

THE NEW RAILROAD STATION AT COLOGNE.

THE new railroad station at Cologne was opened informally on May 27, 1894. According to the *Illustrirte Zeitung* (to which we are indebted for the accompanying engravings and the following data), this is the handsomest station in the world, and there is only one, the station at Frankfurt, that is larger; 103 acres of ground were required for the structure, and 140 houses had to be pulled down to make room for it. It is a masterpiece of technique, and during the whole eight years required for building it the regular work of the road, although so extensive, continued undisturbed, and there was not a single accident to travelers. That part of the road that extends from the bridge over the Rhine to the wall passes over sixteen streets, including the Hansaring, which is 131 ft. wide.

As the tracks had to be raised about 15 ft. above their former level at the main station, the entire roadbed was correspondingly elevated. For this purpose the two tracks from the middle of the bridge to the solid roadbed were raised about 3 ft. (a difficult undertaking, as it was necessary that one track should always be ready for use), and where it intersects the wall the track is more than 9 ft. above the street, then the roadbed sinks to the level of the ground.

The station proper consists of the reception building (541 ft. x 164 ft.), and behind that and 15 ft. higher, the covered space for the tracks (828 ft. x 303 ft.), with the building containing the waiting room between the tracks. The reception building was constructed from the plans of Prof. Frenzen, of Aachen, and cost \$297,500. In it the architecture of the present time has been given the style of the early Renaissance. At the southern end, the end toward the cathedral, the clock tower rises to a height of 144 ft., thus breaking the line of the broad, heavy mass of horizontal building and also separating it effectively from the cathedral. The tower is provided with electrical clocks. The Prince's Rooms are located in this end of the building and are connected by a staircase with the Emperor's Portal, on Frankenplatz. This portion of the building is highly and appropriately decorated.

To the north of the clock tower is the entrance hall, which is 147 ft. 7 in. wide and extends about 16 ft. beyond the front line of the building, the arch of the entrance extending about 9 ft. farther. This arch has a span of 55 ft. 9 in. The pillars at the sides of the arch are extended to form turrets 98 ft. high. North of the entrance hall is the baggage room, which is 197 ft. long and 32 ft. 9 in. high, and above which can be seen the arched roof that covers the tracks. Beyond the baggage room is the exit, which also extends beyond the line of the facade, but is smaller and more simple than the entrance.

In the entrance hall, directly opposite the door, are the ticket offices, while to the left are the offices of the sleeping car department, and to the right is an exchange office, the police room, and beyond, the bureau of information. The arrangement of this part of the building is very practical, and it is so well provided with plain signs in both the Roman and German lettering that no traveler need ask any questions, nor need he look long for anything he wants, and consequently he feels at home immediately. Everything here is so arranged as to meet the requirements perfectly, and the decorations in marble, rich wood carving, etc., are used harmoniously, but there is no overloading of artistic work.

In the baggage room there are separate places for the storage, delivery and reception of baggage, and there are eight hydraulic elevators for moving the baggage to the trains. In the exit hall, to the right, is the office for checking hand baggage, and to the left is the post office. On the ground floor of the extension are bath rooms, etc., while in the upper story there are living rooms for the station master. There are two tunnels under the roadbed leading from the entrance and exit halls, each of which is 33 ft. wide, and is lined with white tiles, and when it is dark they are made as light as day by the innumerable arc lights. In the center of each of these there is an easy staircase by which the traveler can ascend to the train, his ticket having been punched at the stairs.

The roadbed from Trankgasse to Eigelstein is 836 ft. long and 302 ft. wide, and is provided with two through tracks and two tracks for switching purposes. Between the latter is the island-like platform with the great waiting room. The entrances and exits for passengers and baggage are separate, and the mail matter is taken through tunnels directly to the yard of the post office. The entire roadbed, covering 26,551 square yards of surface, is covered by an arched roof, in the construction of which only iron and glass were used.

