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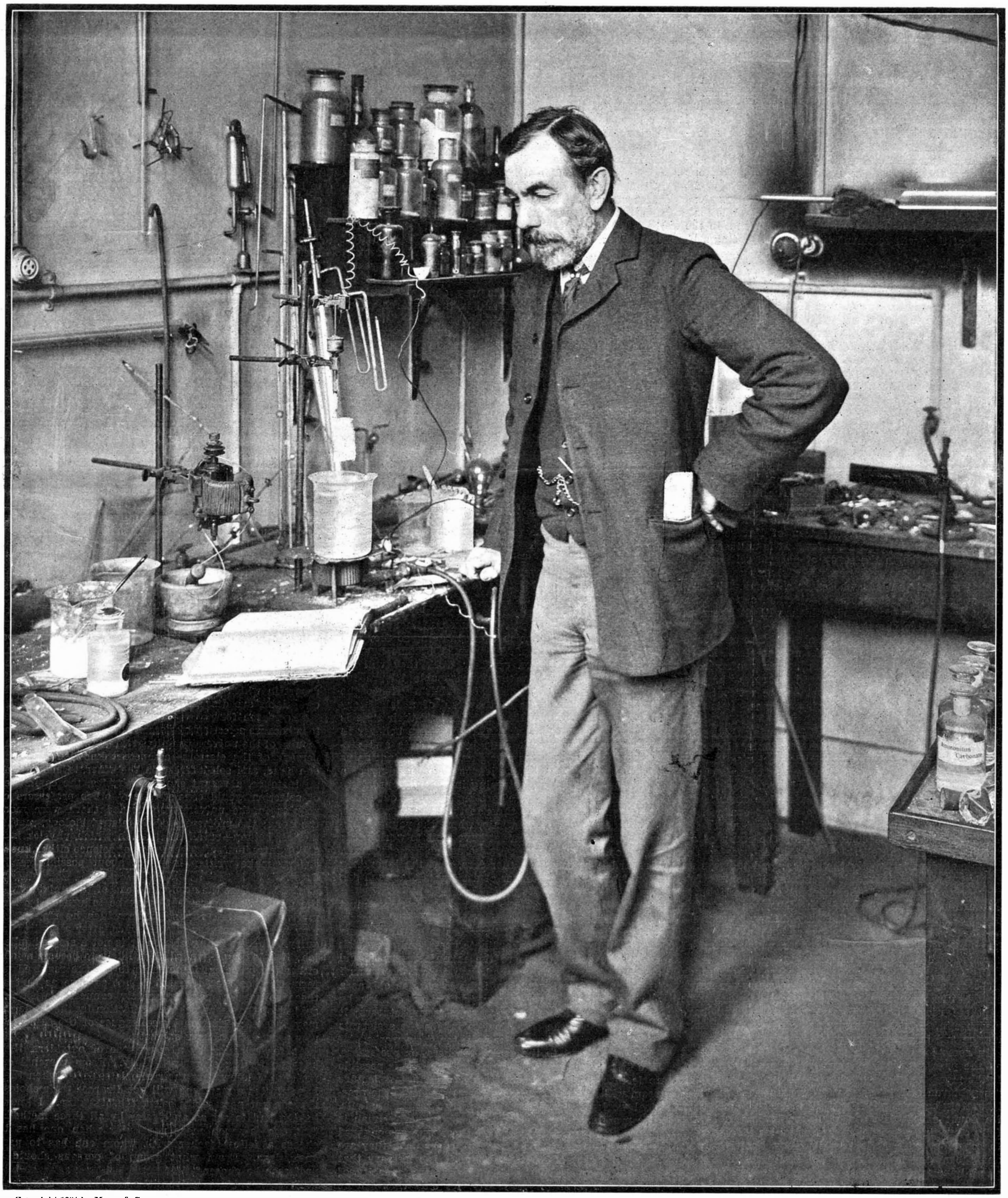


THIS PHOTOGRAPH OF SIR WILLIAM RAMSAY WAS TAKEN IN HIS LABORATORY SPECIALLY FOR THE SCIENTIFIC AMERICAN.

William Ramsay.

SIR WILLIAM RAMSAY WAS PRESIDENT OF THE SOCIETY OF CHEMICAL INDUSTRY AND IS NOW VISITING THIS COUNTRY.

SIR WILLIAM RAMSAY.

THE 1904 meeting of the Society of Chemical Industry, held for the first time in the history of the organization in New York, is rendered memorable by the visit of its president, Sir William Ramsay, K.C.B., F.R.S. As retiring president of the society he presented the annual address, selecting as his subject "The Education of a Technical Chemist." Sir William's vast experience in university chemical instruction, an experience that extends over thirty years, lends to his suggestions a peculiar force. Those who wish to know something of the distinguished English chemist's brilliant career may refer to the SCIENTIFIC AMERICAN of July 23, 1904, from which issue the accompanying portrait, specially taken for the SCIENTIFIC AMERICAN, is republished. We print below the major portion of his address, believing that its recommendations will receive the approval of most of the university professors in this country who have charge of chemical laboratories.

THE EDUCATION OF A TECHNICAL CHEMIST.*

By SIR WILLIAM RAMSAY, K.C.B., F.R.S.

IT is customary in our society for the president to give his address when he is on the eve of retiring, and I have looked for hints in those of my predecessors. I had thought that perhaps some suggestions dealing with the training of technical chemists—a subject of which I have now had over thirty years' experience—might have been favorably received.

Much has been said about the right course of training for a technical chemist, and the example of our Continental friends has been freely cited. No doubt we have much to learn from them; yet there are some first principles which lie at the root of the whole matter, and which I will venture to lay before you, in the hope that they will commend themselves by being self-evident.

The education of a chemist (and the word "chemist," of course, includes the qualification "technical chemist") must be conceived in the sense that it consists in an effort to produce an attitude of mind, rather than to instill definite knowledge. Of course the latter must not be neglected; the definite knowledge may be likened to the bricks which the architect has at his disposal in erecting a beautiful building; he knows their shapes, their capacity for resisting stresses, and, in short, what can be done with them. But the conception of the design is the result of many attempts to create; just as the poet has to utilize words, or the architect bricks, so the chemist has to know the materials with which he is dealing. The training of a bricklayer, however, will never make a man an architect; nor will the dry research of a grammarian train a poet. In short, it is the inventive faculty which must be cultivated.

Here I am met by the criticism—"The inventive faculty must exist; it cannot be implanted." "Poeta nascitur, non fit." I deny it. There are some persons whose dislike for the investigation of Nature is ingrained. But such persons are few. It is unlikely that they will ever begin the study of natural science, unless impelled by too expectant parents. My contention is that most of the lads who enter a chemical laboratory are able to receive some inspiration, or to have a latent inspiration developed, which will fit them to become inventive chemists.

Now how can this be brought about? The answer is perfectly simple: by offering them examples. Every teacher in the laboratory, from senior professor to junior assistant, must be engaged in research, and, most important of all, they must not be reticent, but willing to converse freely on their problems. It is that which creates a "chemical atmosphere."

There are some simple ways of furthering this spirit of research. First, as regards the students. I regard it as a mistake to provide special laboratories for different classes of students. If students of organic chemistry are walled off from those who are working at analysis, then neither set knows what the other is doing. The best instruction that a student can get, he acquires in having to explain his operations to his neighbors. Now it is customary for the study of organic chemistry to follow on that of inorganic; the organic student is usually the senior; and it keeps up his knowledge of inorganic chemistry if he has frequently to place it at the disposal of his neighbors who are making routine analyses. They, on the other hand, cannot help seeing the very different processes employed by the organic man; and they insensibly learn a number of tips and dodges which prove of service to themselves at a later stage.

Of course, for complicated researches, where much elaborate apparatus is erected, special rooms are necessary, but I have noticed frequently that the inhabitants of these rooms hold informal receptions, and have pleasure in exhibiting the result of their skill in manipulation and in glass-blowing.

In some laboratories a trained glass-blower is kept on the premises. There cannot be a greater mistake. If the members of the teaching staff are glass-blowers, "es geht von selbst," as the Germans say. The whole laboratory becomes proficient. Each imitates the other. No doubt advice is often given which refers to the folly of paying sums for apparatus which it is possible to construct with little trouble, after knowing how; and the money is better spent. And glass-blowing is an all-important adjunct to research. I cannot imagine how anyone can stand the annoyance of having to wait for hours, possibly for days, for the repair of a piece of apparatus, which would probably take fewer minutes if the owner was able to manipulate a blow-pipe. Nearly the same may be said of the mechanic's place in the laboratory. Here, however, the work is slower, and in many cases the mechanic's services may be required; but for small repairs, such as soldering, repairing, contriving stirring apparatus, electrical apparatus, etc., much may be done by the student himself without any direct teaching. I confess, however, that a mechanic is necessary, if only to see that the tools are kept in order.

After the preliminary year I do not think it advisable for the student at once to commence research. There are the usual subjects of complex qualitative and simple quantitative analysis to be mastered, separations, gas analysis, and the preparation of typical organic and inorganic compounds, besides physico-chemical operations, such as vapor densities, determinations of molecular weights, conductivities, and electrical separations. But the time spent on these may easily be too much extended. A fairly good student should have done enough, in a year and a half or two years, to place him in such a position that, if necessary, he can help himself when he is face to face with an analysis which he has not made before. By mixing research students in the same laboratory with others at all stages of advance, the man who is working at analysis insensibly gets to regard his operations as partaking of the nature of a problem, and pursues his work with the greater interest. Moreover, it is not difficult to intensify this view of the question by contriving variations on ordinary routine; the determination of calcium and magnesium in a shell; the estimation of phosphoric acid in a bone; the Dumas method for nitrogen applied to a dried mouse; the analysis of the gases of respiration of a fly kept in air confined in a tube over mercury, and so on. When an analysis is regarded as a problem, it gains greatly in interest. And it can always be checked by a duplicate, and if necessary a triplicate. It often happens, moreover, that the research work of a senior student is greatly helped by analytical work which can be safely intrusted to a junior. In this way double interest is gained—in the problem set, and in the research which the solving of the problem furthers.

Above all, not too much teaching. The essence of scientific progress is the well-worn method of trial and failure. It is simply horrible to think of the travesty of teaching in vogue in some of our colleges, where everything is provided, and where the students add one solution to another by word of command, and record their results in special notebooks constructed for the purpose. What do they learn? To obey? That should have been taught in the nursery. Manipulation? Manipulation consists in constructing what is required, not in using what is given. I had rather see a youth commit the Æneid to heart than carry out such time-wasting, soul-destroying routine operations. The first may result in a stronger memory; the second is fatal to all originality.

Let me consider the matter next from the point of view of the junior staff—the assistants, or whatever they may be called, "Privat-docenten," lecturers, instructors. It must never be forgotten that these young men have their way to make in the world; that it is unjust to treat them as teaching-machines; and that the only opportunity given them to make their mark is to afford them all possible encouragement to further the aims of their science, for in doing so they will further their own aims. They must become known; and without publication of their work they will remain unknown; and without reasonable leisure for research they will be unable to publish. Hence the duties of the members of the staff of a laboratory should be so arranged that at least half their time is available for research. Again, I am a firm believer in encouraging joint work done by assistants and students; the student gains much, and the assistant gains an assistant. Moreover, he learns the chief duty of a professor—the need of retaining in his mind problems for solution, and the art of getting the most out of his students in encouraging them to think for themselves. It is, indeed, an apprenticeship, where the young teacher learns his trade. He must have tools to work with; these tools are the students who act as his assistants. I regard it as essential, therefore, that the laboratory should have such a number of assistants that each one has half his time at his own disposal.

But, it may be urged, the number of assistants must necessarily be much greater than the possible vacancies in chairs, and it must therefore follow that many men will grow old in subordinate posts, and grow sick with hope deferred. Here the manufacturers should step in. A man who has had such an experience as I have sketched is invaluable, if he is not too old, as a works chemist. Here I may justify my opinion by citing the practice of many German manufacturers; it is the rule, not the exception, to induce the assistants from university laboratories to enter their works.

We come next to the senior teachers, or professors. The first point I would urge is that, while it is possible to lecture to as many students as the largest lecture room will hold, it is not possible to supervise the practical work of more than, say, forty or fifty students. The professor should always know what every man is doing. It is not necessary that those who are engaged in routine work should be visited every day; they are under the care of assistants; but it is necessary that the professor should be able to gage the capacity of each of his laboratory students; for only thus can he tell whether they are profiting by their studies. The reason why the old laboratories of Liebig, of Wöhler, and of Bunsen are regarded with such loving memory by those who were the students of these great men is that the total number of students was small; they formed a family party, where the individual character of each was known, and where the father lived among his children, and was able to distribute correction, reproof, and instruction in righteousness. Hence the necessity for limiting numbers. Now, if there are forty students, and the professor spends ten minutes each day with each—no great allowance of time—simple calculation shows that more than six hours are gone. I think that two hours is ample for the professor to spend daily in teaching laboratory students. Of course at some critical moment he must spend a much longer time with one; it may be several hours; but that should absolve him from attendance on that individual for the best part of a week. It is better to mix example with precept, and unless a large part of every day is given to research, the professor loses the attitude of mind which it is his duty to cultivate in his students. It does not do to let a day pass without making some effort to continue research; the habit is only too easily lost; it is like all arts; the successful pianist or violinist spends many hours each day at his instrument, and if the acrobat were to take a month's holiday, he would require to begin to learn his trade again. Moreover, it is only by continually keeping his hand in, and his mind turned on his own research, that the professor can conceive new problems, some of which are simple enough to form the best introduction to research to be carried out by his students.

Again, in a large laboratory, the time occupied in the details of organizing is so great as to make a heavy call on the energies of the professor, who is necessarily the director. There are parents to be seen; notebooks to be read; correspondence with old students in search of employment; apparatus to be ordered; servants to be directed; in short, the whole management of a business in addition to the work of teaching and research. The cares of management grow very rapidly with the increase in size of the laboratory, and many of the duties cannot be delegated. Moreover, there are the calls of public duty which often press very heavily on the successful scientific man. Add to these the share which it is always necessary to take in attending university councils, and it is manifest that the administrative duties should be simplified as much as possible.

If the reputation of the professor is such that students crowd to his laboratory, my counsel is, do not build larger laboratories, but appoint a new professor, with a separate chair, and a new laboratory; but do not make your man of talent a mere administrator.

This brings me to consider the method of appointment to chairs, and that involves the government of the university. It is a large question; but as the reputation of a university is entirely dependent on the standing of its professors and teachers, it must be considered.

