tative and involve mathematical processes. In this assignment there is no question of the place of these sciences in the work, as the object to be attained fixes all requirements.

The sciences are all, ultimately and necessarily, taught as applied sciences. There is no time, and no needless expenditure can be made, for the acquisition of abstract knowledge when so much is to be learned which is to be utilized directly. It is thus essential to complete success that the teacher be entirely familiar, as an expert, with the applied science. Experience shows that, in the engineering colleges and schools, thoroughly satisfactory work in the sciences is best insured by the selection, as teachers, of talented and interested scientific men who have given sufficient time to the business for which it is proposed to fit the student to become practically familiar with it and with its applications of his science. The pure sciences are as necessarily also best taught by experts, and this means those who have specialized in the sciences commonly taught in the academic departments of our schools and colleges. In fact, the rule that teaching should not be permitted to amateurs, in any branch, least of all in technical departments, should be made universal.

The curriculum should be as obviously constructed by experts in the business to which the school acts as feeder. Only the expert in the business can say what branches of instruction properly constitute the technical plan of instruction. The determination of the character and extent of the technical work in turn settles the question, What sciences and what general instruction must be supplied as a basis for the technical work? The form of the whole scheme of instruction being thus completely fixed, the details should be assigned to specialists, so far as practicable; each to be familiar as an expert with the work demanded of him.

Every business, even purely commercial, involves some connection with the producing industries, and the commercial man should evidently, in each case, have sufficient familiarity with the industry to be able to buy and sell intelligently and to discuss details involving financial interests with his correspondent.

It would seem that, in the individual case, only the student himself can say precisely what kind and approximately what extent of scientific and technical instruction is required of him. The technical school should be prepared to meet the demands of as large a variety of business interests as practicable, after sufficient experience has been had to permit decision. Probably some knowledge of mathematics, chemistry and physics will prove useful to all. Those intending to go into lines of business connected with the iron and steel industries will demand some instruction in the chemistry of metallurgy; those expecting to deal in products of the machine-making arts will need instruction in applied mechanics and machine-design; those about to enter upon commercial work relating to transportation will need some knowledge of the principles of conduct of shipment and construction of invoices.

The whole case, so far as relates to curriculum building, may be put in a few words, thus: The practitioner in the vocation, professional or other, for which educational apprenticeship is to be provided, should decide what sort and how much technical instruction is needed at entrance into that branch of industry. This schedule of required work should be assigned to experts in each of its divisions, to those who have practical and expert knowledge of the business. The requirements being thus ascertained, the next step is to provide for such studies and such tuition as are needed to prepare the student for beginning the prescribed studies. These being introduced, the next lower stratum of subjects is laid out as introductory to the preceding, and this process is continued until a curriculum is constructed which, leading up out of the common schools, terminates at its superior limit at that point at which the diploma of the technical school or college becomes a sufficient guarantee of satisfactory preparations to enter the business and to perfect the professional education by the regular practice of the vocation chosen.

The final form and extent of this curriculum must necessarily be determined by experience, and the preliminary outline must be accepted as provisional. The curriculum will be subject to constant change, amplification and improvement in detail, as time and the forward progress of the profession or the business permits or compels, and thus the adjustment of the work to the requirements becomes more and more perfect. Ultimately, the practitioner will find that the institution is doing all that can be fairly asked of it, and the novice entering into business will find himself as well outfitted as is possible in the time and at the expense permissible, and the youth proposing to take up the line of work in view will find his progress out of the common school into the business school or college, and out of the latter into business, a smooth and continuous and clearly defined movement. Once in business, thus prepared, his success will depend upon his own talent, industry, tact, and judgment.