The building containing the waiting room is 172 ft. long, 106 ft. 7 in. wide, and about 23 ft. high. It is made of iron, covered on the outside with terra cotta and on the inside with cement. It contains a waiting room for third and fourth class passengers that covers 5,375 sq. ft., and a similar one for first and second class passengers that contains 5,160 sq. ft.; a dining room of 537 sq. ft., two bath rooms, and also rooms for the station master and his subordinates. The dining room is most elaborately decorated, the walls being covered with landscapes representing the Rhine and the panorama of Cologne, done in tiles. Some terra cotta panels on the exterior are decorated in colors with fruit and flower, and on the rear of the building are the coats of arms of Germany and Prussia, and also groups representing arrival and departure, and the coats of arms of different cities are also used in the decoration of the exterior.

An immense amount of business is done here now, ninety-three passenger trains being made up here each day, while ninety-one passenger trains come in, and the number of freight trains varies according to the requirements. Still the station is large enough to admit other lines, for the present number of travelers—3,000,000 each year—might be increased to 4,000,000 or 5,000,000 without inconvenience. The structure was a very expensive one, but certainly it was money well spent. The Chamber of Deputies appropriated \$5,000,000 on April 20, 1883, and \$1,800,000 more in 1892, and Cologne contributed about \$120,000. It would seem that all possible needs had been foreseen and provided for, so that the structure will meet all requirements for many years to come.

GRADUATE AND POST-GRADUATE ENGINEERING DEGREES.

By ROBERT H. THURSTON, Director Sibley College, Cornell University, Ithaca, N. Y.*

THE designation of the degree to be awarded the undergraduate at the completion of his course in any engineering school has been a prolific source of discussion and even of dispute for many years. The title to be assigned the graduate student completing an advanced course in these schools has only been a less widely discussed matter because such courses have been of later origin and much less generally offered by professional schools of engineering. From the first, many schools have followed the course of the older non-professional, the purely educational, colleges, and graduated Bachelors of Science in special lines of work; others have simply labeled their graduates "civil engineer," "mechanical engineer," still others have adopted the hybrid title "Bachelor of Engineering." The second degree is sometimes "mechanical" or "civil engineer," sometimes "Master of Science" in one or the other branch, sometimes "Master of Civil" or of "Mechanical Engineering." The doctorate, so far as the writer is aware, has never been offered in engineering except by a single institution, and as an honorary degree, and then with exceedingly great caution and very rarely. In a few instances the title conferred is entirely different from either of the old forms, as "Dynamic Engineer," to which designation the complementary title "Static Engineer" has seldom, if ever been added. Choice has apparently been usually determined by force of example, as where the custom of the older schools is followed: by professional esprit, as where the title given is that of the profession itself; or by the spirit of innovation, as where the title is newly invented for the occasion. Occasionally, as in the case of Stanford University, the custom is established for all schools and courses alike, by the general faculty; and all graduates are dubbed A. B., whether in arts, sciences, literature, or in engineering, thus giving perfect democracy among alumni and, by the same act, taking from the degree all value for the professional, except as indicating his graduation from a reputable college. In this case, the initials of the college would perhaps constitute a still better badge.

The writer was compelled to take up this question and to promptly decide for himself as long ago as 1871, when called upon to take leading part in the establishment of a course of instruction in mechanical engineering, intended to be as distinctive in its field as was, and is, that offered at the Rensselaer Polytechnic in civil engineering. A thoughtful and careful discussion of the subject with the then best-known and most competent members of the profession confirmed his own impressions and led to the selection of the professional title rather than that of the older class of schools and colleges. The latter, having at least the merits of novelty and logical correctness, was rejected simply as not likely to find favor with either the followers of the gymnastic schools or members of the profession. The reasons for the final decision are simple and easily summarized: The school to be established was intended to be a professional school, distinctively. It was important that the degree offered should, if practicable, indicate that fact and give some presumption that the student graduating from its professional course might be expected to exhibit some special fitness and preparation for entering and advancing in that profession. It was desirable that neither the school, the course, nor the graduate should be confounded with those schools, courses, and graduates, so nearly universally recognized as below the standard set by the profession, the schools organized in connection with the older institutions of learning, controlled by non-professionals, by the clergy largely, and offering singularly inadequate courses of instruction; graduating students neither educated nor professionally trained, hybrids comparatively weak in educational branches and usually compelled to unlearn much of their "professional" instruction before they could be intrusted with any really useful office or field work.

