Prof. Dalby. a plane at right angles to the shaft it was subject to centrifugal force as a whole, and the error from this cause would be greater than if it were arranged round the shaft. He wished to point out that the loss shown between the dynamo shaft and the terminals of the machine included all the interior losses. The machine appeared to Prof. Smith too insensitive in the pulleys—that there was too much weight in them. Many other speakers had thought it too sensitive, so that it was difficult to know how to answer the remark. By tightening the constraining spring the forces acting on the pulleys to keep them in the loops could be increased to any desired amount without causing any increase of friction. The result was that they followed the loops quickly and accurately. The pulleys could be made of aluminium to lighten them, but he did not think they could be made much smaller to be run successfully. It was about the smallest pulley that could be used in order to keep the joint of the band from breaking. With regard to the frame sketched by Prof. Smith, no matter what arrangement was made to constrain the motion of the frames, there must be five points of constraint. If there were more, there would be a redundant number, but a single degree of freedom could not be obtained with less. In Prof. Smith's sketch he had only given a cross-section. If he had added the plan, he thought it would be a more complex frame than the one described in the Paper—it would certainly be heavier. The frames described and exhibited could be very easily made—a boy could file them up. To make an ordinary slide would require a fitter at the Amalgamated Society's maximum wages. He thought that it would be found that to make frames in the way he had suggested would cost much less than if they were made with an ordinary slide.

Correspondence.

Prof. Ewing. Professor J. A. Ewing had enjoyed the advantage of seeing the Author develop his ideas, the dynamometer having been designed and constructed while the Author was still demonstrator in the engineering laboratory at Cambridge. The idea of exhibiting the relative displacement of two parts of the revolving system by means of an endless band was, he believed, a new departure in dynamometry, and it had been well carried out. The Author was especially to be complimented on his design of the kinematic slide in which the guide-pulleys worked. The principle of furnishing just the right number of points of contact to give the desired constraint was one which did not find nearly so much application by engineers as it deserved. Thanks to the application of that principle in the present case, the Author's apparatus worked very smoothly and with conspicuous freedom from friction. It had an open scale, and was sensitive to small changes of load. So long as the load was not liable to sudden fluctuations, that was an advantage, and the Author's dynamometer was found to work exceedingly well when the load was constant or at least fairly steady. It was not so well adapted for a rapidly fluctuating load on account of the absence of anything equivalent to a dash-pot between the fixed and the loose pulleys. The Author was to be congratulated on having produced an instrument which might be of considerable service, and which presented several admirable features as a piece of mechanical design. Prof. Ewing.

The REV. FREDERICK J. JERVIS-SMITH had from time to time for some years worked on dynamometric measurement, and considered that the Author was doing an excellent service to engineers and students of electricity, by bringing before them a machine which gave numerical values of dynamometric tests which were easily observed by means of a pointer moving over a divided scale. He had used spiral springs as a torsional shaft in 1881,[1] but many experiments with such springs had led him to use two solenoidal springs instead of one, the ends being attached to a block keyed on to the shaft, and to the boss of the belt pulley, symmetrically at 180° apart, so that they formed a screw of double thread when in position on the shaft; the symmetrical disposition of the springs contributed somewhat to accurate balancing. The differential method of moving an index or pointer, indicating the torsional angle, devised by the Author, was in theory excellent, and it appeared to have proved itself efficient in practice. In a model of a torsional dynamometer which he had exhibited at the Royal Society in May 1894, an epicyclic differential gear was used to indicate the torsional angle.[2] He used the epicyclic gear to avoid any slip and consequent error; only two elements of the apparatus Rev. F. J. Jervis-Smith.

[1] "Work-Measuring Machines." F. J.-S. Spon. Tract 8vo. vol. 409. Library Inst. C.E.

[2] A Torsion Ergometer, and Differential Gear for Reading the Torsional Angle of a Shaft or Solenoidal Spring Coil, used in the Dynamometric Testing of Screw Propellers; and a Mechanical Integrator. Tract 8vo. vol. 575. Lib. Inst. C.E.

Rev. F. J. Jervis-Smith. were displaced in order to give a direct scale reading of the torsional angle. The Author was to be congratulated on his introduction of the kinematic slide, as it had the great advantage of giving an excellent and reliable result, with but little expenditure of labour upon fitting. He would suggest that as the index moved in a right line over the scale, a record might be easily made on a revolving cylinder driven from the shaft; such a record was in many cases far more valuable than any reading given by a continuous integrator—after the lapse of a known period of time—since it showed by the form of the trace the manner in which the integral was being formed at each instant.