SCIENCE.—SUPPLEMENT.

FRIDAY, SEPTEMBER 3, 1886.

PROCEEDINGS OF THE SECTION OF MECHANICAL SCIENCE AND ENGINEERING.

A CONTINUED improvement was manifest in this section, both in attendance and interest, and it may now be considered as fairly established by the side of the older sections, and likely to become one of the largest in the association.

The most valuable paper presented was one on the 'Strength and proportions of toothed wheels,' by Prof. William Harkness of the naval observatory. This paper, of which about half—over 80 p. foolscap—was presented, is the result of a number of years' work of a most varied and exhaustive character. In twenty-three sections it treats of the form of teeth; mathematical theory of the stress on teeth; review of the formulae of previous authors; spur and bevel wheels with iron, brass, and wood teeth; shrouded pinions; sizes of pinions; coefficient of safety; maximum pitch; relation of pitch to face; length of teeth; their thickness; strength of rims; relations between rim and tooth dimensions; sizes and number of arms; naves; keys and bosses; weight and kinetic energy; applications to special cases; recapitulation of formulae; bibliography. In designing clockwork for the transit of Venus and other purposes, the author found no formulae upon which he could rely, those in use giving results widely different from each other, in exceptional cases showing differences of fifteen hundred per cent; he therefore set about determining, in a scientific manner, a formula upon which some reliance might be placed. We have already had occasion to call attention to the remarkable results accomplished when a mechanical problem is attacked in this way. The work of Professor Rogers in developing a method by which precision-screws are economically furnished for machine tools, showed how an astronomer could handle a practical problem, and Professor Harkness has worked by the methods of higher mathematics. He has made and collected a large number of measurements of gears in actual use and of recognized good proportions, and after ascertaining, by the principles of mechanics, the general shape of a correct formula, he has applied the method of least squares to determine the exact form of the same, with the values of the constant terms, which would best agree with these measurements. Over forty authors on the subject are reviewed, from Buchanan, 1808, and Tredgold, 1825, to Redtenbacher, Weisbach, and Reuleaux. One formula, given by Roberton in 1808, was shown to be absurd by Carmichael in 1814, but was nevertheless copied by Farey in 1827, in an excellent work on the steam-engine, and has been in use ever since. Roberton's proof of the formula was that from his experiments he was satisfied he could not be far wrong. In one author, marked, and indeed unlooked-for, advantages appear from the use of the metric system; in a wheel of 2.30 m. diameter, calculated by means of it, the number of teeth is reduced to one tooth 3.21 m. thick and nearly one space. Another uses figures in a demonstration which, interpreted, require that a brass tooth half an inch thick and one inch wide shall carry 13,000 pounds, though the author by mistake got it 130 pounds. 500 representing the safe amount, attention was called to the heavy tooth-stresses of 800 to 900 customary in watches and chronometers, and to that of about 1900 in spring clocks. When put in print, this work cannot fail to be of great and permanent value.

Prof. W. A. Rogers, as chairman of the committee on accurate standards, tools, and methods in the machine shop, gave an account of his work in that direction, and presented a résumé of his experiments in the use of the microscope in connection with machine tools. In this method, dimensions are read through that instrument from accurately divided scales, or, in some cases, determined by calipers or gauges accurately set by means of a comparator. By this system the workman receives from the tool-room of the shop the necessary number of calipers accurately set to the required dimensions by a skilled attendant in charge of the comparator. It is evident that in this way a high and uniform degree of accuracy may be obtained, with much saving of time and avoidance of errors, in which latter respect we would suggest that calipers be returned to the tool-room unchanged, and their settings checked. For all good work, these methods must supercede the present inaccurate and inconvenient use of scales of but moderate precision, and the setting of calipers by the workman, and they will obviate the necessity of the present expensive standard gauges.

The sort of work done by these gentlemen will mark an era in the development of machine construction.