This development of our system of general education is the great work of our day and generation. The wisdom of our statesmen as well as of our educators is to be tested, and is being measured by the promptness and effectiveness with which they adapt their own ideas, and fit the educational system, to the requirements of a modern industrial organization. When they stolidly follow the ways of the ancients, modern life flows past them. Modern educations illustrate the wisdom, the learning, the knowledge and the culture of later centuries. The wonderful gains of the nineteenth century, particularly, are being supplemented by those who have the wisdom of great statesmen, the learning of modern times, the knowledge which science supplies and the culture which comes of a symmetrical education in all the arts, the sciences, the literatures and the philosophies of our own time, so far as it has been permitted to incorporate them into school and college curriculums. The extraordinary work of the German empire had its origin, in fact, with statesmen who, without being themselves familiar with the scientific curriculum, were wise enough to under-

stand its fundamental importance and to know its place in the modern educations and the social system.

The nineteenth century has been called the wonderful century; but the world has, since the commencement of the seventeenth century, at least, been progressing with swift acceleration, and each century has been wonderful and each more wonderful than the last, to the contemporary looker-on. The twentieth century is probably to be more wonderful than the nineteenth, not perhaps in the fact of its seeing the inauguration of a new era in science and the arts, that is a wonder, unique and probably without precedent or later rival; but it will no doubt bring its share of new wonders and of new achievement, opening new realms of nature, utilizing new forces and energies, and availing itself of the old in new and unanticipated and marvelous ways. New elements and new compounds are to be discovered having more remarkable and more useful properties than the old; new methods of manifestation of that protean power which we call energy will be observed and utilized in forwarding the tasks of the engineer and strange and mysterious phenomena now puzzling all philosophers, "natural" or other, will find interpretation and application to good works for the benefit of mankind.

In all this the young men now coming into their opportunities, and their successors of the next generations, will have their part and find their opportunity. The progress of the world is still an acceleration, and the gain and the opportunity acquire magnitude as a rapidly increasing function of the elapsing time. The work of the educator assumes constantly higher value and greater importance and commands more respect and larger distinction. The place of the engineer in the world, lofty as it has been in earlier days, when Archimedes and Leonardo and Watt and Fulton and Morse pointed the way to advancement through the union of the sciences and the arts, and high as it is to-day, when its apprentices are coming forward with the learning of the centuries at their command and the skill of the modern mechanic and inventor and the productive power of all modern machinery at their will; it must grow with the advances of the new industrial world until it shall become one which old-world, old-time kings may well, and in vain, aspire to hold. The engineer must be the general of the industrial army and in his hands be held the fortunes of nations. Those who to-day witness the foundation or the dedication of a noble structure, appropriated to the work of contributing to the education and the professional training and apprenticeship of the young engineer, are witnesses of an event contributing to the highest welfare of the race. Those so fortunate as to be of the generation entering upon this work with the commencement of the new century have the splendid privilege of taking just as large a part in the growing opportunity of the engineer and his army as their wisdom, talent, ambition, and energy may permit them to assume. The man, to-day, who has the wit to recognize opportunity and the skill and ability to take advantage of it may fairly expect to go as far and to rise as high as he may choose—always provided he maintains himself in a condition of mental and moral and physical efficiency. For he must make himself a part of the great machine and keep time with its march, and maintain what I am accustomed to call "maximum commercial efficiency."

Perhaps, in this day and generation, nothing can more effectively contribute to the weal of the nation than the institution of efficient means of promotion of the work of the engineer and of his profession. As chief of the industrial army of producers of permanent wealth, his wisdom, his knowledge, his culture, and his professional efficiency, as derived by the application of talent and wisdom to the improvement of the apparatus and the methods of production, constitute the primary elements of material progress and, through material gain, of the advancement of the nation and of the race.

The progress of the state, in all directions, is largely influenced by the statesmanship of the people of the state, through the legislation of the representatives of the people in investing available capital in the cultivation of the applied sciences and the encouragement of the universality, the continuity, and the efficiency of the industrial system. A people which is thus made in maximum degree industrious, skillful, fruitful, through the exercise of every talent in the most diversified employments, and capable of thus making the industries in highest degree effective in supplying all the needs of the most enlightened community, attains most promptly and completely the highest position in the scale of civilization.