There are as a rule three methods of appointing to chairs: one is selection by a council or committee—by the governing body of the university; and this, in fact, amounts to selection by the principal or president, for as a rule the principal or academic head of the university is regarded by the council of outsiders as the best judge of scholastic matters. The second method is selection by a committee of specialists appointed by the university; if, for example, a physical chair is vacant, it is filled by a committee consisting of four or five eminent physicists, themselves not connected with the university in which the vacancy occurs. The third method, and it is the one which commends itself to me, is selection by a committee of the faculty in which the vacancy occurs, after a reasoned report in which the relative merits of all the possible candidates are discussed.

The reason for my preference is a very simple one: it is because selection by persons belonging to the same faculty of the university unites two qualifications in the persons of the electors—competent knowledge on the one hand, and self-interest on the other. Choosing, as an instance, a vacant chair of physics, the committee of selection would consist of any other professors of physics in the university, provided there were more than one; the professors of chemistry, biology, mathematics, botany—of all sciences to which physics is a fitting introduction. These men of science either know, or can make written inquiries about possible candidates.

It is true that the academic head of the university—the principal or president—may be influenced by like motives, and that any selection which he may make may be made on very similar lines, after a similar inquiry. But the filling of a chair is not a single-handed job; if it is single-handed, it is likely to become a job; either the principal is not able to get the required information, or his judgment is not so sure as that of those colleagues more intimately connected with the subject of the vacant chair. Selection by the principal may succeed; selection by colleagues of the same faculty practically always succeeds.

As for selection by a committee of outsiders, they have no feeling of responsibility. From personal experience, I know that their aim is satisfied when they have elected a man who will not disgrace their choice; they do not necessarily select the best man. I know, having had to act as an elector by all three methods, that one is much more particular when one has to choose a fellow-teacher with whom one has to pass one's days. From what group of persons should a professor be chosen?

There are large universities, and there are small ones; and obviously the professors in the smaller institutions will be available for selection to the larger ones, with their greater field of usefulness and their higher emoluments. Should the professors in the

* Read before the Society of Chemical Industry at its New York meeting, September 8, 1904.

smaller universities have justified their election, they will doubtless be the first to be considered in filling the more important chairs. And for the chairs in the smaller institutions, the assistants will be available. They will have published work of a nature to make their names known as promising investigators, and they will have commended themselves to their chiefs as capable men to whom the management of a department may well be intrusted.

The choice of the assistant from among the senior students may be left entirely to the professor with whom he has worked, and who is best able to judge of his powers. He will doubtless have filled the position of a student-demonstrator, in looking after junior classes; and his frequent appearances at the local scientific society will render it possible to estimate his ability as a lecturer.

And now let me discuss a question which has not given difficulty in America, I understand, but which has greatly retarded the advance of knowledge and research in England. I refer to examinations. It may well be introduced here, for it may be asked, Should only a graduate be recognized as worthy to occupy a junior teaching position? To this I would reply, Let the choice be free. I have often seen men whose circumstances, or whose character, or whose deliberate choice has led them to abstain from taking a degree, and who, nevertheless, are most successful investigators, well able to increase the knowledge of their subject, and who have proved most inspiriting teachers; and, on the other hand, I have perhaps more frequently come in contact with graduates whose only claim to recognition was a parrot-like ability to repeat what had been told them, and a knack in gaging the idosyncrasies of an examiner. The older I get, the less I believe in university degrees as a test of capacity. Perhaps the reason is the manner in which degrees are awarded in England; the degree follows on one, or at most two examinations, often by men who know the candidate only as a number, and whose idea of examination often is to set questions to trip the candidate, and not to draw out what he can do. Indeed, it raises the question which I have mentioned earlier in this address: the examination is so contrived as to elicit what a man knows, rather than what he can do.

Now here, again, there are certain obvious truths which have often been stated, but too often ignored. The student, working under the eye of the professor and of his assistants, undergoes a daily examination. He may not earn marks; but, none the less, he impresses his teachers with some conception of his character; and the impression is made rather by what he can do, than by what he knows. The qualities tested by such examinations as have been customary for the past forty years in England are the last which one would wish to have in a student of science—readiness of memory to the exclusion of deliberate judgment; the faculty of spreading knowledge thin, and making a veneer of scientific facts instead of the power to correlate them and increase their value; and the skill to gage the capacity of and hoodwink the examiner, instead of the power to incite enthusiasm in others. A sound judgment, though it may be a slow one; persistence in struggling against obstacles; the knowledge where to get information when required, and to use it when found; and the inventive faculty—these are the qualities required, and they can be gaged only after long-continued observation. Moreover, the pernicious system of competitive scholarships and fellowships, instead of eleemosynary support given to the necessitous and deserving youth, has also contributed much to the debasement of the scientific spirit; for it has early implanted in the young mind the idea that to outrun his fellows, and to work solely for a money reward, are the ends to be aimed at, instead of the joy of the exercise of a divine gift, and the using that gift for the benefit of man. It is true that to earn money is a necessity; it is in no way a wrong aim; but it is not the chief aim; and money should be earned as a reward for useful labor, not for success in scholastic competitions. Under present circumstances, as scholarships exist, and must be awarded by examination, it requires considerable ingenuity to devise a method of examination which shall pick out men who will make a good use of them. I recently gave as a question for my own students, "Describe shortly the researches which have been going on in this laboratory during the past six months;" and I found the result very satisfactory. The question put a premium on the interest which a student should take in his friend's work, on the intelligence in following it, on his powers of description, and on his suggestiveness where invention had to stand for want of accurate knowledge. The after-effect of such a question, too, will be considerable. The students will endeavor in future to follow the researches of their neighbors with more understanding than they have done.

A question sometimes debated is whether the professor should lecture to junior or to senior students. Should he introduce the young student to the study of chemistry, or should he lecture to the most advanced students on recent developments of the subject? My reply would be, that students are much over-lectured. The object of lectures is more to open out a subject, and to direct a student what to read, than to give definite information. And for that reason I think the senior teacher is the best for junior students. Experience has generally taught the older man how to make his subject interesting to beginners; he has learned the art of repetition without showing that he repeats; he does not travel too fast on roads untraveled before by the young student; and he is more lenient to their often absurd efforts to form correct conceptions. On the other hand, the senior student is less exacting than the junior; to him the matter is more important than the manner of delivery; if the lectures prove useful to him he is ready to excuse any want of judgment on the part of the young teacher. But we have found it advisable to ask individual advanced students to deliver short courses of lectures on special subjects of which they have made a study; no fee is charged for admission to these lectures; and they are much appreciated both by the deliverers of the lectures, as a field for practice, and by the students, as an easy way of becoming acquainted with special branches.

It consequently appears to me futile to extend courses of lectures to more purely technical subjects. The ideal plan of education for technical chemists would be some system analogous to the apprenticeship of engineers, after they have been educated in the science; that is, after the correct habit of mind has been largely formed. But it is difficult to see how this can be brought about. The obstacles in the way appear to me to be insurmountable. The chemical manufacturer is not willing to throw open his work to students, nor would he do so even if very considerable premiums were paid. Indeed, in England, it is not uncommon for the "chemist," so called, to be refused admission to the works, and to be confined to the laboratory. In the larger German works, where many chemists are employed, it is possible for a young man to gain the requisite experience.

I have wondered if it might not be possible to establish a training school for technical chemists somewhat on the following lines: To start an association having for its object the encouragement of invention, each member of which would subscribe a certain sum for the erection of buildings and plant. There would need to be a number of isolated buildings, and a considerable collection of stock plant of a small scale—stills, tanks, evaporating pans, filter presses, vacuum filters, centrifugal machines, crystallizing vats, and so on. The work should be furnished with steam and electric current. Such a syndicate might let it be known that they were willing to make arrangements with inventors, or with syndicates which had secured the patents of an invention, or secured an option on such patents. The superintendent or professor should be provided with a staff of assistants, who would be each in charge of one building—that is, of one operation. Students would be admitted for an appropriate premium, as in engineering works. Supposing an idea to be brought to the notice of the directors, they would consult as to whether it should be accepted or not. If accepted, then the share of profits would be arranged with the patentee, should it prove successful. It would be committed to the charge of one of the staff, who would first work it out in the laboratory with the aid of a staff of students. If it then seemed feasible, it would be tried on a comparatively small scale, dealing with hundredweights, in one of the special buildings, those students who had investigated the process in the laboratory sharing in the larger-scale operations. The surmounting of difficulties in the transition, the perfecting of the process, the making working drawings of the requisite plant, would afford the best of all training to students; and in case the process proved a commercial success, these students who had helped to elaborate the process would be naturally the first to obtain employment in works, should they be erected. At the same time, manufacturers would naturally be anxious to obtain the services of men trained in so good a school, so that many students would be drafted off to works. Indeed, the scheme may be paralleled from the medical side; after receiving a medical education, for example, in preliminary scientific subjects, such as chemistry, physics, and biology, the medical student devotes himself to professional studies for three years. Then his technical education begins when he becomes house physician or house surgeon. After such experience, he is available for junior positions, for becoming "locum tenens," and so on.

The students in such an experimental works would, of course, have to do laborers' work; employes always respect a man who can "take his coat off." In this way he gets to know their difficulties, and to judge them fairly; to know what they can do, and what reasonably to expect.

I am by no means sanguine that such a scheme of technical education can be started. I acknowledge that it is an imperfect imitation of the magnificent schools of technical chemistry which form part of every large German chemical works. But such schools are unlikely to find a footing, so far as I can judge, in England. I cannot judge of America. Our system is, when trade is good, to let well alone; the manufacturer thinks, "I have done very well without a chemist so far; why have one now?" or, "The class of man who has served us as analyst has sufficed for our needs; he costs only £2 a week; why burden ourselves with a more expensive, even if a more skilled man?" And when trade declines, he naturally shrinks from spending money. It is the policy of "penny-wise and pound-foolish."

A stone viaduct is being built at Plauen, Saxony, over the river Syra, which contains the longest masonry arch in the world, its length being 295 feet 3 inches, measured horizontally from base to base. The new bridge will be opened to traffic about November 1, 1904. The Luxembourg bridge across the valley of Petruffe, which was completed a few months ago, has a span of 277 feet. The next longest masonry arch is in the United States, near Washington, D. C., and is known as the Cabin John Bridge. Its length of span is 220 feet.

THE LONGEVITY OF BIRDS.

Birds, if we consider their comparative weight rather than bulk, live much longer than mammals; but even in birds there is considerable variation. Leaving the why and wherefore, let us see what is known. We can only form our conclusions in most cases from birds living under artificial conditions in captivity. We are therefore at once faced with the question: Do we prolong the life of our captives by providing them with a regular and suitable supply of food, or do we shorten their existence by the inevitable restraint? We may do either if we consider that the average life of a bird in a free state is regulated by the rate of mortality. Few birds, or indeed any animals, die a natural death; few linger to perish by the miseries of old age and decay. Nature provides the "happy dispatch" either in the form of accident or at the hands of enemies, predatory or parasitical. We have no means of telling how long a wild bird's constitution might survive if it could manage to live to die of old age. Too frequently, however, our solicitude for our pets leads to their undoing, and post-mortems do not always reveal where we have erred; now and then we discover that a surfeit of boiled potato or some similar food has hastened the end. If we keep birds, we are constantly struck by the frailty of avian life.

It is an old German popular saying that a wren lives three years, a dog three times as long as a wren, and multiplying each age by 3, goes through a series—horse, man, donkey, wild goose, crow, deer, and oak. This, as Weismann points out, makes the life of man 81 years, and of a deer over 6,000, and although crows can manage better than we can they hardly live 2,000 summers. Small singing birds seldom live over 20; their ages in captivity vary from 8 to 18. Naumann states that a canary will live 12 or 15 years, a nightingale 8 or 9, and a blackbird about 12. Compared with our threescore years and ten, which we lords of creation have the audacity to consider as the standard, these ages are not long. A magpie has been known to reach 20, but others of the crow family have done better; ravens have lived for 100 years or more—one authority states 200—and in a wild state it is possible they may last longer.

"Parrots, which look as if they had lived for ages, they are so wise" (the borrowed expression is very apposite), have several times been known to pass their century. No record, unfortunately, has been kept of the result of the experiment made by an old lady of eighty who purchased a parrot to see if it really would live until it was a hundred. Humboldt, in good faith, tells of a parrot, living in Maypures when he was on the Orinoco, which conversed in an unknown tongue; the Indians said they could not understand it, for it was the language of the long-extinct Atures. Parrots as a rule are quick at picking up recent language, especially if it is vehement; we must take the statement of the Indians for what it is worth. Longevity is not uncommon among raptorial birds; a golden eagle lived in captivity in Vienna for 104 years, and we do not know what age it was when captured. A vulture in the same place lived 118 years, and a falcon is said to have reached the ripe age of 162.

Eider ducks are supposed to live for 100 years, and wild geese may exceed that period, which, however, is considerably below the time reached according to the German saw; swans, which certainly live a long time under favorable conditions, are stated to live sometimes 300 years.

Naturally, the statements about longevity in birds and mammals are liable to exaggeration; Sir Thomas Browne, in his "Vulgar Errors," threw doubt upon the longevity of deer; in such cases, however, as well-known captive elephants, crocodiles, and giant tortoises the evidence is good, and whales have been captured with ancient-dated harpoons embedded in their blubber. The great question of the duration of the life of an animal turns upon one point—How long is it necessary for a creature to live in order to insure the perpetuation of its kind? It must produce a sufficient number of offspring to leave an average of two descendants, in order that the race may not die out. What, then, does this mean? Simply that the chances are against so many young creatures—enemies lurk on every side, accidents, starvation, storms, threaten them so constantly that a vast majority go to the wall before they reach maturity. To maintain the balance of numbers each pair must leave a couple of offspring, and no more; the rest must fall out of the race, and so they do. If, therefore, a bird lays but few eggs, and the young are exposed to many dangers, it must live long enough to produce a minimum balance over and above the number which are wiped out. Weismann's calculation about the golden eagle, whose life may last, say, 60 years, will serve as an example. Suppose that maturity is not reached for ten years—most birds are mature long before this—and two eggs are the average number laid, we shall have 100 eggs in 50 years, and of these only two will develop into adult birds. This is a terrible fact to realize when we consider that a similar waste of life occurs throughout the animal kingdom; but it requires no stretch of imagination to see what would be the inevitable result if a slight—ever so slight—increase in numbers occurred generation after generation. Without entering into the arguments, it may be roughly stated that birds have more odds against them than mammals, and consequently require a longer life to achieve the object of this life; in other creatures, especially in invertebrates, an increased fertility provides for the struggle against the drain; they live a shorter time, but produce more young.—Manchester Guardian.

