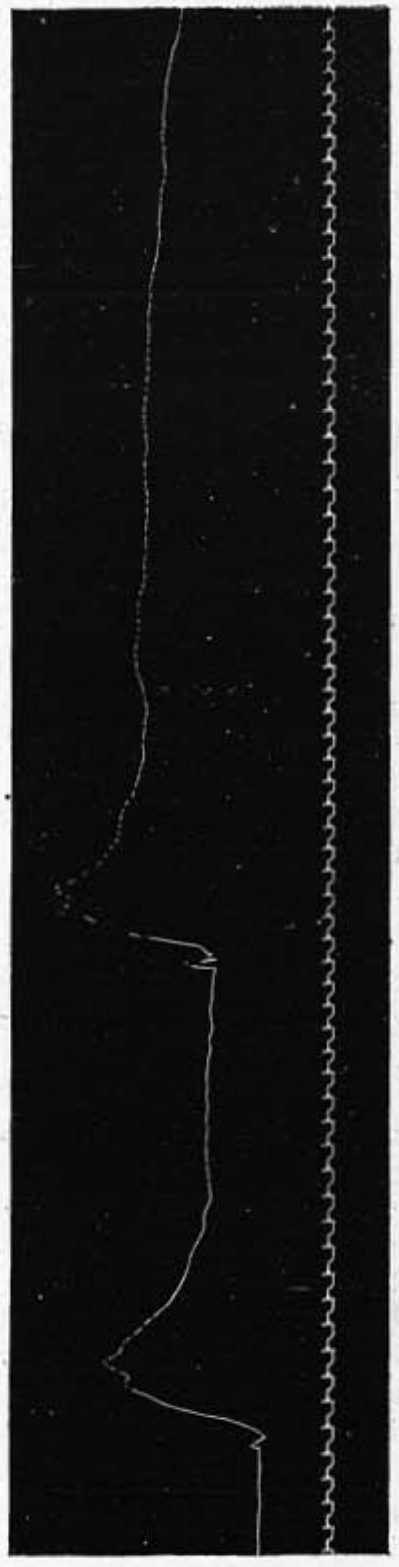

Fig. 10.

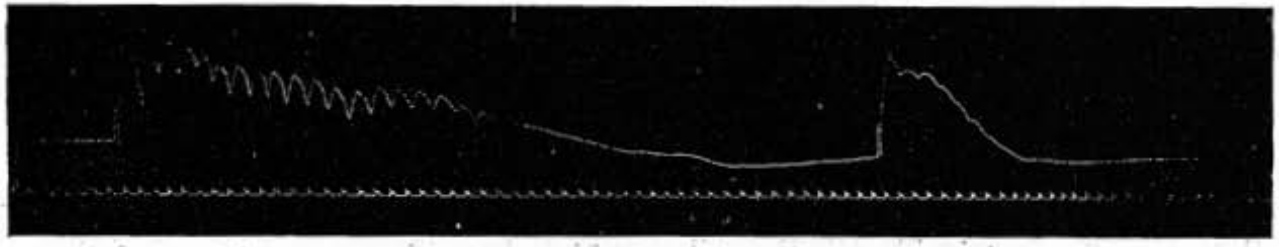

Fig. 11.

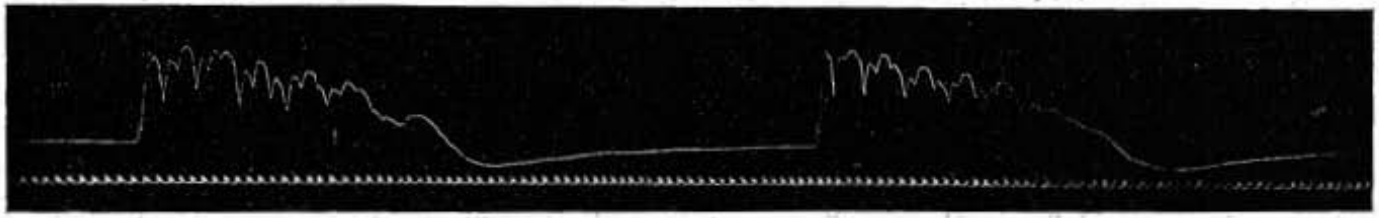

Fig. 12.