At that time and in nearly all such schools, the attempt was being made, under the pressure of the non-professionals in control, whatever the views of the engineers nominally in charge, to give at one and the same time a college education and a professional training in four years, sometimes in three; notwithstanding the now recognized and obvious fact that either education, to be satisfactory, should occupy the full term and demand steady and earnest application throughout. The fact that the student must either get his education first and his professional training later, as in law, medicine, or any other profession, or must choose either the one or the other, was not then as generally admitted as now, and the most singular mixtures of literature, history and other non-professional studies with engineering were often prescribed; as where, in one now famous institution of learning, "biblical exegesis" constituted a portion of the regular course in engineering, or where, as in the early days of Cornell University, Roman history was similarly embedded in a course nominally that in civil engineering, "like a flyspeck on a white wall," as the finally emancipated head of the department was accustomed to say. In the same institution, in the earlier days, we had a course of instruction in "English" for years; taking the place of professional work in mechanical engineering, injuring the efficiency of the course while giving practically little advantage as literary training. This subject is now obtained, with better results, in the preparatory schools, and the consequent elevation and improvement of the course, now demanding more of preparation before entering, gives an average student better literary standing at entrance than he formerly had at graduation, and at the same time permits his securing a comparatively satisfactory and truly professional training. It was recognized, finally, that a professional training is not an education, in the correct and accepted signification of the term, and that the best obtainable education should precede the work of the professional school. Each should do its work independently, if it is to be done well. Either attempting the work of the other, must prove more or less of a failure in proportion to the fraction of time

given to the foreign element. A good professional school, devoting all its time to its legitimate work, still finds that it has no time to spare, and usually that more time still would be acceptable. For these hybrid courses of the older regime the older designation was recognized as appropriate enough. They were not, properly speaking, professional schools; they were, in considerable degree, schools of applied sciences. With them Bachelor of Science was as appropriate as a title as for the schools of pure science beside them.

It was thought by the strongest men in the profession that the professional title would prove more acceptable for the distinctively professional school, both as being more appropriate, in view of the more nearly professional nature of the school, its closer approximation to the standard set by the other professional schools, as of law and of medicine, and as being more likely to satisfy the demands of the student and alumnus, a matter in itself of some importance. It was also thought by many that the old Latin term bachelor was hardly consonant with modern and popular ideas; the classical and somewhat incongruous shade of tone being likely to strike unpleasantly upon the ear of any one at all inclined to be critical in matters involving literary taste and accuracy. "Bachelor of Science in Engineering" was not so bad; but "Bachelor of Engineering" seemed, to many, entirely inadmissible.* For the second degree, however, the good old English term "Master" awakened no opposition, and a "Doctorate in Engineering" was admitted on the ground that engineering was coming to be recognized as a learned profession, and was actually demanding more of its practitioners in its scientific preparatory work than the other professional schools, and its highest order of practice might well be considered to entitle the practitioner, thus standing at the head of his profession or in its front rank, to the designation of Doctor.† The popular assumption that the title is confined, properly, to the profession of medicine has no basis in derivation or practice. It was these considerations, mainly, which led the writer, personally, and he thinks the majority of the able members of the profession and the acknowledged leaders of the time, to agree upon the use of the title of the profession for a first degree and to adopt a Master's degree for a second and the Doctorate for the highest degree proposed.

On the establishment of the course offered in 1871 at the Stevens Institute of Technology, so far as professional, by the writer, then the professor of engineering of the newly organized school, the undergraduate course led to the degree "Mechanical Engineer," while the advanced courses were left to be established later. The honorary degree of Doctor was in a few instances conferred. Post graduate courses had not been established at the time of the transfer of the writer to Sibley College, Cornell University, in 1885. When taking the directorship of this institution, the writer was authorized and directed to organize and establish its courses of instruction, to create departments of study and professional work, and to select and nominate the incumbents of the several chairs; in fact, to completely organize a school of mechanical engineering, and to set it in operation. The same considerations which had determined the partial adoption of the scheme of 1871 at Hoboken induced the recommendation of a similar scheme for the new college. The titles proposed for the first and second degrees were adopted. The doctorate has not yet been established, although large numbers of graduate students are working for the second degree, and the indications seem to be favorable to the experiment of establishing the higher course of professional work, possibly a three years' course in absentia, with commutation of one year if worked out entirely in the college under the immediate supervision of its faculty.