SHAPES OF TIES.*

IN seeking for new shapes of ties the first consideration should be to secure at least the same bearing surface on the ballast which the present ties have, and preferably very much more. It is believed by the writer that the present thickness of ties is one which will probably not be increased to any extent even with

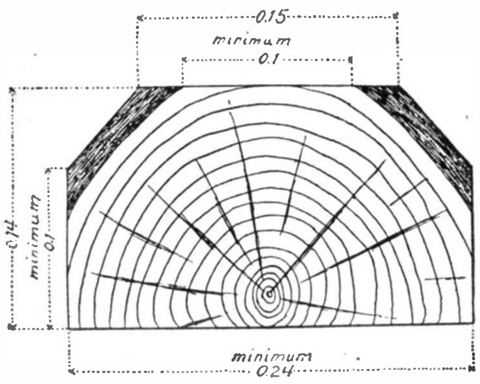


Fig. 1.

Standard Tie, Bavarian State Railways, Suggested for Use in the United States. (Measurements Given are in Fractions of Meter.)

an increased load, and the same may be asserted of the length. Any changes which may be made will probably be in the two bearing surfaces, namely, the one under the rail and the one on the ballast. With light rails, the present bearing surface of 8 to 9 inches under the rail is necessary where ties are used without tie-plates. The broad tie gives greater bearing surface to the base of the rail, and greater safety to the track.

The heavier rails now coming into general use, because of their increased stiffness, no longer require the same amount of bearing surface on the tie as the lighter rails. It is generally agreed that a reduction in the bearing surface of the rail on the tie may be effected with safety, provided the same kinds of timbers are used as in the past. The only point which has been questioned is whether the softer timbers which are now coming to be employed, that is, timbers like red oak, loblolly pine, etc., in which the sapwood is utilized (it give a sufficient bearing surface for the rail, but will also give a very much more stable tie on the ballast. Such a tie would correspond to the type shown in Fig. 1, to which may be given the name of the half-round tie. It is evident that the lines of force here have a very much greater extent on the base, and that nothing

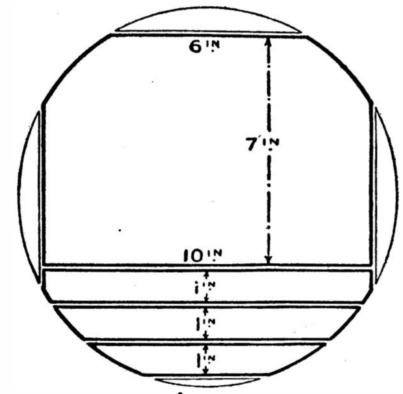


Fig. 4.

Manner of Cutting One 6-Inch Face Tie, with a 10-Inch Bearing Surface and 7-Inch Thickness, and Several Boards, from a Log 11½ Inches in Diameter.

has been lost in the amount of bearing surface which the rail has on the top of the tie. This form would not only give a greater bearing surface at the base, thereby making the tie more stable, but would also permit of laying fewer ties per mile. (See Fig. 2.)

It has been admitted that with the increased stiffness of the rail it might be possible to increase the spacing between the centers of bearing of neighboring ties. If this is true, ties such as the one indicated in Fig. 1, with a top bearing surface of 6 inches and a base of 12 inches, could be spaced so that the distance between the bases of two neighboring ties would be the same as for a 7 x 9 inch tie. This would, of course, increase the distance between the bearing centers on the top of the ties (Fig. 2). It is necessary to space ties so as to get the same number per rail length and avoid joints. This for a 7 x 9 inch tie is about 18 per 30-foot rail, with a space of 11 inches wide between the two ties, or 20 inches between bearing centers. To avoid joints it economical to cut ties of the form just indicated than the present rectangular tie? It ought to be stated that the suggestion for the adoption of the form above specified is by no means meant to exclude the rectangular tie now used. Whenever it will pay to purchase square ties with a bearing surface of 10, 11 or 12 inches, such ties will serve for all practical purposes as well

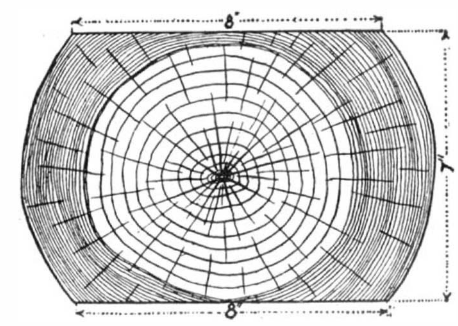


Fig. 5.

Pole Tie.

as the one in which the bearing surface has been reduced to 6 inches.

Ties are now being cut from trees of all diameters from 9 inches upward. If cut but one from a cross section, they are usually termed pole ties.

Most of these are rounded at the edge and squared on two sides (Fig. 3), with a required bearing surface of 6 to 8 inches. Pole ties are now cut from trees as large as 17 inches in diameter. Most of them are hewn, and in the hewing much of the outer portion of the tree is wasted. In larger trees also a great deal of timber is wasted, even when ties are split in the most economical fashion. In the majority of instances no wane is admitted for a first class tie, so that logs less than 10 inches in diameter will not make ties of this class. This means that a great many tops are now left in the woods because they are too small. By adopt-

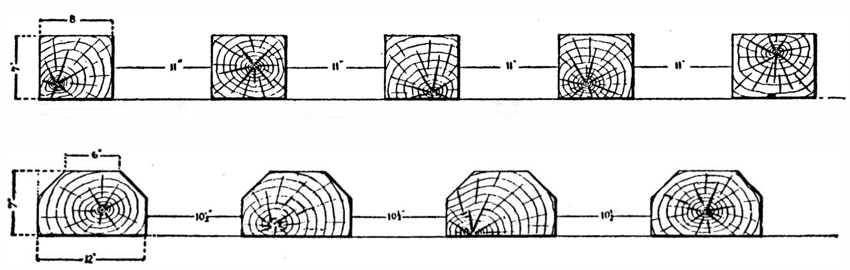


Fig. 2.

Manner of Spacing 7x8-Inch Ties and Half-Round Ties.

being taken for granted that all of these ties are treated), could be used safely with any bearing surface less than the customary 8 or 9 inches. It has been generally conceded that these timbers could not be used safely without some form of tie-plate, and at the present time most of the roads which have taken up the softer timbers are actually using tie-plates of one kind or another.

While it is probable that stiffer rails will reduce the cutting action of the rail on the tie to a minimum, there seems to be no doubt that some form of tie-plate will be necessary with soft woods, even when a stiff rail is used. By using the stiffer rail, which has a broad base, the tie-plate no longer need distribute the weight, as with the lighter rails, or at least that is a minor function. Its chief function on the soft wood tie with stiff rails will be to prevent wear, and for this purpose some form of plate, either of iron or of wood, will be indispensable.

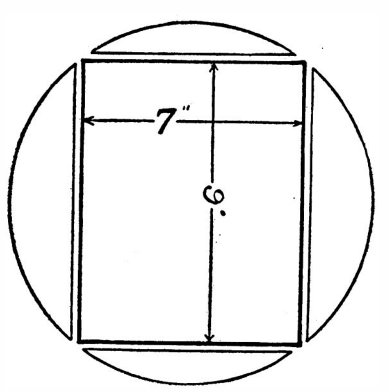


Fig. 3.

Manner of Making One 7x9-Inch Tie from a Log 11½ Inches in Diameter.

Keeping in mind the desirability of an increased bearing surface on the ballast, and the fact that the top bearing surface need be only 5 inches when a tie-plate is used, it is suggested that a type of tie with a top-bearing surface of about 6 inches and a base-bearing surface of anywhere from 8 to 12 inches will not only

* From Hermann von Schrenk's report to U. S. Department of Agriculture, Bulletin No. 50.

will be necessary to space the new form so as to make either more or less than 11 inches between the extreme base joints, and, in the comparison which follows, the spacing will be assumed as 10½ inches per 30-foot rail. (See Fig. 2.) It is by no means meant to imply, however, that such would be the actual distance in practice. It is extremely probable that 10½ inches would be too close together to allow of a proper use of the shovel or other tool employed in tamping the tie, a point which deserves considerable attention when the question of tie spacing is being considered. It is extremely probable that the increased stiffness of the rail will permit of a spacing, with a tie of the form proposed, very much greater than is possible with the present tie.

The comparative showing of rectangular 7 x 8 inch and 7 x 9 inch ties and of ties with a 6-inch top and 12-inch base, spaced respectively at 11 and 10½ inches, is as follows:

	Rectangular tie		New tie, 6-in. top 12 in. base.
	7 in. x 8 in.	7 in. x 9 in.	
Distance between bearing centers, on both top and base of tie, inches	19	20	22.5
Increase in distance between bearing centers by use of ties of the new form, inches........	3.5	2.5	....
Total number of ties per mile......	3,242	3,168	2,846
Number of ties per mile saved by use of new form...........	426	352	....
Total linear bearing on ballast per mile, feet............	2,161	2,376	2,816
Bearing surface on ballast per mile, with 8-inch length, square feet...	17,290	19,008	22,528
Gain in bearing surface by use of tie of the new form, square feet..	5,238	3,520	....

According to this table the number of ties of the new form required per mile is 352 less than with the 7 x 9 inch tie, and 426 less than with the 7 x 8 inch tie, while the amount of bearing surface obtained is greater by 3,520 square feet than that obtained by the 7 x 9 inch tie—an increase in bearing surface of over one-sixth. At the same time there would seem at first to be a considerable saving from the smaller number of ties, but in reality there is little difference in expense because of the larger number of feet, board measure, in the new tie.

Having shown that a tie with a smaller bearing surface at the top and a larger one at the base is a better one from a mechanical standpoint, it now becomes necessary to consider the changed tie form from a lumber standpoint. The question is, Will it be more

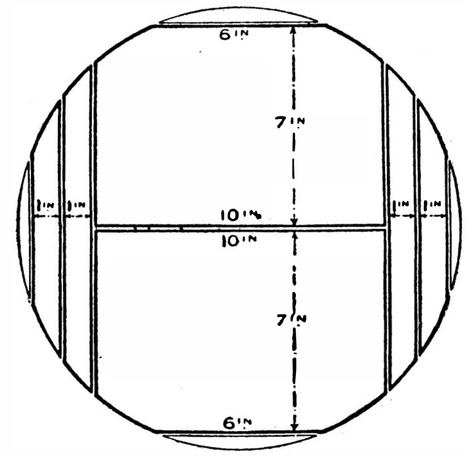


Fig. 6.

Manner of Cutting Two Ties, with 6-Inch Face, 7-Inch Thickness, and 10-Inch Base, as well as Several Boards, from a Log 15½ Inches in Diameter.

ing the tie classification suggested above (and here again emphasis ought to be laid upon the fact that ties cut according to this shape will all be treated) it will be possible to utilize a great many logs which now do not make ties, and also to cut a good many more ties out of the same amount of timber than under the present specifications. This will appear from the diagrams (Figs. 4 to 8). Fig. 8 shows a tree 11½ inches in diameter. Such a tree will make one 7 x 9 inch tie, or it will make a tie with a 6-inch bearing surface, 7 inches thick, and a 10-inch base, and a number of

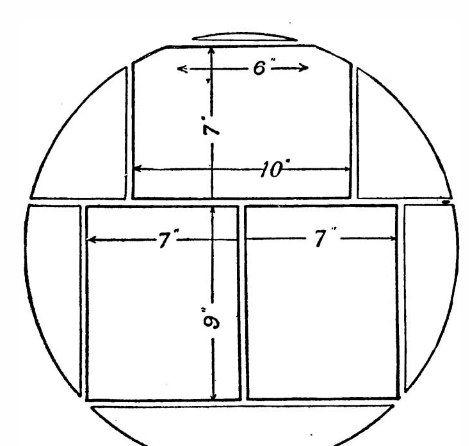


Fig. 7.

Manner of Cutting Ties from a 20-Inch Log.

boards in addition, as shown in Fig. 9. A log 15½ inches in diameter (Fig. 6) will make only one 7 x 9 inch tie, but it will make two of the suggested form (Fig. 1), while from a log 19.8 inches in diameter, which will make but two 7 x 9 inch ties, three ties, two 7 x 9 inches and one of the suggested form, can be cut (Fig. 7).

The cutting of ties of this new form will be essen-

tially a sawmill proposition. Where now there is a great deal of waste in hewing, if the log were sawed it would mean the obtaining of several boards on the side, as indicated in Figs. 5 and 6. The number of boards to be sawed from a tree 16 inches in diameter, making two ties, will depend largely upon the value of the timber from which the ties are made. For instance, it will pay to make as many boards as possible out of a 16-inch two-tie log of red oak or gum, while with timber like loblolly pine, the lumber of which has a low value, it will at present not pay to cut off many boards. In the case of such timber an extreme form of the half-round tie will be applicable (Fig. 8).

The influence which the new tie form will have upon the size of trees cut for tie purposes ought to be a marked one. It certainly would discourage the cutting of pole ties to a very considerable extent. It would not pay to make a tie out of a small tree when by leaving it for a few years two ties could be made from the same tree. In other words, the present policy of cutting trees 11 or 12 inches in diameter would be found less profitable than cutting trees 16 or 17 inches in diameter. There is probably no other branch of the lumber industry in which so many small trees are annually destroyed and the possible re-growth of forests retarded to such an extent as in the manufacture of ties. The practice of sawing ties from logs is going to be more and more prevalent as the old feeling that a sawed tie is not worth having disappears. This feeling is already rapidly disappearing. It certainly will disappear entirely when railroad men realize that with a chemically treated tie it makes no difference whether it be sawed or hewn. With increasing permanency in the source of supply it will pay more and more to put up small sawmills, which will saw ties and such lumber as may incidentally come to them. This will be particularly true in regions where there are rapidly growing tree species, such, for instance, as loblolly pine. The cutting of these trees will, moreover, make possible the use of large quantities of timber which now is practically wasted and from which the lumberman has no return. This is particularly true of tops.

Fig. 6 shows the manner of sawing two half-round ties from a log 15.3 inches in diameter. Such a log will make only one 7 x 9 inch tie, but it will make two of the 6 x 7 x 10 inch ties. The 7 x 9 inch tie measures 42 board feet, and the boards on the side 55

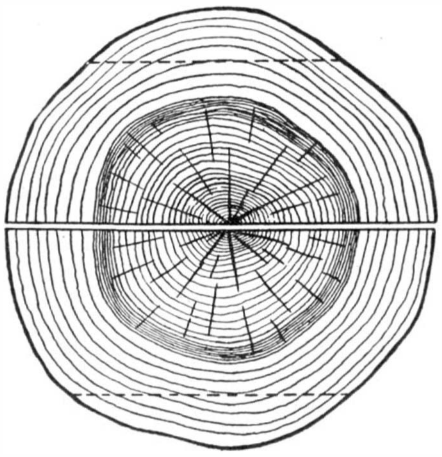


Fig. 8.

