of service. The term professor, as here used, is understood to include presidents, deans, professors, associate professors and assistant professors, in institutions of higher learning.

2. Retiring allowances shall be granted under the following rules, upon the application of the institution with which the professor is connected, and in the application it should be clearly set forth whether the retiring allowance is recommended on the ground of age or service.

3. In reckoning the amount of the retiring allowance the average salary for the last five years of active service shall be considered the active pay.

4. Any person sixty-five years of age, and who has had not less than fifteen years of service as a professor, and who is at the time a professor in an accepted institution, shall be entitled to an annual retiring allowance computed as follows:

(*a*) For an active pay of sixteen hundred dollars or less, an allowance of one thousand dollars, provided no retiring allowance shall exceed ninety per cent. of the active pay.

(*b*) For an active pay greater than sixteen hundred dollars, the retiring allowance shall equal one thousand dollars, increased by fifty dollars for each one hundred dollars of active pay in excess of sixteen hundred dollars.

(*c*) No retiring allowance shall exceed three thousand dollars.

5. Any person who has had a service of twenty-five years as a professor, and who is at the time a professor in an accepted institution, shall be entitled to a retiring allowance computed as follows:

(*a*) For an active pay of sixteen hundred dollars or less, a retiring allowance of eight hundred dollars, provided that no retiring allowance shall exceed eighty per cent. of the active pay.

(*b*) For an active pay greater than sixteen hundred dollars, the retiring allowance shall equal eight hundred dollars, increased by forty dollars for each one hundred dollars of active pay in excess of sixteen hundred dollars.

(*c*) For each additional year of service above twenty-five, the retiring allowance shall be increased by one per cent. of the active pay.

(*d*) No retiring allowance shall exceed three thousand dollars.

6. Any person who has been for ten years the wife of a professor in actual service may receive during her widowhood one half of the allowance to which her husband would have been entitled.

7. In the preceding rules, years of leave of absence are to be counted as years of service, but not exceeding one year in seven. Librarians, registrars, recorders and administrative officers of long tenure, whose salaries may be classed with those of professors and assistant professors, are considered eligible to the benefits of a retiring allowance.

8. Teachers in the professional departments of universities whose principal work is outside the profession of teaching are not included.

9. The benefits of the foundation shall not be available to those whose active service ceased before April 16, 1905, the date of Mr. Carnegie's original letter to the trustees.

10. The Carnegie Foundation for the Advancement of Teaching retains the power to alter these rules in such manner as experience may indicate as desirable for the benefit of the whole body of teachers.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.
SECTION D—MECHANICAL SCIENCE AND ENGINEERING.

THE meeting of the section for organization was held in the engineering building of Tulane University. The following officers were elected to serve during the meeting:

Councilor—F. O. Marvin, professor of civil engineering, University of Kansas, Lawrence, Kas.

Member of the General Committee—G. W. Bissell, professor of mechanical engineering, Iowa State College, Ames, Iowa.

Member of the Sectional Committee, 1906 to 1911—J. B. Webb, professor of mathematics, Stevens Institute of Technology, Hoboken, N. J.

The secretary of the section was elected press secretary.

The vice-president of the section, Fred W. MacNair, president, Michigan College of Mines, Houghton, Mich., served as chairman of the section.

Owing to the small number of members in attendance, it was decided to combine the programs of Sections D and B in two joint sessions. These proved to be of general interest and value. The report of the papers offered in Section B will be found on pages 415 to 421 of the issue of SCIENCE for March 16, 1906.

The first paper was read by Fred W. MacNair, president, Michigan College of Mines, Houghton, Mich., and described 'An Experiment on Easterly Deviation beneath the Earth's Surface,' which he had made in the No. 5 shaft of the Tamarack Mine. A detailed report has already been published on page 415 of SCIENCE. It might be added, however, that the experiment of dropping a steel ball from the top of a shaft forty-two hundred feet deep and finding it lodged in the timbers at a depth of only eight hundred feet from the surface, adds but another example to the general experience that bodies which are dropped in a mine-shaft seldom reach the bottom.

A paper by A. S. Langsdorf, professor of electrical engineering, Washington University, St. Louis, Mo., on 'A New Type of Frequency Meter,' was read by the secretary and was published in *The Electrical World*, Vol. 46, page 1029, for December 16, 1905. The device was originally described by the author.[1] It was independently conceived by Mr. J. F. Begole, of the Wagner Electric Manufacturing Company of St. Louis, and has recently been placed on the market. The principle involved in this instrument is based upon the fact that if an alternating (sinusoidal) electromotive force of E volts and frequency $\omega (= 2\pi n)$ is impressed upon a condenser of capacity C farads the current will be

$$I = E \omega C \text{ amperes.}$$

In other words, for a given value of C, the indications of an ammeter will be proportional to the frequency, provided E remains constant, in which case the scale of the ammeter could be graduated to read directly in cycles.