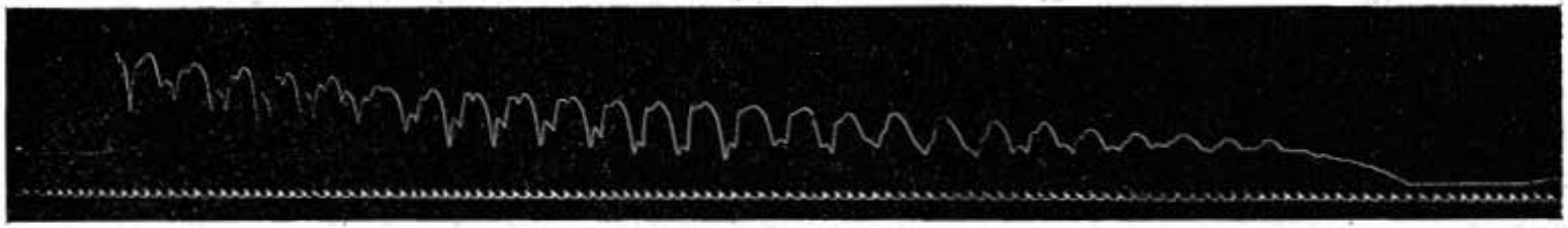

Fig. 13.

and only the slow automatic extension and flexion movement with a rhythm of $2^2/_3$ per second remained visible, often during 30 seconds and longer.

All the records shown in this paper are obtained from the patellar tendon-reflex. Yet their significance is more general, as also other exaggerated deep reflexes sometimes show changes of a similar nature.

Physics. — "*The specific heat at low temperatures.* I. *Measurements on the specific heat of lead between* 14° *and* 80° K. *and of copper between* 15° *and* 22° K." By W. H. KEESOM and H. KAMERLINGH ONNES. Communication N°. 143 from the Physical Laboratory at Leiden. (Communicated by Prof. H. KAMERLINGH ONNES).

(Communicated in the meeting of October 31, 1914).

§ 1. *Introduction.* Soon after the methods of obtaining baths of temperatures which are accurately known and can be kept constant for a long time, in the range between the boiling point and the melting point of hydrogen, had been worked out in the cryogenic laboratory at Leiden, a series of investigations on the calorimetry at very low temperatures was started there. DEWAR's measurements on the mean specific heat of different substances between the temperature of liquid air and the boiling-point of hydrogen [2]) had particularly drawn attention to the interest of those investigations. The continuation of his experiments in the still lower region of temperatures mentioned above seemed very desirable [3]). As was done by DEWAR the series of investigations in this direction was begun by determinations of the heat of vaporisation of hydrogen. A report on the first results of those determinations was given at the Dutch

[1]) Cf. specially H. KAMERLINGH ONNES, Leiden Comm. N°. 01*f* (Proceedings Sept. '06) and H. KAMERLINGH ONNES, C. BRAAK and J. CLAY, Leiden Comm. N°. 101*c* (Proceedings Dec. '07).

[2]) J. DEWAR, Proc. Roy. Inst. March 25, 1904, Proc. Roy. Soc. A 76 (1905) p. 325, later more extensively between the boiling point of nitrogen and that of hydrogen: Proc. Roy. Soc. A. 89. (1913) p. 158.

[3]) This was pointed out at the Ist International Congress of Refrigeration at Paris 1908. H. KAMERLINGH ONNES, La liquéfaction etc. Note I. Sur les expériences à faire aux températures très basses. Leiden Comm. Suppl. N°. 21*a* p. 29.