Extreme Form of Half-round Ties Cut from Log of Inferior Lumber Value.

feet, a total of 97 board feet for a 15.3-inch log when sawed into a tie of the present standard shape. The same log will make two 6 x 7 x 10 inch ties equal to 84 feet board measure and boards equal to 17 feet board measure, a total of 101 feet board measure; that is, 4 board feet in favor of cutting the half-round ties. It must be remembered, however, that only in the rarest instances will it be possible to realize the full number of boards estimated for the ideal round tree; hence the difference between the two methods of cutting will probably be very small.

SUMMARY.

From the foregoing discussion we may make the following generalizations:

First.—It is not desirable to continue the present method of classifying ties as first class, second class, etc., and culls. Instead, an alternative classification is proposed, which substitutes a division into grades A, B, C, etc., each standing for a certain definite size. Such a classification would throw out the cull tie entirely.

Second.—It is not desirable to decrease the number of ties of the present breadth now laid per rail length for the reason that even with an increased stiffness of rail a reduction in the bearing surface on the ballast is not warranted, in view of the fact that a larger bearing surface on the ballast is continually being sought for. In this connection it must be remembered that closer spacing of ties will not be possible, since a certain minimum space must be maintained to permit proper track work. In other words, increasing the breadth of the tie will necessarily mean a reduction in number per rail length.

Third.—Triangular ties are not desirable and ought not to be used, because they give less bearing surface on the ballast rather than more.

Fourth.—Assuming that tie plates are to be used on treated timbers of inferior grade, it is a waste of timber to require an 8-inch top bearing surface. It is therefore proposed that the present requirement be modified so as to admit timbers having a minimum of 6 inches top bearing surface. At the same time it is proposed that the bearing surface on the ballast be increased above 9 inches to such an extent as may prove advantageous, depending upon the class of timber from which the ties are made. This would make a "half-round tie" (Fig. 1) of the following dimensions: Top bearing surface, minimum breadth, 6 inches; bearing surface on the ballast, 10 to 12 inches; thickness, 7 inches; length, 8 feet or more.

Fifth.—The half-round tie is advantageous from a mechanical standpoint, because it gives greater bearing surface per mile and a correspondingly more stable track when spaced at approximately the same distance now used with 7 x 9 inch ties.

Sixth.—The half-round tie is good for the lumberman, because in numerous instances it will make two ties where it would have been possible to make only one of the rectangular form.

Seventh.—The half-round tie is good for the forest, because it will encourage the cutting of large trees and the saving of small ones, and, further, will prevent the waste due to leaving many tops in the woods.

Eighth.—Taking all these matters into consideration, it would appear that the half-round tie is worthy of trial. Experiments are now under way to test the practicability of sawing large numbers of these ties. These experiments are being made in co-operation with the New York Central in the Adirondacks, with beech and birch; with the Santa Fé in Texas and Arizona, with various pines, and the St. Louis & San Francisco Railroad in Missouri and Arkansas, and the Northern Pacific in Montana and Washington with red fir and lodgepole pine.

A NEW SYSTEM FOR SECURING SECRECY IN WIRELESS TELEGRAPH SIGNALING.

By EMILE GUARINI.

THE securing of absolute secrecy in the dispatches sent by wireless telegraphy is a problem that is yet to be solved. Before the new telegraph, to which Marconi has contributed so much, can enter the domain of industrial practice, a solution of this problem will be absolutely imperative. We have syntonization, it is true; but it is conceded by every one, even by the inventors of wireless telegraphy apparatus, that this offers but a provisional and very imperfect solution. On the other hand, no one up to the present has practically solved the problem of the concentration in any one direction of the energy emitted by the antennæ, that of the determination, at the receiving office, of the direction of the waves coming in. Several contrivances have been proposed, but none has given conclusive results.

M. Blondel, in France, and Prof. Artom, in Italy, have followed another idea and devised a transmitting and receiving system for wireless telegraphy, characterized by the combination of two or more sensibly parallel antennæ, the distances and phases of which are selected as a function of the wave length of the oscillations communicated by the radiator, in such a way that the Hertzian waves radiated or received respectively by the antennæ shall be sensibly in phase—concordance in the plane in which it is desired to transmit the energy—and shall annul one another in a plane at right angles. We shall dwell for a few moments upon the arrangements of Prof. Blondel, who thinks that he has found a happy and rational solution of the problem. Being given the great wave lengths, which are of immense importance in the phenomena of diffraction, Prof. Blondel does not claim to produce parallel or very concentrated pencils, but only a relative concentration.

If several antennæ (Fig. 1) be arranged in parallel and the electric oscillations of the same period therein be determined by the ordinary methods, the actions produced at a distance by the system thus formed will be found to be the sum of the effects of the various antennæ, provided one takes into account the phases of the currents in each and the distances that separate them. Each antenna behaves, in fact, like a sonorous pipe open at the bottom and closed at the top, and presents a current swell and a node; and we may consider that it radiates with sensibly the same phase throughout its entire length, so that it is possible, without great error, to attribute a single phase to each antenna at the moment of the production of the oscillations.

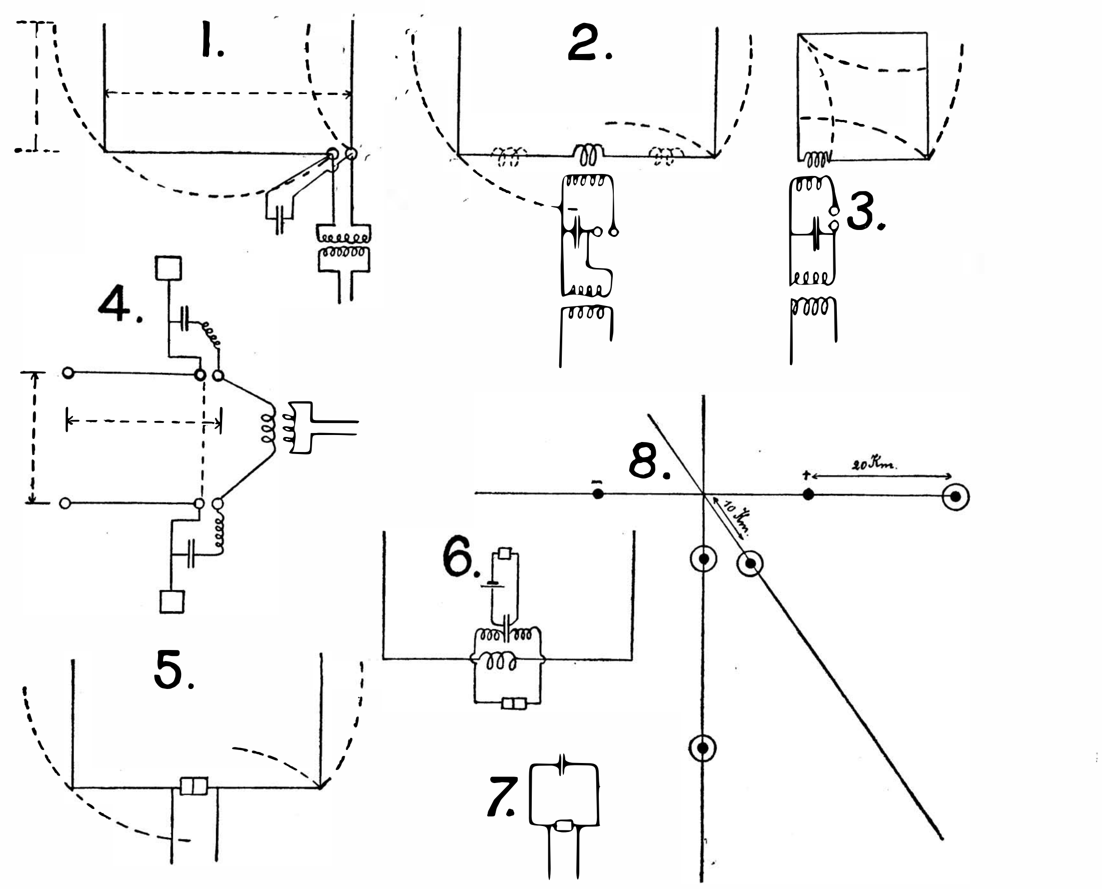
If, between the two phases of two parallel antennæ, we establish a difference equal to one period minus the phase lost during the time that it takes the waves to traverse the interval that separates them, the oscillations of the antennæ will produce effects that exactly agree in the direction of their common plane, and that, on the contrary, will be reduced to a minimum in the direction at right angles. The directions of the maxima and minima would have been the reverse had the difference of phase indicated above increased or diminished by a half-period. Such is the new principle of the Blondel arrangement.

The most interesting application of this principle is that of two antennæ distant by a half wave length and forming the two extremities of an oscillating system corresponding to one wave length. In this case, the maximum effect in the plane of the antennæ is equal to double the effect of a single antenna, and becomes zero in the plane at right angles (Fig. 2). More generally, it varies proportionally to the cosine of the angle formed by the direction in which we measure it with the common plane of the antennæ.

In order to supply the antennæ, the persistent oscillations of a local circuit formed of a condenser and an inductance coil connected in series and discharging through a spark gap are employed. The condenser is charged periodically by the secondary circuit of a coil or transformer analogous to the similar apparatus generally employed.

The two vertical antennæ (Fig. 1) are connected with the two balls of the oscillator—one of them directly and the other through the intermedium of a horizontal wire of a length equal to half a wave length of the oscillation brought about; and the length of each antenna is equal to a quarter of the same length of wave. It is easily seen that, under such circumstances, the antennæ will be the seat of electric oscillations differing by a half-period (Fig. 2), and the amplitudes of which (those of the variations of potential at each point) will continue to increase up to a maximum, which is found at the upper end of the antenna. On the contrary, there are nodes of potential at the lower ends of the antennæ.

This fundamental arrangement may be variously modified. In the first place, the spark gap and its local circuit may be placed, not at the base of an antenna, but at the center of the horizontal wire (Fig. 2), if care be taken to transmit the oscillations of the local circuit to the system of the antennæ through a transformer in such a way as to produce a maximum of potential at the center of the horizontal wire. The transformer employed in such a case is analogous to the high-frequency transformers of Tesla, Thomson, and Marconi, being formed of a certain number of turns of primary and secondary insulated wire wound on the same core and immersed in oil or insulated in any other manner. As the number of turns of



DIAGRAMS ILLUSTRATING A NEW SYSTEM FOR SECURING SECRECY IN WIRELESS TELEGRAPH SIGNALING.

secondary wire is very small, the latter do not count for much in the total length of the circuit of the antennæ; but they may be taken into account by so reducing the height of the latter that the total length of the circuit shall always represent a half wave length.

More generally, it is possible to modify the above mentioned arrangements by giving the antennæ heights less than a quarter the length of the wave, if, on the other hand, we add to the horizontal wire some coils representing an equivalent length (an imaginary equivalent length, taking account of the effects of reaction of which the other coils are the seat) in such a way that the equivalent length of the oscillating system of the antennæ shall be equal to a half wave length and present two swellings at the upper extremities.

Finally, in order to produce a cumulative effect, it is not necessary that the antennæ shall be exactly at a distance of a half wave length from each other, although the addition of the effects is then no longer so completely produced because of the difference of phase that is introduced.

The other variant consists in submitting the secondary circuit to the electric oscillations, no longer in open circuit, as in the preceding, but in closed circuit (Fig. 3). The two antennæ should again be given heights bordering upon a quarter of a wave if we unite them above and below by horizontal wires having also about a quarter of a wave length. The closed circuit should in all cases have a length equivalent (taking reactions and capacities into account) to a wave length, so as to have resonance with the oscillations of the local circuit. As the oscillations of the two antennæ differ in phase by a quarter of a period, and their distance is a quarter of a wave, their effects are further added in the direction of the vertical plane that embraces them, and are annulled in the direction at right angles.

Prof. Blondel also uses (Fig. 4) a quincuncial arrangement of antennæ formed of two systems of two antennæ placed in parallel one behind the other at a distance equal to half the common wave length of the two local circuits. The antennæ have a height of about a quarter of a wave. The secondary circuit of a transformer closed by the earth or by a direct connection simultaneously charges two condensers until disruptive sparks jump at the deflagrators. Starting from this moment, oscillations, which will be synchronous if they have been made equal, arise in the two local circuits. The same grouping of antennæ may be utilized for receiving (Figs. 5, 6, and 7).

The simplest grouping is that of two antennæ (Fig. 5) arranged as we have shown for the transmitter, but without a deflagrator and acting synchronously upon a coherer placed at the center of the horizontal junction wire, when the plane of the antennæ coincides with the direction of the diffusion of the waves. In fact, since the length of the system of the united antennæ is made by construction equal to the wave length, and since the distance of the two antennæ is chosen equal to half the length of a wave, it results that the system is in unison with the waves, and that the actions of the latter upon the two antennæ are in concordance and added together. On the contrary, if we direct the system of the receiving antennæ in a plane at right angles with that of the waves, no oscillation, or at least none that is notable, will be produced, since the two antennæ are the seat of equal and synchronous electro-motive forces.

As usual, the coherer is in communication with a battery, a relay, and the striking and receiving apparatus, as in the ordinary wireless telegraphy stations.

It is possible also to employ a more perfect arrangement (Fig. 6) with a transformer (jigger) interposed upon the horizontal wire, the secondary of which acts upon the coherer. This secondary circuit is completed in the same manner as in Marconi or other syntonic telegraph systems by a regulatable capacity, in the shunt of which acts the circuit of the battery and relay. The length of the horizontal wire and antennæ is regulated in such a way as to take into account the equivalent length of the primary circuit of the jigger, so that the distance of the antennæ shall be about half a wave length, and the equivalent total length of the oscillating circuit formed by the antennæ shall equal a wave length.

The closed circuit arrangement that we have described for the transmitter may evidently be employed also for the receiver.

These double receiving antennæ arrangements, just like those of the generating antennæ, are distinguished from all the Marconi systems hitherto described in print by the special spacing of the antennæ and the selection of the total length as a function of the wave length. These systems are independent of any ground plate. In certain cases only, in order to favor the production of nodes of potential, it is possible to put the points where they are produced in communication with the earth, or simply with large masses of metal insulated or otherwise.