It is of course evident that the assumption of constant electromotive force is not justifiable where commercial circuits are concerned. If the scale of the ammeter mentioned above were graduated to read cycles, a change in line voltage would be recorded as an apparent change in frequency. This difficulty can be overcome, however, if the scale of the ammeter is itself movable and pivoted on a line coaxial with that of the pointer or indicator of the ammeter; if the motion of the scale, due to a change of voltage, is made equal to, and in the same direction as, that of the ammeter needle, there will be no relative motion between the two, and the reading will remain unaltered.

To secure this compensating scale motion, the scale need only be attached to a wound bobbin which is constructed in all respects like that of an ordinary voltmeter, this voltmeter winding being then connected across the line.

In the instrument as built the bobbin to

[1] *Proc. American Association for the Advancement of Science*, Vol. LIII., 1904, p. 380.

which the pointer is fastened, and which carries the condenser current, is mounted either directly above or below the bobbin which carries a graduated scale. Advantage is taken of the fact, suggested by Mr. Begole, that the instrument is a combined voltmeter and frequency-meter.

Carl Kingsley, of the department of physics, University of Chicago, presented a paper which was read by abstract on 'A Critical Analysis of the Methods of Supplying Power to Branch Telephone Exchanges on the Common Battery System.' The five possible methods are considered, and three of these are chosen as most worthy of critical analysis. In each of the three cases the total costs are determined in terms of the distance from the central and the total energy to be supplied at the branch exchanges. Three equations are obtained, each of which contains the three variables, cost, distance and energy. For any particular exchange, the method of supply can be, therefore, readily chosen, which will give the minimum cost of operation. Complete curves have been drawn and a graphical solution of the problem can be obtained by inspection.

D. S. Jacobus, professor of experimental engineering, Stevens Institute, Hoboken, N. J., read and illustrated a paper giving the results of his experiments on 'The Difference in the Coefficient of Discharge of Steam through a Single Circular Orifice in a plate and through a Number of Circular Orifices in the Same Plate.'

The flow of steam through an orifice in a plate was determined and compared with that obtained when six orifices of the same size were placed near each other in the same plate. The flow per orifice was about 14 per cent. greater than with a single orifice. This shows how important it is to consider the conditions which exist on the exhaust side of the orifice. The experiments also showed that the position at which the pressure on the exhaust side of the orifice was measured was an important factor, as this pressure varied considerably when measured at different distances from the orifice plate.

The orifices were 3/8″ in diameter. The pipe conveying steam to the orifice plate and conducting it away from the same was 2″ standard size. The orifice plate was placed in a flange union. The single orifice was at the center of the plate and the six orifices were arranged with one orifice at the center and five midway between the periphery of the center orifice and the inside of the pipe. The pressure on the high-pressure side of the orifice was about 147 pounds per square inch, and on the discharge, or low-pressure, side, about 105 pounds per square inch. The pressure on the discharge side was measured at a considerable distance from the plate in order to avoid a jet action which existed at a point near the plate, which caused the pressure near the plate to be less than at some little distance from the plate.

In a second paper he discussed the subject of 'Priming caused by Poor Circulation in a Boiler,' and described experiments which he had made.

A small vertical tubular boiler of about fifteen rated horse-power was employed in the experiments. This boiler was of the ordinary construction with a water heating surface enclosing a circular grate and with tubes leading directly upward from the combustion space above the fire to the upper tube sheet at the top of the boiler. The steam was taken from the boiler at a point in the outer shell near the top of the boiler. When the boiler was run under normal conditions the steam generated was dry for ordinary rates of combustion, and superheated when the boiler was forced to a high capacity.

In this class of a boiler, the temperature of the flue gases escaping from the tubes near the center of the tube sheet is much higher than that of the gases from the outer tubes, and tests were projected to determine whether there should be a gain in the economy through placing retarders in the center tubes so as to more evenly distribute the work done by the different tubes. In these tests the retarders were so adjusted that the temperature of the escaping gases was made about the same for each of the tubes. After this was done there was an unexpected action through the boiler priming so severely that it was impossible to run it at other than a low capacity. The water level would be constant for a short time and the steam would be dry, when suddenly foam would appear in the gauge glass and water would be thrown from the boiler along with the steam. On removing the retarders the priming disappeared, and on replacing them it was again present. It therefore appeared that the retarders caused the priming, and it remains to explain how this could be so.