In 1893, ninety-three took the first and fourteen the second degree. In 1894 the number taking the second degree was seventeen, the total being a little less than in 1893. In 1893 and in 1894 over sixty candidates were on the lists for second degrees in 1893 and later. Many were instructors taking three or four years to perform the work, being seriously impeded by their daily duties. The number graduating in 1886, the year in which these courses and degrees were first put in effect, was five, taking the first degree. In 1887 sixteen took the first and three the second degree, and from that time on the growth of the institution was exceedingly rapid, and was attributed, in part, to the wisdom shown by the faculty in the adoption of the professional title for its degree. Of this, of course, there can be no really crucial proof; but it was probably one of numerous conspiring causes.

There are various objections urged against this system of nomenclature of degrees, some of which undoubtedly have weight, some of which are as unquestionably fanciful. That most commonly and most seriously urged, perhaps, is the undesirability of conferring a degree which is at the same time the designation of the profession itself. This seems to the writer rather an argument for than against the title chosen. The undeniable fact that the graduate is only prepared to begin to learn the essential practical routine of his vocation, and is not and cannot be prepared to practice, has no more weight than in medicine, where every graduate is a "doctor." The fact is well understood by every one that his title, as conferred by the school, is simply an assurance that he has had a course of professional instruction, and is thus given a certain indispensable preparation for entrance into the profession which he has chosen, precisely as in any other profession. The degree "Civil" or "Mechanical Engineer" gives no more presumptive evidence that he is competent to practice than does the degree of "Doctor of Medicine" in that field. Neither ever is or ever will be misunderstood. It is just as true that a master's diploma in science, literature, arts, or

* The term bachelor is from the Latin, baccalaureus, one crowned with laurel. In the French it becomes "a young squire, not a knight." Its first English meaning was "a young, unmarried man." In old times, the student undergraduate was forbidden by the law of the universities to marry, on pain of expulsion. Violation of this law by William Lee resulted in his invention of the stocking loom.

† Master is from the old Anglo-Saxon maester, one who has attained physical superiority over other men, later, one who is superior in any art, profession, science or department of learning. The first of these two collective titles is, in the opinion of many members of the profession, as incongruous for the engineering schools as the second is appropriate.

† Doctor: from the Latin doctus, doctus, to teach; designating, in English, one who has received the highest degree from an institution of learning; one who is learned, an expert and an adept; a teacher of his craft.

* A paper read before the Society for Engineering Education, at the Brooklyn meeting of the A. A. S., 1894.



THE NEW RAILROAD STATION AT COLOGNE—GENERAL VIEW OF THE BUILDING FROM THE TERRACE OF THE CATHEDRAL.

engineering gives no assurance that the holder is a master in the vocation he may have selected; it is simply the certificate of a reasonable proficiency in those branches of learning which are customarily pursued in such courses as are prescribed as leading to the stated degree. The same is as true of the doctorate in any branch or profession. No one ever mistakes these diplomas for certificates of proficiency in anything outside the courses of the schools to which they each specifically appertain.

It is the business of the schools of the professions to make certain that these diplomas, however, represent as strong, condensed, and fruitful a course each, in the sciences underlying the profession, as the state of contemporary science and professional learning and practice permits—that is to say, so much of human knowledge as bears upon that vocation in the form of the history of the development of the art and its state at the time, the applied sciences so far as they bear upon professional work, the literatures of our own and other nations so far as they have professional importance, the methods of allied arts, so far as they can properly be described and illustrated in the lecture room, class room and laboratories, and the theory and practice of scientific research, so far as bearing upon the problems arising in practice or in the development of the sciences finding application therein. In many cases, even the practice of the profession in certain important lines may be taught and illustrated, and to that extent the graduate is often better prepared for business than his older and less favored colleague, who has never had the advantages of systematic instruction and laboratory practice. It is the business of the professional school to develop methods of reducing the work of the practitioner to scientific form and method, and to that extent to teach the practice as well as the theory of the art. It is in this manner that the methods of scientific determination of the efficiency of steam engines, boilers, and other apparatus of the engineer have come to constitute a part of every course of instruction in any truly engineering school. The chemistry and physics of the development and transfer and storage and transformation of heat in the production of mechanical energy is thus supplemented by the engineer's practice, in measuring the useful effect obtained from a stated quantity of thermal energy thus derived and dealt with. In engineering, the schools are schools of applied science, and it is their purpose and duty to make the instruction in application as extensive and complete as the state of the sciences and the arts permits, quite as much as to give a good knowledge of the underlying pure sciences.