Professor Webb of Hoboken presented his method of determining maximum points and stresses in bridge inclines, which are applicable to trusses of the most irregular form, and to any style of loading, irregular or uniform. The method, as applied to the graphical determination of strains, was illustrated by blackboard sketches and finished drawings, and some of the features of a new notation were explained.

Prof. De Volsen Wood contributed two valuable papers in mechanical engineering. In one of them he showed, by diagram and analytical processes, the application of the equation of 'moment of momentum' to the case of turbines, explaining abstruse points in the action of the latter; in the other, he called attention to the effect of variations in speed upon cylinder condensation, illustrating the same by experimental figures. The section, and indeed the profession, should congratulate itself upon the acquisition of men who bring to their work not only a natural and cultivated knowledge of mechanics, but an intimate acquaintance with and great facility in the use of the higher mathematics. The professor's genius for imparting knowledge is also well known.

The committee on the best methods of teaching mechanical engineering reported that papers would be read upon the subject by a member of the committee and by Dr. Thurston. Professor Alden is an earnest advocate of manual training, and sums up in these four propositions: "Manual processes in education must be primarily for the acquirement of knowledge and discipline;" they "should be such as are adapted to the development of powers, faculties, and habits of mind which have been but little cultivated in the schools;" those "involving the use of tools and construction should be confined to properly designed structures, and should be taught and supervised by experts capable of producing the best quality of standard practical work;" they "should be restricted to those operations for which suitable facilities are provided for carrying out the operations in a practical and thorough manner."

Dr. Thurston outlined the differentiation which has occurred in the profession of engineering, and in engineering schools, defining the titles 'engineer' and 'engineering,' and showing how different the training necessary for each branch of the profession. He called attention, also, to the relation of technical to the ordinary academic education, considering the natural and correct course to be, first, the giving of a general academic, next, a general professional education, and, finally, a special professional training. The usual course has been, too commonly, an attempt to omit real education and to provide only professional training. He thought that the graduate degrees are likely to be, generally, civil engineer, mechanical engineer, mining engineer, etc., etc., and he suggests the conferring of second degrees, if not of the doctorate. The titles 'master in civil engineering' and 'master in mechanical engineering' are already given, and that of 'doctor of engineering' has been given as an honorary degree, no reference being made to the branch in which the recipient labors. The establishment of the latter degree in course is advised.

Dr. Woodward of St. Louis, who has during the past year investigated some of the foreign technical schools, led in the discussion, calling attention to the necessity of using books in connection with manual training exercises to insure a knowledge of the underlying principles. He held also that it is not the amount of instruction that counts, but its quality; and he objected to the attempt to thus train those who are too young to profit fully by it. Dr. Thurston, Professor Wood, and others followed.

Mr. Wm. Kent laid before the society the details of his scheme for an American academy of engineering, which should be composed of the cream of the civil and military, mechanical, mining, electrical, and sanitary engineering societies, with yearly accessions therefrom by regulated and impartial election. It was held that men, organization, and money were all that were needed, and that the first were ready, the second proposed, and the third sure to come. This academy is to be of such high standing as to be the sought authority in all matters of government and civil engineering work, and is to be the custodian of donated and government funds for scientific research, for which purpose expensive and various working laboratories and a library would be required. Many features of the scheme recommended themselves strongly, and such laboratories would doubtless be of immense advantage to the country. The discussion showed marked approval of the scheme, and a valuable suggestion was offered by Dr. Woodward and Professor Webb, to the effect that the granting of masters' degrees to engineers should be in the hands of such a body, in order to protect society from incompetence in these professions. It was felt, too, that the various societies are getting too widely separated, and should in some such manner be brought together.

Dr. Thurston read a paper on the friction of the non-condensing engine. The friction of an engine has been supposed by De Pambour, Rankine, and others, to consist of a constant and a variable part, the resistance of the engine unloaded, the other the increase produced by the fact of its doing work. The last quantity is taken, by De Pambour, as ordinarily about fourteen per cent

of the total resistance due the load. As the result of some experiments, "it is found that the friction of the high-speed non-condensing engine, such as is used in electric lighting, is, under standard conditions, practically constant at all loads, but is variable both with speed of engine, and with steam pressure."