It seems evident that the priming was caused through a lack of proper circulation in the boiler. Without the retarders the tubes near the center of the boiler were hotter than those near the side and caused an upward current of water at the center of the boiler, and a downward current at the sides, and the circulation was a brisk and definite one. With the retarders, however, all the tubes were at the same temperature and there was no tendency to produce a definite circulation so that the water was quiescent for a time, and after storing a certain amount of heat, it would foam up and some of it would be thrown from the boiler.

A paper by Paul C. Nugent, professor of civil engineering, Syracuse University, Syracuse, N. Y., on 'The Dual Degree for Engineering Courses' was read by the secretary.

In the College of Liberal Arts of Syracuse University, the best students are graduated with 'honors' of one of three grades. It has been suggested to adopt the practise in the college of applied science. Its object is to reward merit and to stimulate the student to more strenuous efforts to gain a high standing in his class, and to thus result in graduating a better class of men. The first purpose is in a measure fulfilled. It is doubtful whether the second is accomplished at all.

He reviews the two systems for granting degrees now in use in engineering colleges, namely, granting the engineering degree at the end of a four years' course, and secondly granting the degree of bachelor of science at the end of the undergraduate course, and the full engineering degree on the completion of a year or more of postgraduate work, or two or three years of practical work and on presentation of a thesis. He is strongly in favor of granting the full engineering degree at the end of the four years, and claims that engineering can be taught just as practically and just as professionally as is medicine, and that the engineering graduate is as much entitled to the professional degree as the medical graduate is to the medical degree and the title of 'doctor.'

The author then suggests a fourth plan:

At the end of the regular four-year course, let two degrees be granted, the B.S. being given to those who have passed in all required subjects, but have failed to attain a certain set grade for all the work of the last three years. This plan places the engineering degree on a higher plane than that occupied by the baccalaureate. It is thought that many students who would not care whether they graduated with 'honors' or not would redouble their efforts when it came to graduating as an 'engineer.' Another result would be that almost every engineering graduate would be a man to whom his college could point with confidence and pride. The B.S. men might be permitted to return for a year to obtain the full degree. The dominant thought of all such work should be quality and not so much the teaching of new things as the better teaching and more thorough teaching of the old: it should aim to produce better reasoning powers and general ability in the student, and failing that, the full degree should never be granted.

The paper received considerable discussion and elicited much opposition. Engineering professors, as a rule, seem to be quite well satisfied with the present practise of their respective institutions.

A paper by Mr. Fullerton L. Waldo, of New York, N. Y., was next presented on 'Panama: A Discussion of the Present Conditions and the Prospects.' The paper is true to its title, discusses the various reports of the present conditions, gives examples of these conditions, shows why they are so, and then bears worthy tribute to the character, integrity and engineering ability of the canal commissioner, the late George S. Morison.

Mr. Morison insisted that we must take two years to clean up the mess left by the French, to burn the hovels, to drain the swamps, to petrolize the breeding places of the mosquito, and to build clean, wholesome houses for the men. He went down there himself and put his fingers into the dry-rot, and found there the seeds of his own mortal illness. Whitewash, either in engineering or in politics, could not fool him. Had he lived, he might have been able to check the tendency to 'hustle' in the scrambling ambition to make dirt fly, simply that the foolable part of our country's population might be deceived by the specious appearance of 'something doing.' All calamity howlers to the contrary notwithstanding, the canal is as sure to be built as that a natural law is certain of fulfilment; and those who to-day busy themselves trying to find arguments against it are going to be ashamed and sorry when the seas are eventually linked by the greatest engineering undertaking in the history of mankind.

Mr. Waldo speaks knowingly and 'makes clear the fundamental soundness of the Panama Canal proposition, and the nature of the temporary difficulties which have hampered the execution of the plans.'

Mr. Worcester R. Warner, of Cleveland, O., who spent a week on the Isthmus in the winter of 1904–5 with the congressional committee, presented a paper on his 'Observations on the Panama Canal,' which was read by the secretary, showing why he is more convinced than ever that the sea-level plan is the only one that our government ought to adopt. He states:

The cause of the failure of the French Company was primarily, and almost wholly, due to maladministration, which is indicated by the ruins of expensive machinery now lying along the route of the canal, more particularly near the Atlantic terminus. Twenty-five years ago, the control of the Chagres River was considered the difficult problem; now it is considered only ten or fifteen per cent. of the problem. Now the great difficulty is the excavation of the material from the Culebra cut. The great wonder of the canal is that so much of it is practically level. From Colon to Gamboa, the fall is only two feet per mile for twenty-eight miles. Ten miles at the Pacific end of the canal compares in grade with the Atlantic end. This leaves about ten miles through the Culebra cut, which can be considered as embodying practically all the difficulties in excavation.