Besides, such systems of antennæ possess the curious properties of concentrating the energy in certain directions. They might, were they made movable around a vertical axis, serve for determining the direction whence the waves came, and hence might be very usefully applied upon ships. In placing even two stationary antennæ upon a ship, it will suffice, according to Prof. Blondel, to cause the latter to change their relative positions, while at the same time noting the position corresponding to the maximum and minimum intensity of the signal receiver, in order to recognize the direction whence the signals came. For this latter application it is not even necessary that the antennæ and their distances shall be precisely selected, as just indicated; a simple frame occupied on one side by the coherer and on the other by a condenser (Fig. 7) may suffice. It is possible to increase the sensitiveness by giving the condenser a proper capacity to cause the circuit thus formed to correspond to half a wave length, capacity included, adding, if necessary, self-inductions in series. Finally, it is to be noted that the double antennæ systems render the syntony much more precise and sensitive, since waves of different lengths than those for which the stations are established, not only do not excite the resonance, but produce dephased and no longer concordant electromotive forces in the two antennæ.

The Blondel arrangement gave practically all that its inventor promises us. Everything would be for the best. We in nowise desire to say that the principle from which Prof. Blondel starts is bad, but far from it. The fact that Prof. Artom, in Italy, has obtained results at distances of a few miles with an arrangement based upon the same principle, goes to prove it. But does it give good results at a great distance and in all cases? For short distances wireless telegraphy may be explained by electrostatic and electrodynamic induction, but does the conduction of the earth intervene in long ones? And if it does intervene, how would the Blondel arrangement be still efficacious? Would it not be necessary to do for the ground plates what Prof. Blondel does for the antennæ? And do things proceed in the same way? It is possible, but what is certain is that with great distances the use of great energies (with large condensers) and of high antennæ and of great capacities involves the production of long wave lengths, often of several miles. Would it be practical to sometimes space the antennæ half a mile? Would that not be impossible upon ships, and the more so in that Prof. Blondel would wish to turn the plane of the antennæ upon a ship a few score of feet in width? Again, is it practical to expect the vessel to turn about in order to bring the antennæ in line?

This is a series of questions that MM. Blondel and Artom will have to answer, especially by experiment. But there is one thing that we can assert with positiveness, and that is, admitting that everything goes for the best, the solution of the problem is still far from being complete, especially for a movable receiver (upon ships, for example). In fact, according to Prof. Blondel a given receiver of determinate sensitiveness (is the sensitiveness the same always and everywhere?) will be able to operate perfectly when it is situated in the plane of the antennæ, 12½ miles distant (maximum range) from the latter, for example, and not operate at all at various distances when it is situated in a plane at right angles with that of the antennæ. We say, however, that Prof. Blondel's statement holds good only when the receiving system is situated always at the same distance from the transmitting antennæ. But ought not the same receiver to operate also when, being in a plane that forms a certain angle with the antennæ, it is situated at a distance of 6¼ miles, for example (Fig. 8), that is to say, at less than the maximum range of the transmitter? This would indeed be expected from what Prof. Blondel himself says. The solution of the secrecy problem would not be perfect, even when confined to land telegraphy upon the earth. In order that the Blondel-Artom system be efficacious, all the receivers must be not only at an equal distance from the transmitter, but also at the extreme range of the latter. And how can this range be determined if it varies with the place, and especially with the state of the atmosphere?

We conclude, then, that it is by concentration, such as Hertz effected with his reflectors, that we shall be able (granting that the waves can be directed) to solve the problem of the absolute secrecy of dispatches in wireless telegraphy. Is it to be done with the present wireless telegraphy that employs high frequency and high tension, the former perfectly useless and the latter serving to overcome the resistance of the atmosphere? Is it with another telegraphic system yet to be devised that the problem will be solved? This is a question that will perhaps be positively answered in a very short time.

NATURAL AND ARTIFICIAL PERFUMES.

By Dr. Max Heim.

Scarcely any natural sensation strikes deeper into man's elemental being than the perception of the fragrance of flowers, and from primeval times and in all lands he has cherished the art of conserving their too fleeting perfume and adding its grace to his environment. Starting in Egypt this art spread to the sunny land of Greece, and from there reached Italy, where, at the time of the first emperors, it was practised to such an immoderate extent that Vespasian, that wise observer of men, found occasion for the saying: "*Mulieres bene olent, si nihil olent*"—"Women smell good when they smell of nothing."

But, like many other wise men before and after him, Vespasian was not in accordance with general opinion; and from the Middle Ages until the present time perfumes have enjoyed constant favor with the fair sex. Although they are no longer employed upon the individual person in such extravagant quantities as in earlier times, their use has become more general, and their manufacture has become an important industry of to-day.

If we inquire into the principles of the production of these perfumes, we find that we have to-day, in many respects, the same path to follow which was trodden ages ago. Aside from the use of fragrant flowers, leaves, and especially balsams and resins, simply dried, as perfuming agents—as in the case of incense—the process was soon reached of impregnating with the fresh flowers of fragrant plants some liquid which absorbed and kept the perfume. Certain fats and oils were soon recognized as the best mediums for this, and such were specially prepared—we might almost say made aseptic—by the Greek physician Dioscorides, under Nero, through boiling with water, salt and wine. If freshly-dried flowers are immersed in a fat or oil thus purified, and slightly warm, and if they are replaced after a few hours by new ones, and this process repeated several times, there is obtained in the first case a product resembling a salve or a pomade, and in the second an oil, which retains the perfume of the flowers in greater or less degree, according to the quantity employed, but always in perfect naturalness and purity.

This old method, with some improvements, is employed at the present time to a very large extent, especially in the south of France, in the neighborhood of Cannes, Grasse and Nice. The most delicate perfumes, such as those of the jasmine, the violet, the tube rose and the orange blossom, are thus fixed, and sent in enormous quantities to all parts of the world in the form of pomades or oils. In the latter case the ancient method of production is indicated by the designation *huiles antiques*.

Although the natural fragrance is most perfectly reproduced in these products, their form is not suitable for all purposes. The favorite form of flower odors is that the volatile "perfumery," so called, with which garments, handkerchiefs, gloves, etc., can be moistened, which would of course be impossible with the oils and pomades. This perfumery, technically called "extracts" or "spirits," results from a simple process of shaking the pomades and *huiles antiques* with pure alcohol, which does not dissolve fats or fixed oils, but upon continued and intimate contact absorbs the incorporated fragrance and becomes entirely saturated with it. The alcohol is mechanically separated from the oil by filtration, and a double product is obtained—an alcoholic, perfectly volatile and pure "extract" and a residue of weak but pleasantly fragrant and utilizable fat or oil.

The above described method of immersing flowers in fatty substances is called "maceration;" it is the most primitive and without doubt the most ancient process, but it has many disadvantages, among which may be reckoned first of all the loss of the oil adhering to the flowers. Efforts have constantly been made, therefore, to replace this method by a more perfect one. In the so-called "enfleurage" the flowers do not come into direct contact with the liquid or solid fat; frames covered with gauze are placed above one another in cupboards which admit of being closed, and upon these frames are placed alternately a stratum of purified and pulverized fat and a layer of flowers. By means of a current of air, the perfume of the flowers is conveyed to the fat, and after repeated renewals there is obtained a pomade of a strong and natural flower odor, which can be treated with alcohol to make extracts.

This method not only has many technical advantages, but it permits first of all a more complete utilization of the odorous plants. Since the flowers do not come into contact with the fat, they exhale their fragrance as long as they have any vitality, that is, the fragrant secretions are continued for a time after separation from the stem, and by the "enfleurage" process can be brought into effect. Accurate analytical tests have of late led to the belief that seven times as much of the odorous substance of jasmine can be obtained in this way as by direct extraction with liquid fat, which quickly destroys the vital functions of the plant.

In spite of this, the extraction of the odorous elements is still an important process, especially in cases where they exist in tangible quantities, and also where they are to be obtained from dried portions of plants, from seeds or roots, instead of from the plant in bloom. The best of results have been reached here by the use of volatile extracting agents, such as petroleum ether and benzine. With suitable extracting apparatus, the solutions, through evaporation of the dissolving agent, yield the less volatile odorous substances in the form of a thin or thick liquid, sometimes even of the consistency of a salve, mostly colorless or pale in color. These substances are generally called essential or volatile oils. They all have the property of being entirely volatile with steam, and for this reason they are easily separated from other substances. The plants are put into stills filled with water, and steam is forced through in such a way that, after it has heated plants and liquid to the boiling point, it can escape into a cooled receiver, where it is condensed. It has by degrees taken from the plants all their essential oil, and carries it with itself into the receiver, where it collects in drops upon the surface of the condensed liquid. From large quantities of the distillate these drops can be gathered together and separated from the liquid by pouring off or skimming.

This method has likewise been long in use in various parts of the world; it is practised in some places in a very primitive form, and has made possible the production of a great number of fragrant volatile oils.

The very costly oil, or attar, of roses, is manufactured in Persia, and now especially in Bulgaria. On the island of Luzon, in the Philippines, and in Java is produced from the blossoms of a tree belonging to the family of Anonaceae—*Cananga odorata*—the no

less exquisitely fragrant oil of ylang-ylang, called in Java oil of cananga. In France neroli oil, an important constituent of eau-de-Cologne, is obtained from orange blossoms—to say nothing of the numerous oils, less costly, but still valuable, employed in the greatest quantities in the manufacture of perfumery, soaps and cordials, as, for example, rose-geranium, peppermint, lavender, etc.

The volatile oils produced by either method are characterized, as has already been remarked, by fixed properties, especially by their individual and very strong odor, which to a certain degree can at once be distinguished from any other.

In spite of this they are very far from representing uniform chemical substances; each, rather, is a mixture of several different substances, some one of which, for the most part, is the real odorous principle, and therefore the only valuable one.

The technical production of volatile oils having become a great industry of modern times—pursued with especial zeal in Germany—the chemists are making more and more strenuous efforts to reach an understanding of the intimate composition of these substances and of odorous substances in general; and chemical science has attained in this field the most notable and brilliant results. In this matter technics and science have been obliged, as so often before, to go hand in hand. The great firm of Schimmel & Co., for example, of Leipsic, manufacturers of volatile oils, have had most of their products subjected to the most exact scientific investigations, and in many cases light has been thrown thereby upon obscure and complex points of composition.

Not a few chemists of repute have devoted all their energies to this interesting field; a prominent pathfinder, whose efforts were attended by unusual results, was the late Prof. Ferdinand Tiemann, of the University of Berlin, who had most admirable and astonishing success with syntheses of two of the most valuable perfumes, vanilla and violet.

Looking at the results of these investigations, as far as it is possible to do so within the limits of our article, we shall see that in the examination of single natural perfumes they were quite simple and comprehensible. Liebig and Wohler, in their fundamental labors, had already recognized the oil of bitter almonds as the aldehyde of benzoic acid, and this was not only confirmed later by synthetic methods, but the *benzaldehyde* soon became a subject of technical synthesis. The aldehyde of cinnamic acid was found to be the principal constituent of the spicy Ceylon cinnamon and cassia oil; and the methyl-ester of salicylic acid almost the sole constituent of the fragrant oil of the American wintergreen (*Gaultheria procumbens*).

The artificial production of such substances was early undertaken, and has tended to increase their use by making prices lower. A number of perfumes which very perfectly reproduce the odors of various fruits are called fruit-ethers, and their composition has been known for a considerable length of time. They are compounds—esters, so called—of alcohols, such as ethyl-alcohol, butyl-alcohol and amyl-alcohol, with acetic, butyric and valerianic acids; and they are extensively used in the manufacture of fruit beverages and confectionery for the imitation of all possible fruit aromas.

Researches into the nature of these few comparatively simple substances comprised at first the whole of our chemical knowledge of the subject, and it was a long time before further information was gained in regard to the complex odorous elements. It seemed at first as if a hydrocarbon, $C_{10}H_{16}$, were a common and characteristic constituent of a large proportion of the essential oils; but it was soon discovered that this substance, isolated from the different oils, showed, with the same composition in point of percentage, entirely different physical properties, and above all things did not determine their odor. The essential and very important practical question of the characteristic odorous principle of each volatile oil was thus little advanced and was the chief point of interest in all researches. The investigators were led in the main to observe the oils of similar odor in groups, and to look for them according to their common constituents. For example, the costly oil of roses, valued sometimes at one thousand marks and more per kilo, is unmistakably similar in odor to a very inexpensive oil obtained from a species of East Indian grass, *Andropogon schoenanthus*, and also to geranium oils distilled from different species of Pelargonium, in Spain and North Africa, particularly at Reunion. This resemblance was well enough known to the old Oriental producers of oil of roses, and was probably of less interest to them from a scientific standpoint than on account of the opportunity thus offered of adulterating the costly liquid, a practice always willingly and extensively followed.

As a matter of fact, there has been very recently produced from all these oils a common, nearly if not quite identical, substance, called by different investigators geraniol, rhodinol, or reuniol; and chemists are inclined to regard it as the essential odorous principle of oil of roses. It is not yet equal in abundance and character to the oil of roses, but it is believed that only a few trifling additions are needed to make it so. The very latest researches claim the discovery of the required substances in the so-called phenyl-ethyl-alcohol, and in the aldehyde of nonylic and decylic acids, and there is already upon the market an artificial oil of roses, prepared according to these formulas.

Similar perhaps, even finer, results had before been reached in the production—or, more correctly speaking, imitation—of another costly perfume, the oil of jasmine. It was proved that this oil, obtainable from the blossoms in very small quantities, consists essentially of the familiar benzyl-alcohol and an acetate of benzyl, which, in an undiluted state, has a very strong flower fragrance; together with 2 or 3 per cent of a substance, discovered indeed some time ago, but not sufficiently regarded in point of odorous properties. The latter, which can be produced in beautiful white crystals by the combination of methyl-alcohol (wood spirits) with anthranilic or ortho-amido-benzoic acid, has so distinct and intense a fragrance of orange blossoms that with its aid an artificial orange blossom oil has been manufactured which is almost equal to the very valuable natural product, and seems qualified to enter into strong competition with it.