This end can only be secured by systematic and thorough education, not only in the departments of culture, but also of economic production, including, it should be understood, apprenticeship in the professions and the trades. In no department is this more essential than in engineering, where the sciences of mathematics, of physics and chemistry and of construction find their most important uses, and where a perfected economic system must find its directing minds.

This is also quite as true where the interests of the agricultural classes are involved. This intimate relation of engineering and agriculture comes of two principal requirements. First: The energies and the skill and the talents of the people should be so applied in agriculture that the energy of that industry shall be in minimum proportion given to that form of production which directs its powers toward the provision of articles for necessary but, nevertheless, in an economic sense, wasteful expenditure. The products of agriculture are intended to be destroyed, and the less this production of ephemeral forms of product compels a diversion into the work of providing the needed food-products, the larger the proportion of the producing power of the nation to be directed toward the production of permanent forms of wealth. Secondly: The more efficient this thus increased proportion of the producing power of a people can be made, the larger the accumulation and the more rapid the growth of wealth in the community, in its most permanent forms.

Already agriculture is a branch of mechanical engineering.

(To be continued.)

ANGLO-SAXON MEDICINE.*

By JOSEPH FRANK PAYNE, M.D.Oxon.

BESIDES their native herbal medicines and the more scientific therapeutics and pathology which they had borrowed from the Greeks the Anglo-Saxons made a large use of charms and what are called magical rites in the treatment of disease. It would be a mistake to suppose, as is sometimes thought, that this was their only or chief method of treatment or that it was in any way peculiar to the Anglo-Saxons. A great deal of it was taken from the later Greek and Latin medical writers who show a credulity and superstition quite equal to that of the Anglo-Saxons. Again, the magical and superstitious medicine lasted much longer than the Anglo-Saxon period. It went on all through the Middle Ages up to recent times and is not extinct even at the present day. But it is by no means characteristic of our own country. Indeed, the numerous collections of "folk-lore," or what is called "folk medicine," from the peasantry of continental countries show that these ancient superstitions are more prevalent and more inveterate among them than they are among our own people. What is most remarkable is not only that the same general beliefs have survived but that the very same forms of words have in many cases been preserved for centuries and may be even now recited in certain places.

It is very difficult to define precisely what is meant by magical medicine or what by charms. But, broadly, they imply a belief in some supernatural efficacy belonging to verbal formulae, recited or written, in special circumstances or with reference to special objects. Originally it would seem that this belief implied also the belief in spirits, demons, or some supernatural beings who could be either conciliated or coerced by the use of certain words. The belief in supernatural personages gradually waned and in the case we are now considering heathen or mystical conjurations were to a large extent replaced by Christian prayers and benedictions, while the occult rites of unknown origin were superseded by the services of the church.

Without pretending to a complete classification the various magical processes and charms may be brought under the following heads: 1. Prayers or invocations addressed to medicinal herbs or to supernatural beings supposed to have power over them. 2. Special verbal formulae or observances employed in collecting the medicinal herbs or other natural remedies. 3. Prayers and mystical words repeated over the patient or written and applied to some parts of his body, with or without ordinary remedies. Such words are very often in a foreign tongue unknown to those who use them, such as Latin among the barbarous or uneducated, Greek or Hebrew among the Latins, and so on, sometimes in a quite unknown language, which have been called Ephesian charms. But they may also be in the vernacular. 4. Direct conjurations or exorcisms addressed to diseases as if they were evil spirits. 5. Narrative charms—that is, trivial stories relating to sacred or legendary persons who suffered from or did something analogous to what the patient is suffering from. 6. Material magic—that is, the attribution of magical power to certain objects, such as plants or parts of animals, stones, or engraved gems called amulets, these objects being not used medicinally but applied in some way to the patient's body. 7. Transference of disease by a magical formula or ceremony, to some animal or material object or in some way to the outside world. Examples of all these can be found in older medical literature as well as in the Anglo-Saxon books and also throughout succeeding centuries.