Dr. Thurston exhibited a photograph, and described the great dynamo recently designed by Mr. C. F. Brush, for the Cowles electrical smelting and aluminium company of Cleveland, Ohio, and Lockport, N. Y.

Two papers were read on civil engineering subjects, one with reference to the improvement of harbor and river channels, by Prof. Lewis M. Haupt, and the other upon the difficulties met with in the Panama canal, and the rights which France will be disposed to assume in that connection.

Professor Haupt maintained that all structures of any considerable magnitude and weight, intended to regulate currents, and which rested on, or depended upon, sandy or alluvial bottoms for their support, violated to a greater or less extent the fundamental requirements that they should not oppose the ingress of the tide, nor injuriously modify the currents; also that dikes or jetties were to a great extent below the zero plane or plane of action of waves of translation, and were dependent for their strength upon their mass, and that this was frequently composed of individual fragments of small dimensions, not cemented. It was stated that all such constructions occupy a large volume, produce great pressure and leverage, are wasteful of time and materials, result in serious modification in the regimen of rivers or harbors, are unnecessarily expensive, and if improperly located, they cannot be readily changed. In contrast with this, the professor then suggested a solution, consisting of a floating system of deflectors intended to be attached to buoys or floats, and anchored to heavy moorings, composed of ground chains, held in place by screw discs sunk considerably below the bottom, and proceeded to describe his system.

As a set-off to the papers of more certain value, and perhaps for purposes of recreation, the section listened to a paper detailing observations and experiments, mixed up with some remarkable theories upon the flight of birds, and the serious business of the meeting being over, a last session was devoted to a continuance of the discussion thereon. A letter to the following effect received from a member explains to some extent this action of the section: "In order that this investigation may not be dropped, you may announce that if the gentleman will successfully reproduce before the section the experiments for which he vouches, i.e., if his apparatus, without moving mechanism or outside assistance, supports itself in still air, and moves against a current of air without falling, I will give fifty dollars as a prize for the best paper on the subject, at the next meeting."

An extract from the abstract furnished will also explain to a sufficient extent, for any one acquainted with the laws of mechanics, the supposed peculiar action of gravity in favor of soaring birds. According to the abstract, 'explanations of soaring flight' have been failures, and the 'gravity of the bird's mass' must be resolved 'by the plane of the wings under the law of fluid pressures, and Newton's third law of motion,' in consequence of which 'artificial birds or effigies' 'will imitate the soaring birds,' and 'move against the wind indefinitely!' The abstract concludes with something like a new law in mechanics: "The gravitating force is a continuous motive power when forcing a properly constructed plane to work on air in a certain definite manner, of which the soaring birds are examples." We have often brooded, in that part of our imagination devoted to the figures of mathematics and plus and minus quantities, over the pleasure it would afford to physicists, and ordinary people, could some way be found of changing at will the algebraic sign of gravity or producing negative mass, so that a body might fall upward, but we were scarcely prepared to hear that it could be accomplished by so simple a device as a bird's wing, rough in one direction and smooth in the other, — but the section no doubt needed recreation.

PROCEEDINGS OF THE SECTION OF ECONOMIC SCIENCE AND STATISTICS.

THE programme of this section was popular and varied, as usual, for, besides contributions strictly statistical and bearing upon social and political economics, it is customary to refer to the section all papers which are philosophic rather than technically scientific, or which, although based upon sound science, are in an especially popular form. The casual visitor, after being wearied, puzzled, and confounded in the rooms of the other sections, usually finds in this one something interesting and instructive, and its audiences are largely local in character. The Buffalo sessions have been no exception to the rule. The meetings of this section have been well attended, and while the standard of the papers read has been hardly equal to that of last year, when Mr. Atkinson so well led the way, the average has been good, and the section has been comparatively free from the attacks of socialistic and economic cranks, to which it is especially subject.

Following appropriately the address of Vice-