To dub the graduate of a professional engineering school Bachelor of Science, or those taking advanced courses, Masters of Science and Doctors of Science, seems as inaccurate and unsatisfying as would be the adoption of the same system in any other professional schools. Law and medicine are based upon sciences and their practice is a system of applied science; but the distinction between the student of pure science and the professional is wisely preserved by emphasizing the professional side, that of application; and the doctor in medicine or in law, just as much a scientific man as his neighbor the engineer, is designated by terms which leave no possibility of confounding him with the chemist, the physicist, the physiologist, the biologist, whose learning he must always borrow for his professional work. Similarly it would seem that the engineer should be distinctively designated as an expert in scientific professional work, not as a man of science simply. John Doe, M.E., or Richard Roe, C.E., is unmistakably marked professionally; John Doe, B.S., or Richard Roe, B.S., presumably a student of sciences, is certainly not likely to be taken by the stranger reading his card as legitimately inducted into the profession which he may claim as his.

Perhaps the most potent argument in favor of the adoption and retention of the special title is the fact that a very large proportion of the graduates of engineering schools, and an increasing proportion, are carrying that title. Another important consideration is the fact that the recipients of the degrees given prefer the professional title. When, with the advance in the requirements for entrance and the considerable accompanying improvement of the professional courses at Cornell, some years ago, the title was changed from Bachelor to Civil and Mechanical Engineer, it was provided that for the time either title might be received, at the option of the graduate, in electrical engineering courses, not one graduate, out of scores taking that course of study, ever called for the degree of Bachelor of Science; all preferred the degree giving professional distinction, precisely as in other professional schools. That provision still stands; but it has completely dropped out of sight through non-application. The young graduate aspires to be known as a member of a profession and an aspirant in engineering, not as a student in science, simply; however honorable and honored the latter vocation may be. His pride lies in professional success, and all his hopes, ambitions and labors tend that way. Even the title assigned him by his alma mater, intrinsically unessential as it in fact is, becomes to him a matter of interest and pride and assumes real importance.

This form of diploma is preferred by the greater number of the representative men in the profession. They welcome the young engineer into the profession, and adopt him into the society, not as distinguished as a student in the sciences, but as one whose ambitions lie in the same line with their own, as one who aspires to follow in their footsteps, to emulate and improve upon their work, to accomplish all that talent, genius, education, industry will permit in what their seniors regard as the noblest of the professions, the most useful and fruitful of direct good of all the vocations. They welcome him as a novice in engineering and take him into the profession as one of their own family. The school is simply the first stage of professional work, and its title should indicate that fact.

The question of designation of the degree conferred is, after all, a small matter beside the problem which is involved in the construction of a suitable professional course of instruction for the real professional school. By real professional school is here meant an engineering school, in which the work is purely that of professional preparation and instruction, precisely as in any real professional school of law or of medicine, and which no working time is sacrificed to general educa-

tion, to "culture," or to purely gymnastic studies. Its requirements for admission are, properly, simply those branches of learning which necessarily preface the work of the professional, as mathematics up to the point at which, either, the schools from which the candidates for admission mainly come, cease to teach the higher mathematics, or the work of applied mathematics of the science of the profession properly begins. These requirements do not properly include any branches not finding later application either directly in professional work or as introductory to studies or laboratory work forming a part of the professional course. The course itself properly consists of just so much of the sciences, the arts, the literatures of contemporary and earlier times, finding application in the practice of the profession, as essential elements of professional work, and so much of methods of application, as can be systematically given in a course of the length assumed as practicable. In engineering schools, four years is generally thought none too long for even the purely professional course; in schools of law and medicine, two years, and often less, may be admitted. The engineer has come to be the most completely trained, the most learned, among professionals. Given, as is now not uncommon, a good preliminary course of culture, of general, of gymnastic, education, supplemented by a full course of professional training, in a real professional school and in the higher school of practice, he is necessarily the most thoroughly educated and at the same time the most learned of professional men. James Watts was perhaps the leading member of the Lunar Club, composed of the great scientific men of his time; the modern engineer, who has enjoyed all the opportunities coming to the man of moderate circumstances of our time, and who has taken full advantage of them, or who, as a "self-made" man, has acquired both an education and a professional training, may always emulate Watt in this direction. But, whatever his location, position or specialty, the ideal and representative member of the engineering profession, hereafter, will be a man of ability, strength, and supreme integrity, who has secured the best education that the best university can offer, or that can be obtained by study and travel, perhaps, followed by the best professional training that the best professional schools can give, and who has shown by his works that he is a fit disciple of Telford or of Watt. It is of comparatively little consequence what title shall be conferred by the schools upon this representative engineer.