The actual origin of these beliefs and practices is extremely obscure and cannot here be considered. Doubtless there was an element of traditional popular belief in each particular country and also, as regards European medicine, an introduction of Oriental superstitions. But they formed no part of the regular classical medicine of the Greeks and Romans till the period of its decline. Hippocrates, Galen, Aretaeus, and Celsus are entirely free from such superstitions. The first Greek medical writer of any repute who introduced the incantations into the practice of medicine was Alexander Trallianus, who has been already referred to as having been a great authority with the Anglo-Saxon leeches. Alexander has been blamed, and justly, for thus lowering the character of Greek medicine. He was, however, followed in this by later Greek physicians and by those late Latin writers to whom the Anglo-Saxons were much indebted. The Latin work of Marcellus Empiricus, older than Alexander, which appears to be partly founded on Roman popular medicine or folk-lore, was the great repository of superstitious rites and formulae.

On examining the Anglo-Saxon charms a considerable number are found to be directly taken from, or founded on, passages in the late Latin writers; a few are suggestive of passages in the Greek physicians. From all these sources it is easy to find examples of the various kinds of magical medicine above spoken of.

1. The invocation of herbs is found in Alexander Trallianus. For instance, he recommends as a remedy for gout that the sacred herb *hyoscyamus*, or henbane, should be dug up with certain precautions and addressed as follows: "Sacred Herb! I summon thee to the house [of my patient] to stop the rheum of his feet," etc.; "I conjure thee by the great name Jaoth Sabaoth." The Anglo-Saxons did not use prayers addressed to the herbs themselves, as benedictions and Christian prayers addressed to God or the saints were often substituted. But there are instances of certain formulae of conjuration. For instance, the herb mugwort (*artemisia*) had the reputation of preventing a man who carried it with him from getting tired on a journey. But it was to be gathered before sunrise with these words: "*Tollam te, Artemisia, ne lassus sim in via.*"

2. Special words and mysterious rites were often made use of in gathering medicinal herbs to give them special virtue. The formulae used by the Greeks and Romans being generally heathenish, the Anglo-Saxons often substituted Christian prayers. For instance, for gatheringcelandine the directions are: "Delve round the root and take it up with thy two hands turned up-

* Abstract of the FitzPatrick Lecture.

ward, and sing over it nine paternosters, and in the ninth, at the words 'Deliver us from evil,' snap it up," etc. There are also some very remarkable Anglo-Saxon "lays"—poems celebrating the virtues of herbs. In one of them Wodan is referred to, showing that it must have originated in heathen times. In many of the directions for gathering herbs the essential thing was to name the sick man and his father. This was a popular belief among the Romans, as quoted by Pliny. For the old ceremonies the Anglo-Saxons often substituted prayers and litanies. Thus before gathering certain herbs litanies of the saints and the paternoster were to be sung in church. Then the clergy or choir were to go three times round the herbs intended to be gathered, singing the same. The herbs were to be brought into the church with the same song and twelve masses sung over them in honor of the twelve apostles. Then they could be used.

3. The most important part of magical medicine consisted in mystical formulæ, conjurations, and prayers either uttered over the patient or written out and in some way applied to his body. Many, or perhaps all, were, it would seem, originally meant to be sung, as shown by the words "carmen" and "incantamentum." These were well known among the Greeks and many instances might be quoted from the poets of wounds being healed by the use of magical words. Alexander Trallianus recommends for the gout that a certain verse of Homer (Iliad II., 95) should be written on a gold leaf while the moon was in the sign of Libra, wrapped up and applied, presumably to the patient's joints. Why this particular verse was chosen does not appear; it would not seem specially appropriate.