With the above-described substances it was evidently a matter of copying, so to speak, a complex perfume by a compound of already known odorous substances; and although this was in a certain degree successful in the case of jasmine oil, neroli oil, and even oil of roses, yet in none of these cases was the real odor-bearer detected and named with certainty. There was only a combination of several substances, which, with manifold variations of their compound perfume, imitated more or less perfectly the fragrance of the orange blossom, the rose and the jasmine. But Ferdinand Tiemann had already succeeded in producing, by pure scientific synthesis, the first characteristic precious perfume, the substance whose delicate lustrous crystal needles cover the pods of the vanilla bean, and give it the delicious fragrance especially esteemed by northern nations. This was recognized as the methyl-ether of the aldehyde of protocatechu, and Tiemann produced it (an enigma to the unscientific mind) from the sap or pitch of our native pine. It was very soon employed technically. In regard to the value of such substances, it is interesting to know that this, on its appearance in commerce, was sold for not less than six thousand marks per kilo. The price long remained quite high, but advancing technics soon learned to replace the first method of its production by a cheaper one, which is always the case when the composition and decompositions of a chemical substance have once been accurately learned and studied in all their bearings. To-day vanilline is exclusively manufactured from eugenol, abundantly present in the inexpensive oil of cloves and chemically related to it. To the sorrow of all manufacturers and patentees, the price has gone down from six thousand marks per kilo to sixty in a few years. A hundred times as much can thus be had for the same money as in the first years of its production, and the use of vanilla for perfumes, foods and beverages is practicable to a degree formerly impossible. Similar changes have taken place in the prices of other perfumes which science has made accessible, as, for example, piperonal, or heliotropine, the odorous principle of heliotrope, which resembles vanilla, and is related to it in chemical composition. Other examples of such technical achievements are cumarine, which perfectly reproduces the odor of the fragrant herb called woodruff (Waldmeister) and lends its characteristic aroma to many a spicy brew, and terpineol, obtained from ordinary turpentine oil, which has an extremely strong odor of lilacs, and is an indispensable adjunct to all modern lilac perfumes; to say nothing of the cheaper and more ordinary perfumes, such as safrol, nitrobenzol, etc.

To name all would lead us too far; but we must not leave unmentioned one discovery, that of the artificial violet perfume, the last important work of Tiemann. Starting from the analyses of orrisroot, the rhizoma of a species of lily, *Iris florentina*, in which he suspected the existence of the genuine aroma of violets, he succeeded through his wonderful gift of combination in condensing with acetone the so-called citral contained in lemon-rind and some other volatile oils, and obtained a substance which he called pseudo-ionon. Under the action of dilute sulphuric acid this is changed to the real ionon, which, in a thousand-fold dilution with pure alcohol, exhales a delicious and natural fragrance of violets, and is the foundation of the favorite violet perfumes, whose use has been so widely extended since the discovery.

Our subject would now be nearly exhausted but for one remarkable substance, which must not be forgotten, artificial musk. Baur, its fortunate discoverer, found, about fifteen years ago, that if toluol and butylic chloride are combined according to the well-known chemical method of Friedel and Craffts, and the resulting oil treated with highly-concentrated nitric acid, the so-called "trinitro-butyl-toluol" is obtained in pretty crystals, which have an odor of musk wonderful in quantity and intensity. When we remember that the natural musk—a secretion of an animal of the deer family, native to the interior of Asia—is a very costly and extensively used substance, sold for more than three thousand marks per kilo, we shall become conscious of the economic bearings of this and analogous discoveries. Scientifically considered, the manufacture of artificial musk does not stand upon the same plane as the synthetic construction of vanilline, cumarine, or ionon. With these substances the chemist has succeeded in discovering, by dint of laborious researches, their correct composition, and has then reproduced the natural product in a more advantageous way. Perfumes, on the other hand, like mirbane oil or artificial musk are simply imitations of the corresponding natural substances, and chemically unrelated to them.—Translated from Prometheus for the SCIENTIFIC AMERICAN SUPPLEMENT.

About 8 400,000 gallons of water are evaporated daily from the salt ponds of Utah when the pumps are operated ten hours a day during June and July. In August the salt harvest begins, and the yield is at the rate of 150 tons per inch per acre.

ARTIFICIAL GUTTA-PERCHA.

THE German Telegraph Department has for nearly two years had some cables of artificial gutta-percha in use which have so far given every satisfaction. The material is the invention of Adolf Gentzsch, of Vienna, and is described as a mixture of rubber and a palm wax of the same melting-point as the rubber. Electrically the product is considered equal to the natural gutta-percha, and it softens only above 60 C. (140 deg. F.), the mixture remaining homogeneous at these temperatures. The manufacture of this artificial gutta-percha was taken up by Messrs. Felten and Guilleaume, of Mülheim, and after experimenting, the Telegraph Department ordered a cable, nearly six miles in length, of the Mülheim firm for connecting the island of Föhr with Schleswig. The cable consists of four strands, each of seven copper wires, 0.6 millimeter in thickness; with its covering of artificial gutta-percha, the diameter of each strand is 6 millimeters (about ¼ inch) and the whole cable, with its jute and galvanized iron-wire sheathing, has a diameter of 36 millimeters (1½ inch). The weight is 3½ tons per kilometer (about 5½ tons per mile). An insulation resistance of 500 megohms and a capacity of 0.15 microhm were guaranteed. The tests were made at temperatures between + 30 deg. and — 5 deg. C. (86 deg. and 23 deg. F.), as the cables would be exposed to considerable temperature changes in the shallow water off the Frisian coast; an insulation resistance of 650 megohms was found, and the contract conditions were more than satisfied. The Gentzsch gutta-percha cables are 35 per cent cheaper than gutta-percha cables. Although the artificial gutta-percha softens only at a higher temperature than the natural product, it is somewhat more sticky. Junctions and repairs are effected with the aid of Chatterton's compound and of natural gutta-percha. When the Föhr cable had successfully been laid, more cables were laid over to the island of Norderney, in the mouths of the Ems and the Vistula, and at other spots in the North Sea and in the Baltic. The total length of these cables is 15 miles, and as they are in exposed positions, a few years' experience should allow us to get a good idea of their durability.—Engineering.

SOME GENERAL RULES FOR STAINING WOOD.

IN the staining of wood it is not enough to know merely how to prepare and how to apply the various staining solutions; a rational exercise of the art of wood staining demands rather a certain acquaintance with the varieties of wood to be operated upon, a knowledge of their separate relations to the individual stains themselves; for with one and the same stain very different effects are obtained when applied to the varying species of wood.

Such a diversity of effects arises, of course, from the very unlike chemical composition of the wood. No unimportant rôle is played by the presence in greater or lesser quantities of tannin, which acts chemically upon many of the stains and forms with them various colored varnishes in the fibers. Two examples will suffice to make this clear. (1) Let us take pine or fir, in which but little of the tanning principle is found, and stain it with a solution of 50 grammes of potassium chromate in 1 liter of pure water; the result will be a plain pale yellow color, corresponding with the potassium chromate, which, be it said, is not fast and as a consequence is of no value. If, on the contrary, we stain, with the same solution, oak, in which the tanning principle is very abundant, we obtain a beautiful yellowish-brown color which is capable of withstanding the effects of both light and air for some time; for the tannin of the oak combines with the penetrating potassium chromate to form a brown dye-stuff which deposits in the woody cells. A similar procedure occurs in the staining of mahogany and walnut with the chromate because these varieties of wood are very rich in tannin.

(2) Now take some of the same pine or fir and stain it with a solution of 20 grammes of sulphate of iron in 1 liter of water and there will be no perceptible color. Apply this stain, however, to the oak and we get a beautiful light-gray, and if the stain be painted with a brush on the smoother oaken board, in a short time a strong bluish-gray tint will appear. This effect of the stain is the result of the combination of the green vitriol with the tannin, and it is in constant evidence that the more tannin is present the darker the stain becomes. The hardness or density of the wood, too, exerts a marked influence upon the resulting stain. In a soft wood, having large pores, the stain not only sinks further in, but much more of it is required than in a hard dense wood; hence in the first place a stronger, fatter stain will be obtained with the same solution than in the latter.

From this we learn that in soft woods it is more advisable to use a thinner stain to arrive at a certain tone; while the solution may be made thicker or stronger for hard woods.

The same formula or the same staining solution cannot be relied upon to give the same results at all times even when applied to the same kinds of wood. A greater or lesser amount of rosin or sap in the wood at the time the tree is felled, will offer more or less resistance to the permeating tendencies of the stain, so that the color may be at one time much lighter, at another darker. Much after the same manner we find that the amount of the tanning principle is not always equal in the same species of wood.

Here much depends upon the age of the tree as well as upon the climatic conditions surrounding the place where it grew. Moreover, the fundamental color of the wood itself may vary greatly in examples of the

same species and thus, particularly in light, delicate shades, cause an important delay in the realization of the final color tone.

Because of this diversification, not only in the different species of wood, but even in separate specimens of the same species, it is almost impossible always, and at the first attempt, to match a certain predetermined color.

It is much more desirable that trials at staining should first be made upon pieces of board from the same wood as the object to be stained; the results of such experiments furnishing exact data concerning the strength and composition of the stain to be employed for the exact reproduction of a prescribed color.

Many cases occur in which the color tone obtained by staining cannot always be judged directly after applying the stain. Especially is this the case when stain is employed which slowly develops under the action of the air or when the dyestuff penetrates only slowly into the pores of the wood. In such cases the effect of the staining may only be fully and completely appreciated after the lapse of twenty-four or forty-eight hours.

Wood that has been stained should always be allowed twenty-four or forty-eight hours to dry in ordinary temperatures, before a coat of varnish, polish or wax is applied. If any dampness be left in the wood this will make itself apparent upon the varnish or polish. It will become dull, lose its glossy appearance, and exhibit white spots which can only be removed with difficulty. If a certain effect demand the application of two or more stains one upon the other, this may only be done by affording each distinct coat time to dry, which requires at least twenty-four hours of time.

We must not fail to call attention to the fact that not all the dyes, which are applicable to wood staining, and as such highly recommended, can be profitably used together, either when separately applied or mixed.

This injunction is to be carefully noted in the application of coal tar or aniline colors.

Among the aniline dyes suitable for staining woods we recognize in particular two groups—the so-called acid dyes and the basic dyes. These two groups of dyes behave toward each other very much like two unfriendly brothers, the further apart the better are they contented. If a solution of an acid dye be mixed with a basic dye they immediately proceed to fall out, the effect of their antagonistic dispositions is shown in the clouding up of the stain, a fine precipitate is visible and we often note a rosin-like separation.

It is needless to say that such a staining solution is useless for any practical purpose. It cannot penetrate the woody fibers and would present but an unseemly and for the most part a flaky appearance. In preparing the stains it is therefore of the greatest importance that they remain lastingly clear. It would be considerably of advantage, before mixing aniline solutions of which the acid or basic characteristics are unknown, to make a test on a small scale in a champagne glass and after standing a short time carefully examine the solution. If it has become cloudy or wanting in transparency it is a sign that a separation of the coloring matter has taken place.

The mixing of acid or basic dyestuffs even in dry powdered form is attended with the same disadvantages as in the state of solubility, for just as soon as they are dissolved in water the reactions commence and the natural process of precipitation takes place with all its attending disagreeable consequences.—Schweizer Schreinerzeitung.

THE VAST EXPOSITION PALACES OF THE WORLD'S FAIR.

It is not likely—in some respects it is not desirable—that the world will ever see an aggregation of such majestic Exposition Palaces as are to be found at the World's Fair of 1904. So large are they, that the task of visiting them one by one, and intelligently viewing their miles of exhibits (there are four miles of main aisles in the biggest of them, the Agricultural Palace) becomes oppressive. Yet one can forgive this drawback for the sake of the splendid architectural effect that individually and collectively they produce.

Although many visitors to the grounds declare the Palace of Education the most artistic of all the exhibit buildings, we think the palm should be given to the Government Building. The dimensions of the Education Palace are 925 feet by 750 feet, and it covers 9.1 acres. The entire field of education has been subdivided into definite groups. The first deals with elementary education, public, private, and parochial, followed by secondary education as shown in high schools and academies. In higher education are shown colleges and universities, various technical schools, libraries, and museums. Fine arts and education include art schools and institutes, also musical conservatories. Group five consists of special education in agriculture, which includes experiment stations. Congress appropriated $100,000 especially for this exhibit. Publishers of educational works and manufacturers of school furniture have made some very complete and handsome exhibits here.

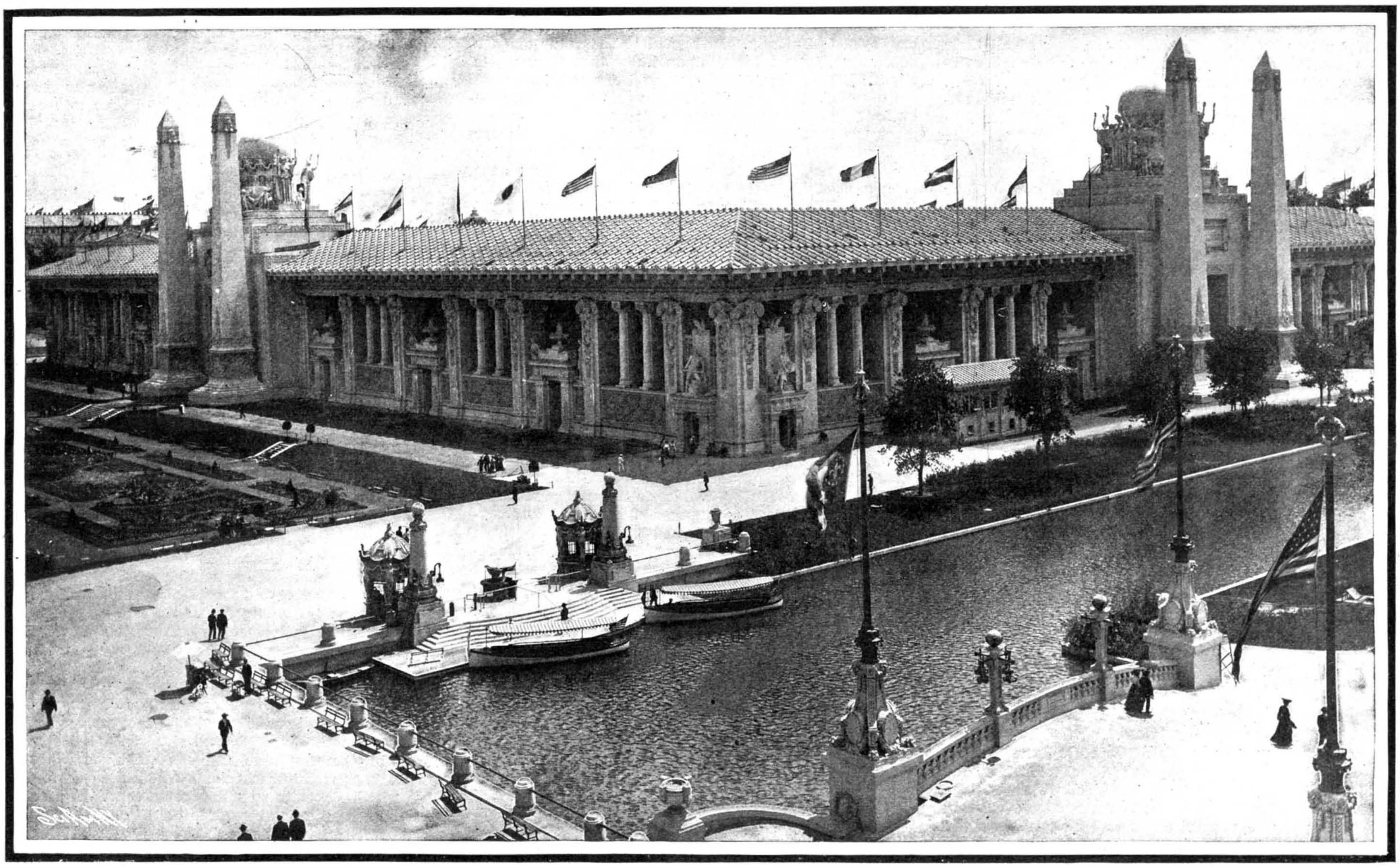
The Art Palace, which is a permanent fireproof structure built of gray stone, is 348 feet long and 166 feet wide. It is supplemented by two side pavilions and a hall of sculpture built of brick and staff. The side pavilions are each 240 feet by 422 feet. The three larger buildings cover 5.1 acres. At this Exposition there is no discrimination between the different forms of art production. Painting, sculpture, architecture, and the various applied arts are regarded from the same standpoint. Almost every civilized country in the world is represented in the art buildings. There is a Contemporaneous division, which includes works produced since the opening of the World's Columbian Exposition at Chicago, and a Retrospective division, including works produced between the date of the Louisiana Purchase and 1903; also a division devoted to loans from American collections, both public and private. The total number of galleries is 135.