Reviewing the field, it would seem probable that a variety, both of courses and of titles, must be accepted and endured for a time. Colleges and professional schools alike must usually be restricted and controlled in their work by the possibilities. All seek to make their requirements for admission as high as practicable; all are compelled to accept what they can, for the moment, secure from the preparatory schools. The so-called schools of engineering will, probably for years to come, in some sections of the country and under ordinary local conditions of environment, be compelled to offer semi or partial, professional courses; incorporating with the elementary work of the purely and truly professional more or less of the gymnastic and educational work of the non-professional schools. A few and perhaps usually the independent engineering colleges, will be able, to offer courses demanding the higher mathematics and the modern languages, in part, for entrance, and consisting mainly of professional work and studies in applied science. Now and then one, the numbers probably increasing with the progress of time, may be able to secure full preparation for a purely professional curriculum, and may thus attain the standing of a real and unadulterated professional school. Such technical colleges, whether independent or connected with the universities, must probably long remain few in number, possibly small in magnitude.

The first of these classes of school, with its mixed course, its limited professional, largely educational, curriculum, ought not, in fairness, to receive the title of professional school; it gives simply a course of study which properly takes its place as a modification of the usual and standard higher courses in science, of the non-professional colleges and the universities, and its degree should, obviously and naturally, following convention, be that of Bachelor of Science, and the reading of its diploma may be qualified by a statement of the special branch which constitutes its characteristic feature. It would be neither logically correct nor fair to its graduates or to the profession to unqualifiedly call this a professional school, or to give its graduates what might be interpreted to be a title to entrance into the profession as from a truly professional school. It would be as wrong, and exhibit as serious incongruity, as to dub M.D. the graduate of a high school in which anatomy, physiology and hygiene had been taught with exceptional development at the expense of the usual and regular high school studies, or M.E. when manual training had been similarly added to the older courses, with an attempt at teaching applied mechanics without adequate preparation in the calculus and accessory mathematics, and without laboratory or other higher training in mechanics and the physical sciences.

The second of these classes, once it has succeeded in fully emancipating itself from the thralldom of the preparatory schools, in formulating its courses on a correct basis of applied science, and in making them completely professional, will probably prefer to give a title to indicate that fact; as have for many years already, some of the leading schools, even before reaching that higher stage. With these schools on a level in position and standing with the law schools, and having, as a rule, higher requirements for entrance and a stronger, as well as much longer, course of work in exclusively professional lines, the wise and the politic plan would seem to be to give titles denoting and defining their character with honesty and directness; distinguishing themselves from the schools of mixed curricula as completely as from those of an absolutely non-professional kind. The title should be apposite to the work.

In distinguishing between schools of these several grades it would perhaps be well to make some such classification as the following: Where the curriculum includes less than one-half modern languages and applied sciences, and, commencing in the line of mathematics with elementary algebra and geometry and terminating with elementary applied mechanics in the senior year, requires for entrance the common school branches only and contains no laboratory instruction,

except in chemistry, I would consider the course as in no sense a really professional one and would give the degree of Bachelor of Science simply. Where plane geometry and elementary algebra through quadratics are required for entrance on a four years' course, in which one half or more of the work is in modern languages and the applied physical sciences and in laboratories, and where the applied mechanics—a strong course in that subject—comes in the junior year, as introductory to professional work in the senior year, I should consider that we have reached the border line and would give either the bachelor's degree in engineering or the professional title, accordingly as the character of the course in detail approximates the one or the other, pure or applied science, most closely. Where a four years' strong course of applied science and mainly professional work is offered, its applied mechanics in the junior or the sophomore year, the higher mathematics being required for entrance, all purely educational and gymnastic study being supplanted by work directly bearing upon the main purpose of the course, and with extensive lines of laboratory work, in the sciences and in engineering, in the junior and senior years, the school of engineering becomes fully the equal in rank with the schools of medicine of the highest class and superior to the average, and stands above all the law schools in length and strength of professional courses, and should unquestionably offer the professional titles.