The Anglo-Saxon charms were mostly in Latin, sometimes with corrupted Greek or possibly Hebrew words. One charm is described in the book as Scottish, but according to the editor the words belong to no known language. On the other hand, in another case, the ap-

looked sad and when our Lord inquired the cause he complained of toothache, whereupon Christ uttered a long adjuration addressed to migraine or other pains not to harm the servant of God. This was, of course, to be repeated. The story of Longinus, the traditional name of the centurion who pierced the side of Christ upon the cross, was told in order to take away a stitch in the side. To hasten child-birth the story of the raising of Lazarus with the solemn words, "Lazarus, come forth!" was thought to be efficacious. All these narratives and others like them were used not only by the Anglo-Saxons but frequently in the Middle Ages.

6. Amulets Derived from Natural Objects.—As a preservative from fits a fox was to be caught, its canine tooth knocked out while it was alive, and the animal then set free. The tooth was then to be wrapped in a fawn skin and carried on the body. The eyes of a crab removed from the living animal were good for affections of the eye if hung round the neck. In all cases the animal was to be kept alive. For headache certain herbs were to be bound on the head with a red fillet. There are many similar prescriptions in Alexander Trallianus and Marcellus Empiricus.

7. Transference of Disease.—It is a common belief in many parts of the world that disease is something which can be got out of the sick man and transferred to something outside. The Anglo-Saxons had mysterious rites, sometimes combined with forms of words, for this purpose. Often the disease was transferred to running water. Thus for a certain skin disease it is ordered to score or to scarify the neck after the setting of the sun, to pour the blood silently into running water, to spit three times, and to say, "Have you this evil and depart away with it." Or, again, a hazel or elder stick was to be taken, a name written upon it, and stained with blood. Then it was to be thrown over the shoulders or between the thighs into running water. In another case an oaken stick was to be

period belongs another manuscript which contains a version of the Herbarium of Apuleius later than that previously spoken of. This is not included in the Rev. O. Cockayne's "Leechdoms" but has been published in Germany, as edited by Herr Berberich. This manuscript is referred to the middle of the twelfth century, about 1150. It therefore touches on the extreme limit of Anglo-Saxon written literature, and, indeed, is called by Herr Berberich "Early Middle English;" but, like the last-mentioned work, it shows the long continuance of Anglo-Saxon medicine after the conquest. This work closes the early English medical library, and as the celebrated Anglo-Saxon Chronicle came to an end in 1150 the general literature and medical literature of our early ancestors reached their limit about the same time.

A HANDSOME TAPESTRY.

THE example of tapestry which we illustrate is a particularly handsome one. Our engraving is taken from a French contemporary.

A BALLOON TRIP OVER THE ALPS.*

A REMARKABLE balloon trip over the Alps was lately made by the well-known aeronaut Capt. Spelterini in his balloon the "Stella," accompanied by a party of aeronauts and scientists, among others Dr. Hermann Seiler. This feat is of great interest from many points of view, both on account of the high altitudes which were reached in passing over the mountain peaks and also for the different meteorological and other data which were obtained and will be published later. The party were well equipped with scientific and photographic apparatus. Dr. Seiler gave the following account of the voyage to our correspondent:

The balloon rose from Zermatt at 1:30 P. M. and

A HANDSOME TAPESTRY

parently unintelligible words turn out to be corrupt Irish. In some the words seem to be without doubt mere rhyming or jingling nonsense—as, for instance, "Gonmil, orgomil, marbumil," etc.—words which were to be sung into the right ear of a man but the left ear of a woman in case he or she had swallowed a worm in drinking water. The use of such charms was often combined with the use of drugs. In one prescription a drink made of twelve herbs over which seven masses had been sung was to be drunk out of a church bell with the accompaniment of singing certain psalms. Also the mass priest was to sing a formula of benediction over the patient. This was for a "fiend-sick" man—that is, a demoniac or lunatic. Sometimes charms were written on the "holy dish," or sacramental paten, and washed off with holy water which was to be drunk.