The Liberal Arts Palace contains the treasures of art, science, and industry as applied to the every-day needs of mankind. The building is the same size as the palace of education, and presents an imposing architectural appearance. The Graphic Arts section contains exhibits showing the development of printing and typography during the last century, including a complete type foundry, a photo-engraving plant, electrotype foundry, and a model printing office. In another group are all the appliances known in modern surgery, in another instruments of precision, including a 12-inch equatorial telescope, weighing 4,000 pounds. An alchemist's laboratory is installed in the reproduction of an old German house, and nearby are paints and chemicals. From many countries are exhibits sent to rival those produced in the United States.

Two buildings are occupied by the department of manufactures, the Palace of Varied Industries and the Palace of Manufactures. Each of these buildings is 1,200 feet long by 525 feet wide. The word "Manufactures" represents a regiment of the industrial arts and crafts. This department is especially noticeable for its representative foreign exhibits, and in this respect it greatly surpasses the Exposition at Paris in 1900. The exhibit of cutlery at St. Louis is unique and interesting, comprising the most extensive collection ever seen. The work of the goldsmith and silversmith is on exhibition as never before, and their methods of manufacture are shown, as well as the complete products. A most interesting feature is the department of precious stones, and another shows the advancement in the manufacture of clocks and watches. Under another classification enter all things that go to make up the "house beautiful," including the rarest of porcelain and china ware from the Orient. The display of toys is on an elaborate scale, and includes special exhibits from Germany, the land of doll makers.

Force and power have a home in the Palace of Machinery, which covers 10 acres, and is 1,000 feet long by 525 feet wide. Here are shown the methods of developing and transmitting power, and the methods of constructing every variety of machinery. The prime movers that furnish this great power are living exhibits occupying the entire western half of the Palace of Machinery. Such lines of engines and dynamos have never been seen. In close connection with this Palace is the Steam, Gas, and Fuel Building.

In a palace of Corinthian architecture, a part of the main picture, Electricity has its home. The structure is the same size as the home of Education, and cost $415,000. All classes of machinery for the generation and utilization of electrical energy are here exhibited, the majority of the machinery being in motion. Another division is devoted to electric chemistry, and still



MINES AND METALLURGY BUILDING.

THE MAIN EXHIBITION BUILDINGS OF THE ST. LOUIS WORLD'S FAIR.

another to transmission of intelligence, in which wireless telegraphy rivals the land lines and the submarine cable.

Fifteen and six-tenths acres are covered by the Palace of Transportation, which is 1,300 feet long by 559 feet wide. In this great structure the modern methods of transportation that have revolutionized the commercial world are shown, and in marked contrast with the wonderful machines used for locomotion to-day are the primitive appliances of a hundred years ago. A central exhibit is an immense locomotive upon a turntable, which slowly revolves. The wheels of this giant turn at a rate which, were the locomotive on a level track, would give it a speed of 20 miles an hour. There is a department of scientific research and investigation, the most notable feature of which is the locomotive testing plant of the Pennsylvania Railroad. Marine and aerial navigation are features, and the latter are especially attractive because of the $100,000 prize offered the most successful aeronaut.

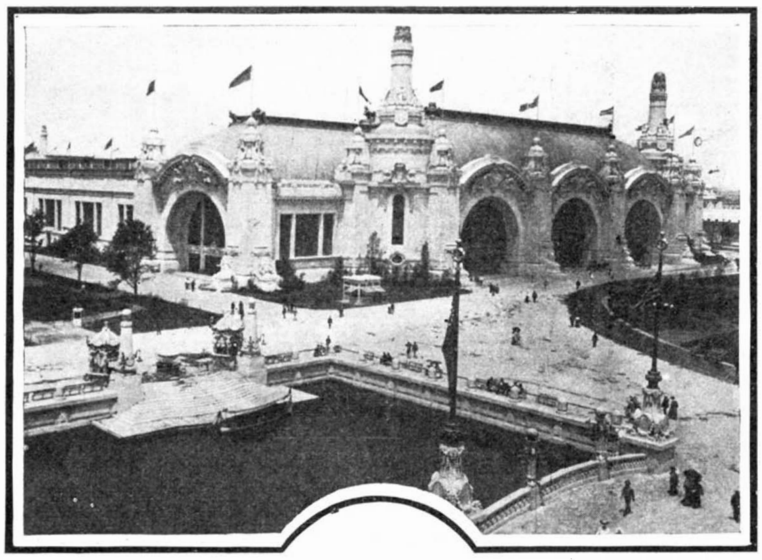
The largest of all the exhibit palaces is the home outdoor display supplements that within the walls. Implements and appliances used in horticulture are shown in all divisions.

Four acres and a tenth under roof is given to the products of the forest and stream. Large aquariums occupy most of the central space, and here and there are artificial ponds, in which the largest specimens of the finny tribe are kept.

The Mines and Metallurgy Palace presents modified Egyptian features of architecture, yet the building is not inharmonious, but adds to the attractiveness of the main group by its novelty. It is 730 feet long by 525 feet wide, and covers about 9 acres. This is the largest structure provided for mines and mining by any exposition. Methods of delving beneath the surface are exhibited, as well as the ores and metals that are found. A supplemental exhibit out of doors shows the manner in which oil derricks are operated, how machines are used for crushing ore, and an underground mine in operation.

The United States Government Building is directly also devoted to the Library of Congress, the Smithsonian Institution and the Bureau of American Republics. The building is a vast storehouse of an endless variety of treasures dear to the heart of every true American. Precious documents are to be seen here, and the autographs of our great men of the past are on display. Relics of famous statesmen and soldiers, carefully preserved through generations, are exhibited. Each governmental department has installed an exhibit showing its official character and mode of operation.

Passing out at the end of the Government Building one sees more terraced steps, which lead down to the Government Fisheries edifice, a beautiful structure in the classic Roman style. This building is 135 feet square, covered with ornamental staff, and is devoted exclusively to the display and exploitation of the United States Fish Commission's enterprises and the exhibition of food fishes and shellfish. Specimens of fishes from river and sea, lake and brook, from far and near, are displayed here, swimming in huge tanks



TRANSPORTATION BUILDING.

NORTH ENTRANCE OF AGRICULTURAL BUILDING WITH THE GREAT FLORAL CLOCK.

LOUISIANA PURCHASE MONUMENT.

MANUFACTURES BUILDING AND STAIRWAY TO MAIN LAGOON.

THE MAIN EXHIBITION BUILDINGS OF THE ST. LOUIS WORLD'S FAIR.

of Agriculture, which covers 23.4 acres, being 1,660 feet long by 546 feet wide. This building is in the western portion of the grounds, and forms the center of a second picture, being surrounded by immense beds of flowers. Special features are the crops of the United States, which have never before been demonstrated at any exposition. Especially broad and comprehensive are the displays of the cow, including all that is modern as applying to the dairies, creameries, and cheese-making. The methods of cultivation of crops both at home and abroad are shown, and all manner of literature pertaining to agriculture is on exhibition.

The Palace of Horticulture consists of a main central room, 400 feet square, with two wings, each 204 feet by 230 feet, the whole building covering six acres of ground. The space devoted to the fresh fruit exhibit is twice as large as that given by any other exposition, and the rivalry among States is so keen that the Horticultural display has been made the finest ever witnessed in the world's history. An extensive opposite the Cottage entrance to the World's Fair grounds, from Forest Park. It is undoubtedly the finest architectural effort of the whole of the palaces. It occupies an elevated site just south of the main picture of the Exposition. The great central dome of the Government Building is visible from the very center of the fair, looking across the picturesque sunken garden that lies between the Palaces of Mines and Metallurgy and Liberal Arts.

The hill slope in front of the Government Building is terraced with broad stairways almost completely covering the slope. The building is 800 feet long by 250 feet wide, and is the largest structure ever provided at an exposition by the Federal government. It is distinguished from all the other large buildings at the Exposition by the steel truss construction, the entire roof being supported by steel arches, forming a splendid domed ceiling.

In this building are installed the exhibits of all the executive departments of the government, and space is which are supplied with fresh or salt water to suit the habits of the species which they contain.

Around the walls inside the building are thirty-five glass tanks, most of them 12 feet long and 5 feet high. Salt water from the ocean is brought to St. Louis in tank cars for the sea fish, the tanks being refilled at intervals. For fresh-water fish, water is piped from the Mississippi River and stored in tanks, where it is filtered and pumped into the exhibit tanks as needed. The filter plant underneath the building has a capacity of 100,000 gallons daily. An ice plant manufactures ice to cool the water in which swim trout from mountain streams. Fresh air also is pumped into the tanks, to furnish the necessary oxygen.

In the center of this building is a pool 25 feet square, in which seals disport themselves. Lobsters, oysters, crabs, and clams are shown in great variety. Hatching apparatus of various kinds is on exhibition. Such processes of fish propagation as cannot be shown in reality are represented by mutoscope pictures.

STEAM TURBINE PROPULSION FOR MARINE PURPOSES.*

By Prof. A. Rateau.

There is no need, in a country which has given birth to the Parsons turbine, to insist upon the interest attached to the application of the steam turbine to the propulsion of ships. The remarkable results which the distinguished inventor of that engine has obtained are matters of common knowledge, and the author is one of those who have most admired and appreciated the methodical manner in which these results have been achieved. Mr. Parsons has himself set them forth in the paper which he read before the Institution at the last summer meeting.

This important question has also attracted much attention in France for several years past, and I propose, therefore, to give the results which have been so far attained there. If these results are but slender, it is due to the fact that the means at our disposal have not been sufficient to enable more progress to be made.

There are, at the present time, two ships fitted with our turbines, namely, the French torpedo boat, No. 243, and a first-class torpedo boat built by Messrs. Yarrow & Co. The latter alone has been constructed according to our ideas, as the restrictions imposed by the naval authorities upon the French torpedo boat, and the conditions laid down for its propellers, have created such difficulties that it has been impossible up to now to obtain a satisfactory speed with this vessel. It was, however, only a trial boat, and the speed was not required to exceed 20 knots; in point of fact, we have obtained over 21 knots. With Messrs. Yarrow & Co.'s boat, on the other hand, the conditions are such as to utilize the full value of the turbines, and the latter have been further supplemented by a small reciprocating engine for economical working at reduced speeds. The trials with this boat are, therefore, of considerable practical interest, and I have much pleasure in acknowledging our debt to Mr. Yarrow for the breadth of view which he has shown in dealing with these new conditions.

Another small vessel, the "Libellule," was to have been fitted with a turbine of our manufacture, and the engine has been completed for some time past, but the trials have not yet taken place, as the special boiler with which it was desired to make the experiments was not ready.

Before going into details of each of these applications of our system of turbine, it may be well to set forth some of the obstacles which arise in using turbines for the propulsion of vessels; obstacles which, in the author's opinion, can only be satisfactorily overcome by a joint use of reciprocating engines and steam turbines.

As to the advantages of turbines, these are well known: absence of vibration, great reduction of weight, ease in handling, absence of wear and tear, etc. There is no need further to insist upon them.

The three principal difficulties in applying turbines to the propulsion of ships are as follows: (1) Design and arrangement of propellers for a high speed of rotation; (2) Efficiency of turbines at low speeds; (3) Reversing and maneuvering powers.

(1) Arrangement of Propellers for a High Speed of Rotation.

When the turbines are not restricted to any particular speed of rotation a very high efficiency can be obtained, certainly higher than that of the best reciprocating engines.

The author's experiments confirm this fact, which had already been shown by the published trials of the Parsons turbine. Unfortunately, the best speed for turbines is usually much too great for screw propellers. In high-speed vessels, by some give and take between engine and propeller, a working agreement can be arrived at; but it is not easy to do. The gearing of the rings has to be higher than with a turbine for other purposes, and the turbine itself must be divided up into several sections in series, and, further, it is necessary to devise some arrangement for the propellers by grouping them either singly, in pairs, or in threes on several shafts, and to so increase their surfaces that the extreme outside diameter shall be greater than the pitch, all of which tends to reduce the total efficiency of the engine and propellers.

If, therefore, the turbine is theoretically superior to the reciprocating engine as regards consumption of steam at full speed, it is not by any means certain *a priori* that the joint efficiency of both engine and propeller is better or even as good.

The practical difficulties, moreover, increase as the speed diminishes, for in the first place the total surface (and consequently the size of the propellers) is mainly determined by the principal cross-section of the ship, whereas, on the other hand, the size of the turbines is limited only by the speed of rotation, and not by the power developed. The speed of the turbine must be reduced in proportion to the speed of the ship, so that the dimensions of the former are increased, either by the number or the diameter of the moving rings, while the power diminishes approximately as the inverse of the cube of the speed. There is, therefore, a lower limit of speed, below which the use of turbines cannot be recommended. The author has already expressed the opinion (in a paper read before the Association Technique Maritime in 1902) that this limit is in the neighborhood of 20 knots. The author is aware that certain ships now under construction for transatlantic service, and of a proposed speed of 17 knots, are being fitted with turbine engines, but the future will show how these will turn out.

(2) Efficiency at Low Speed.