The practice of the engineering schools seems to be approximating this classification already, and the schools giving the first and second forms of curricula are, in many cases, offering the title given by those approximating the last form, after a specified amount of graduate work has been performed, while the higher class of professional school is taking the graduates of the others for post-graduate work in professional branches and offering them the appropriate degree, often supplemented later by its own advanced degree. It is, in fact, not a bad plan for the student desiring to secure a good scientific training in engineering to take his first (B.S.) degree in the nearest and most convenient school or college, advancing, after graduation, into the semi-professional school of the second grade, and finally completing his work in the purely professional school, and perhaps even then taking an additional year for laboratory work and research in lines in which he proposes to specialize, taking a master's degree, or its equivalent, in conclusion of his final work. Such cases are not unknown in my own experience, and seem likely to become somewhat common hereafter, as the number of students seeking graduate work in engineering is rapidly increasing.*

Such a course is thought by many in the profession, as well as outside it, to constitute the ideal preparation for work in life. The young man fortunate enough to be able to give the time and to pay its cost, securing first an education and then a professional training such as will in the end permit his easy acquirement, if he have the talent—without which none should enter upon such professional work—of reputation and competence, and enable him to make profitable use of all those opportunities, professional, or, and especially, in culture, which come only to the educated, as well as professionally accomplished, man. This is coming to be a common plan of education with able and thoughtful young men, and the number adopting it is rapidly growing. Students completing the courses in arts and in letters in our universities are sometimes, and in constantly increasing numbers, doing the same thing, and thus securing, first an education, second, a professional, scientific training in engineering. Such men reach the level of experimental investigation comparatively easily and quickly, and enjoy, as does none other, that highest pleasure of combining study with original research in previously unexplored fields of science and professional work. Although so long and so powerful a diversion of the mind from practical matters is apt to give a permanent set to the mind of the student having insufficient talent for work, converting him into the impractical theorist, those who have the genius for engineering cannot be seriously affected in this manner, and the right man, in his right place, ultimately profits enormously by such a training. Opportunities come late, usually, and he has all the years from his leaving college to the age of thirty five or forty to fit himself into his place in professional practice.

INTENSIFYING NEGATIVES—IMPROVED METHOD.

By JOHN VANSANT, M.D.

THIS subject, though somewhat hackneyed, is not exhausted or unimportant; nor has a perfect method of increasing the density or improving the detail of a thin photographic negative, so far as I know, been heretofore published.

Of all the known methods, that commonly called the "mercurial method" seems to be the most used and is, doubtless, the best. It is simple, easy of execution, and will often improve the printing quality of a negative. But it is at best, as usually employed, very imperfect and unsatisfactory. From time to time I have made many experiments endeavoring to find a practical solution of the difficulties, and have recently, I believe, succeeded in this, and recommend for trial the following process to all interested. But before stating this, it may be well to glance at the present modes of procedure and their deficiencies.

The negative image, being composed of metallic silver in a minute state of division, when exposed to the action of a watery solution of mercuric chloride (say a grain to the ounce), takes one atom of chlorine from the mercurial salt and becomes white silver chloride, while the molecule of mercuric chloride is at the same time converted, by the loss of chlorine, into mercurous chloride, or calomel, also white, which is deposited along with the silver chloride, much increasing the bulk and weight of the latter and of the original metallic image.

Now, after well washing the whitened picture, to free it and the film from every trace of the mercurial solution used, the object is to convert the silver chlo-

* The numbers registered for the work of this kind in Sibley College 21 1892-93 and 1893-94, respectively, out of 500 and 620 students, were 64 and 68; of these 14 and 17 took the master's degree.