If a sea-level canal is constructed, a dam will be required at Gamboa, where there is splendid foundation for it, and it would make an artificial lake with sufficient capacity to care for the largest freshets whose waters would be drawn off towards the oceans by routes other than the canal bed. Sufficient water would be let into the canal to provide the necessary power for generating electricity for lighting and power purposes. On the other hand, if a lock canal is constructed, a dam 2,000 feet long must be built at Bohio, and possibly another at Gatung, on foundations which are found only at 150 feet or more below sea level, and they can be constructed only with the greatest trouble and at an enormous expense. That a dirt dam at Bohio has been suggested seems hardly credible.

When we consider that the maximum height of the canal at the beginning was less than the height of some of our modern buildings, and that the French Company reduced that height to 150 feet above sea-level, which is practically the height of our nine or ten story buildings, and further, that this height extends only for less than ten miles, Mr. Warner is confident that if the present Congress does not direct a sea-level canal to be built, that the next one will, for our government engineering works in the past have not been conducted on the 'penny-wise and pound-foolish' plan.

One other argument should be mentioned, and that is that without exception the great engineering works of the present generation have proven themselves too small and too limited. This is illustrated by the 'Soo' canal, the first locks of which were discarded years ago and larger ones built, which are soon to be replaced by others still larger. If the Panama Canal is built on the sea-level plan, it can be enlarged without interfering with traffic and without difficulty. On the other hand, if a lock system is used it is limited, and can not be enlarged without being rebuilt.

The vice-presidential address was delivered by Professor Jacobus in the assembly room of Gibson Hall. The subject which he chose was 'Commercial Investigations and Tests in Connection with College Work.' It was concurred in and heartily appreciated by the members of the section and association who had the pleasure of listening to it. It was published in full in the issue of SCIENCE for January 19, 1906, and will be found on page 92. It was also published in the January issue of the *Stevens Institute Indicator* (Vol. XXIII., p. 7). The author quoted Mr. Walter C. Kerr, in connection with his work as trustee of Cornell University, as being in favor of the plan that a professor shall be thrown upon his own resources and be compelled to work in the practical field one year out of seven. It seems that the author was misinformed as to Mr. Kerr's real meaning, and that Mr. Kerr has called his attention to the matter in a letter which will be found in the April issue of the *Stevens Institute Indicator*. Mr. Kerr explains his ideas at some length, and includes a memorandum on the subject which he made to President Schurman. Eight other letters are included commending the substance of this address and pleading for the more intimate connection of engineering professors with actual practise.

It gives the secretary much pleasure to state that the Society for the Promotion of Engineering Education has decided to meet at Ithaca June 29 to July 3 as an 'affiliated society' of the American Association for the Advancement of Science. It is probable that one or more joint sessions will be held with Section D during the meeting. In view of this, the sectional committee has decided that there shall be a summer meeting of Section D. The members of the association are requested to submit their papers by abstract at as early a day as possible. Papers on the science of engineering education, its problems and its advances, and on municipal ownership from the engineering point of view, are especially requested.

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PANAMA: A DISCUSSION OF PRESENT CONDITIONS AND THE PROSPECT.[1]

WHEN a certain prominent member of the engineer corps returned to New York in the fall, after a year's residence at Panama, he declared the working force on the isthmus was badly demoralized on account of the defection of native labor, the resignation of John F. Wallace, the yellow-fever scares, and the excessive humidity, which decreases one's vital energy in the tropics fully fifty per cent. It is now about eight months, he said, since Wallace resigned, and the Shonts Commission, with Stevens as chief engineer, took hold of the work. In May, 1905, the yardage excavated had dropped to 70,000, as compared with 130,000 in April. The figures for June showed a further retrogression. Accordingly, by order of Chief Engineer Stevens, all work was stopped on the canal excavations, and the energies of the force were diverted to sanitative work—the building of houses for the men, cisterns and pipe-lines and reservoirs for drinking-water, sewers to drain a country which has been innocent of sewer-systems and plumbing for four centuries. This is the work which the distinguished engineer and canal commissioner, George S. Morison, said would have to be done in advance of canal excavation, and he allowed two years for it. Governor Magoon has built a reservoir twelve miles from Panama and installed a first-class system of water-works. Two thousand houses of the French have been repaired, new barracks built, and Dr. Gorgas has been doing a magnificent work in eradicating the breeding-places of the mosquito, and purging the whole region of the agglomerated filth of the Spanish occupation.

The necessary action of Chief Engineer

[1] Read at the New Orleans Meeting of the American Association for the Advancement of Science, Tuesday, January 2, 1906.