4. Exorcisms addressed to diseases as evil spirits are not common. An example is a charm for a strange "swelling." The sufferer was to sing a paternoster, to draw a line round the sore, and to say, "Fuge diabolus! Christus te sequitur." There is an elaborate charm against agues and fevers in which they are adjured in the name of Christ to depart. A form of words against "poccas"—that is, small-pox—is remarkable because this word is taken as the equivalent of variola. Many formulæ of this kind are found in late Latin writers.

5. Narrative Charms.—This class of charms was used by the late Romans—for instance, by Marcellus Empiricus and probably in still earlier times. In the Anglo-Saxon books they are always scriptural stories or else Christian legends. One of the most extraordinary, or most absurd, is against toothache. It relates how when Christ was sitting with His disciples Peter

stained with blood, then four strokes were to be made with it toward the four quarters of heaven. Then it was to be thrown away and a certain charm was to be recited. This was a charm against "flying venom," or in modern phrase, air-borne contagion.

Later Books of Anglo-Saxon Medicine.—One book contained in the three volumes of "Leechdoms" differs a good deal from the rest. It is that which bears a Greek title *Περὶ Ἀδράσεων*, interpreted as meaning "Of Schools of Medicine." This title only refers to the first chapter of the work. The rest consists of a collection of medical recipes differing from those in the other books of the Anglo-Saxon library. It is entirely free from charms and superstitions and the prescriptions are for the most part simpler than those of the Anglo-Saxon leeches. This treatise has been shown by a German philologist, Dr. Max Löwenack, to be based upon a Latin work belonging to the first period of the school of Salerno—viz., the *Practica* of Petroncellus or Petronius—a work written probably about A. D. 1035 and printed in the "Collectio Salernitana." One fragment has been traced to the writings of another Salernitan teacher, Gariopontus, of the same period. But these identifications do not account for the whole of the Anglo-Saxon text, and it does not seem that this was translated directly from the Latin. The actual origin of the work is therefore still somewhat obscure. The date of this manuscript is the first half of the twelfth century, probably before 1150. It shows that the Anglo-Saxons were beginning to profit by the teaching of the school of Salerno before that school was influenced by the Arabian medicine. It also shows that the Anglo-Saxon medicine, like the other written literature of that language, went on for some time after the Norman Conquest. To this same

mounted very rapidly up to an altitude of 9,100 feet. It approached the peak of the Mettelhorn (11,080 feet high), and came so near as to almost touch it. From this point a current of air drove the balloon in the neighborhood of the Weisshorn (14,670 feet high) where it rose to 10,500 feet altitude and soon exceeded this height in its movement toward the Dome des Mischabel. The balloon now took a direction at right angles to its former course. The wind was not very strong, so that it was only between 2 and 3 o'clock that the balloon commenced to change its course. It continued to mount progressively and traversed the northern extremity of the Mischabel, between Randa and Herbrigen; it then took a somewhat southerly direction, crossed the valley of the Saas, and at 16,000 feet altitude it crossed the Weissmies (13,100 feet high). From this point the balloon directed its course toward the north Italian lakes. During this trajet the aeronauts enjoyed the magnificent panorama of the Alps which presented itself to their view, and took a number of photographs. Near Weissmies they attained the maximum altitude of 17,200 feet and rose above the clouds, which are denser here than on the side next to Zermatt. Most of the mountain peaks were now hidden from view, but they could perceive the summits of the Bernese Alps, which rose above the clouds far in the horizon. The balloon now descended slowly and a mist enveloped the aeronauts. Before 4 o'clock they approached the Lago Maggiore and the immense extent of the Italian plain presented itself to their view. The contrast which was offered between the grandiose mountain scenery and the plain made an impressive spectacle, and Dr. Seiler states

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.