If the steam turbine is capable of giving good results at the maximum power, it cannot be gainsaid that the results are certainly unsatisfactory at reduced speeds, not so much on account of the reduction of power, as on account of the reduction in the speed of rotation, which involves a lowering of what is termed the "hydraulic efficiency" of the turbine. The increase in the coal consumption at speeds of, say, 12 to 15 knots, at which they are usually working, would, however, greatly diminish their radius of action. A partial remedy, as used by Mr. Parsons, may be effected by adding a supplementary turbine for cruising purposes, into which the steam first enters when proceeding at low speeds. This, however, does not improve the hydraulic efficiency of the turbine, and the steam consumption nevertheless remains high.

The author considers that under no circumstances can turbines alone be economically worked at low speeds, and that the only satisfactory solution is the employment of a reciprocating engine of more or less power, according to the circumstances, in conjunction with turbines. With this combination, economical results can be obtained at all speeds, and an example of this will be given later.

(3) Reversing and Maneuvering Powers.

With a reciprocating engine, stopping and reversing are effected in the simplest possible manner, whereas, the very principle of the turbines is essentially opposed to this. Various inventors have tried to solve this problem by means of special blades to enable the same rings to be used for both directions of motion, but these attempts do not appear likely to come to anything, as one can only obtain reversibility by a considerable sacrifice of efficiency in forward motion. It is, therefore, necessary to supplement the turbine by special engines for going astern, and, as it is obviously impossible to have the latter as powerful as the former, one must be satisfied with a very much smaller speed astern than ahead. This difficulty in freely going astern makes maneuvering very awkward. The engine for going astern may be a reciprocating one, which would also be of use for going ahead, but it can just as well be a steam turbine. From the very start, Mr. Parsons used in his vessels special turbines for going astern, and these were attached to the same shafts as the main turbines; but this arrangement has the inconvenience of taking up a good deal of space lengthways.

In my patent of 1898 I have indicated how these can be fitted so as to be, as it were, hidden inside the main turbines on the low-pressure side, and without taking up any additional space. When they revolve freely, the astern rings offer no appreciable resistance while the main turbine is at work, and, conversely, the latter is idle when the astern turbine is in motion. This is the arrangement we have got in torpedo boat No. 243 and in the "Libellule," and it has the advantage of great simplicity. I think that Mr. Parsons has also made use of a similar arrangement in a certain number of his recent vessels.

According as the astern turbine is more or less developed, so the astern speed is more or less increased. With a single live ring, as on torpedo boat No. 243, and for the same expenditure of steam, the stern speed will be about 40 per cent of the speed ahead, but with two rings it can be increased to 50 per cent. Adding more rings, however, adds very little to the speed, unless the number is so greatly increased as to make this engine almost as important as the principal one.

For quickly stopping a vessel, turbines are apt to be inconvenient. After steam is cut off, the propellers continue to revolve by the action of the water, and they usually carry around with them the live rings, for the resistance to rotation is very slight. One can, however, increase this resistance by admitting steam in the opposite direction on the astern rings.

This question of stopping, reversing, and maneuvering is one which, in the author's opinion, may prove a serious hindrance to the extensive use of turbines for ship propulsion. It is particularly important for warships to be able to maneuver with ease, and it will necessarily lead to the adoption of a combined system of turbines and reciprocating engines.

Combined Use of Turbines and Reciprocating Engines.

For the various reasons given above, the best solution appears, therefore, to be the simultaneous employment of a reciprocating engine and turbines attached to independent shafts, in order that the reciprocating engine may be used at any speed. Each kind of engine is thus adapted to the work which suits it best. The reciprocating engine does for slow speeds, while the turbines come into play progressively as the higher speeds, up to the maximum, are required. They can, moreover, be equally well arranged for going astern, and the combination of the two then makes maneuvering almost as easy as with ordinary twin screws. An effective horse-power astern of 75 per cent, or more, of that when going ahead can thus be obtained.

The power of the reciprocating engine should not be less than one-sixth of the total, and it can quite well be increased to one-third or even to one-half of the maximum horse-power. It may be urged that this arrangement is complicated, and that if such an important reciprocating engine is to be retained, it is better to stick to the present system. In reply to this objection, however, the following advantages may be shown: (1) Reduction of weight, although rather more space is taken up in plan; (2) Easier working and maintenance, and subsequent saving in personnel; (3) Reduction of the vibration due to the reciprocating engines; (4) Increased efficiency, as the turbine is particularly suited to utilize the expansion of steam up to its extreme limit. It may be estimated that the increase in power for the same consumption of steam would amount to 15 to 20 per cent, or, in other words, that 5 or 6 per cent increase of speed would be obtained by the arrangement here proposed.

Moreover, this arrangement will make it possible to bring the turbines advantageously into play at a lower limit of speed. With turbines alone, this limit is about 20 knots, whereas, with the combined system, it is possible to begin at 15 knots, or perhaps even less.

Mr. Parsons, in a paper read before the Institution of Shipbuilders and Engineers in Scotland, on "The Marine Steam Turbine and its Application to Fast Vessels," spoke of the speed of rotation of turbines falling when at reduced speed within the limits of those at which reciprocating engines can work, and he proposed to attach the latter on the same shafts as the main turbines, and have both work side by side. At reduced speeds these triple-expansion reciprocating engines would receive steam straight from the boilers, and expand it to, say, atmospheric pressure. The steam would then pass into the high-pressure turbine, and thence into the low-pressure turbine before reaching the condenser. When the power and speed are such that the speed of rotation rises above the limit for reciprocating engines, the steam will be cut off from the latter, and the turbines alone will propel the ship. With this arrangement, the reciprocating engines would, therefore, be useless at the very time when the greatest power is required, and there would, further, be a chance that the engineers might not throw the engines out of gear at the right time, and so cause an accident. This direct coupling of engines, essentially adapted for very different speeds of rotation, is obviously unsound. The only rational arrangement, in the author's opinion, is to make the reciprocating engine mechanically independent of the turbine, by having it act on a shaft and propeller of its own. But as regards the supply of steam, this can be combined in various ways with that of the turbine, either side by side, as in Messrs. Yarrow's boat, or in series, by having the steam begin on the reciprocating engine and complete its expansion in the turbines. A special combination of this kind, quite different to those already suggested by Mr. Parsons, is what the author advocates.

Results Obtained with the Rateau Turbine.

Description of the Engine.—The author's design of turbine has already been described in several publications. It need only be stated that it consists of a series of flat moving rings, varying in number according to the requirements, and fitted on a single shaft. These rings are placed between circular disks whose rims fit into grooves on the inside of the casing. The shaft traverses these diaphragms through bushes, which allow but little play. Elsewhere, the clearance between the moving and the fixed parts generally exceeds the 3 millimeters, and can even be as much as 5 or 6 millimeters without causing trouble. With this arrangement, and by using the work by "impulse" instead of work by "reaction," we have sought to obtain an engine using as little steam as possible, simple in construction, needing but little care in working, and capable of running for a long time with but little wear and tear, which, although inevitable, can yet be reduced to a very small amount. The loss of steam is entirely confined to the clearance allowed around the shaft. Moreover, the live rings are so constructed as to be very light, and this is of advantage in reducing the gyroscopic effect which comes into play when the vessel pitches.

It has been said that with this system, supposing one could reduce the loss of steam to a minimum, it would, on the other hand, greatly decrease the efficiency by the friction between the rings and the steam contained in the chambers in which the rings rotate. As a matter of fact, however, the friction in our engines of 1,000 to 2,000 horse-power amounts to only 2 or 3 per cent of the maximum power—an insignificant proportion—whereas in turbines without diaphragms, the loss by the escape of steam reaches 10, 15, and even 20 per cent of the maximum horse-power, directly the clearances increase at all. All the trial results so far obtained show that our system of turbine is extremely economical in steam consumption. Here are a few of the principal results obtained:

Turbines of the Torpedo Boat No. 243.—These were the first multicellular turbines which have been constructed from our designs by Messrs. Sautter-Harlé & Co., in Paris. These turbines were designed some five years ago, and several improvements have been since effected which considerably diminish the consumption of steam.

A turbine exactly similar to the one installed in torpedo boat No. 243 was tried under the direction of the French Admiralty engineers in the workshops of Messrs. Sautter-Harlé & Co. This engine was coupled to a three-phase alternator, so as to measure exactly the effective horse-power of the turbine. The electric current generated was taken up by liquid resistance. As the losses of energy in the alternator had been measured, it was possible to calculate the net effective horse-power of the turbine, and consequently its efficiency. By the "efficiency" of the turbine is meant the ratio of the effective power which it develops on the shaft to that which the steam consumed is capable of giving, assuming that there is no loss between the pressure at admission and the pressure at exhaust into the condenser. This experiment gave a result higher by 1 per

* Read at the spring meeting of the forty-fifth session, held in the hall of the Society of Arts, London, March, 1904.

cent than had been originally estimated, viz., 54 per cent instead of 53 per cent. The curves there drawn are obtained by reducing the speed of rotation to the uniform speed of 1,700 revolutions per minute, and the condenser vacuum to 26 inches of mercury. It will be seen that at full power, with a steam pressure at admission to the turbine of 145 pounds per square inch, the consumption per effective horse-power on the shaft is 15.2 pounds. At the normal speed of 1,800 revolutions per minute, for which the engine was designed, the efficiency is rather higher, and the steam consumption rather lower.

We can now make engines of this power with 60 per cent or even 70 per cent efficiency, according to the speed of rotation which can be used for the turbines, depending on the use for which they are designed.

The turbine for the Yarrow boat has not yet been tested at the works up to its full speed, but from previous calculations it is estimated that the efficiency should be 61 per cent at a maximum of 2,000 horsepower, with a normal speed of 1,500 to 1,600 revolutions per minute. The loss due to friction between the rings and the steam is only 41 horse-power, or 2 per cent. With 170 pounds per square inch pressure, and a vacuum of 27 inches, the consumption of steam of this engine is 8.2÷0.61=13.4 pounds per effective horsepower hour, which corresponds to 11.7 pounds per indicated horse-power for a reciprocating engine having 12 per cent loss due to internal friction.

Other turbines driving alternators, continuous-current dynamos, centrifugal pumps or fans, and constructed by Messrs. Sautter-Harlé, have been carefully tested, and among the results obtained, I would call attention to the following:

An engine of 600 horse-power, at 2,400 revolutions per minute, consumes 14.6 pounds per electrical horsepower per hour. The efficiency of the dynamo being 91 per cent, it follows that the consumption of steam for the turbine was 13.3 pounds per effective horsepower hour, or 11.3 per indicated horse-power hour, assuming the efficiency of the reciprocating engine to be 85 per cent, the steam pressure at admission being 142 pounds, and the condenser vacuum 26 inches.

An engine of 350 horse-power driving an alternator at 3,000 revolutions per minute showed a consumption of 26.2 pounds per kilowatt generated by the alternator (including exciter), the steam pressure at admission being 152 pounds, and the condenser vacuum only 24 inches. The efficiency of the alternator being 87 per cent, this corresponds to a steam consumption of 14.1 pounds per indicated horse-power. It will be seen that this was a case of a relatively weak engine working with a very poor condenser vacuum.

A low-pressure turbine of 350 horse-power, installed in a mine at Bruay, gave an efficiency rather higher than the above, the total efficiency of the turbine and dynamo combined reaching 58 per cent, or for the turbine alone 63 per cent. Recent tests have shown that the efficiency of this engine has remained the same after a year and a half of continuous work, and no appreciable increase in total steam consumption for the same amount of energy produced has been observed.

A turbine pump of 500 horse-power, for raising 950 gallons per minute to a height of over 1,200 feet, and which was recently tested, gave a consumption of 22.5 pounds per horse-power hour in actual water raised, the pressure at admission being 90 pounds per square inch, and the condenser vacuum 26 inches. The efficiency of the pump being 70 per cent, this corresponds to an efficiency of 61 per cent for the turbine. In all the above cases the steam was not superheated.

It will be seen from these examples that even for engines of only 300 to 600 horse-power a working efficiency of over 60 per cent can be obtained, while for engines of 1,000 horse-power and over, it is certain that upward of 65 per cent efficiency can be realized, as already stated. Hence it is easy to arrive at the consumption of steam per effective horse-power under various circumstances, by using the formula which I have already given. For instance, we could guarantee that for an engine of 5,000 to 6,000 horsepower, supplied with steam at 150 pounds, and superheated to 350 degrees Centigrade, with 28 inches vacuum, the consumption per effective horse-power would not exceed 9.6 pounds, which corresponds to 8.6 pounds per horse-power hour, assuming 10 per cent to be lost in internal friction.

In order to properly understand the value of these figures, it is necessary to compare them with those obtained with reciprocating engines. When the expansion of steam in the cylinder has been carried sufficiently far, which occurs at from one-half to two-thirds of full power, the efficiency of powerful reciprocating triple-expansion engines is as much as 62 per cent (this is net efficiency; that is to say, the ratio between the work performed on the shaft and the work that the same amount of steam would give with no loss). But this is not the case when the engines are working at full power, for then, in order not to increase the weights too much, especially on warships, one must increase the admission to the cylinder up to and even beyond 70 per cent. From an investigation made by Mr. Lelong, French Admiralty engineer, published in the Transactions of the Association Technique Maritime (1899), the efficiency in work delivered on the pistons of several engines of from 3,600 to 8,400 horsepower, varies from 51.7 per cent to 57.8 per cent, or an average of 55.2 per cent. (Carnot, Charles-Martel, du Chayla, Galilée, Lavoisier.) Deducting therefrom 8 per cent for internal friction losses, this would leave 51 per cent for the net efficiency, whereas, from what has been said above, steam turbines can easily yield over 60 per cent net efficiency when working at full power.

I will now give a few details of the application of these turbines to ship propulsion.*

(To be continued.)

* There are, at the present time, either in use or in process of construction, over 50 turbines of the Rateau design, with an aggregate of 25,000 horse-power, of which 6,200 horse-power are used for ship propulsion, 950 horse-power for turbine pumps, and 760 horse-power for turbine fans.

ELECTRIC THEORY OF MATTER.

In a recent number of Harper's Magazine Sir Oliver Lodge presents a popular account of the electronic theory, which is well worth quoting:

Our present view of an atom of matter, says Sir Oliver, is something like the following: Picture to one's self an individualized mass of positive electricity, diffused uniformly over a space as big as an atom—say a sphere of which 200,000,000 could lie edge to edge in an inch, or such that a million million million million could be crowded tighty together into an apothecary's grain. Then imagine disseminated throughout this small spherical region a number of minute specks of negative electricity, all exactly alike, and all flying about vigorously, each of them repelling every other, but all attracted and kept in their orbits by the mass of positive electricity in which they are embedded and flying about. In so far as an atom is impenetrable to other atoms, its parts act on the sentinel principle, not on the crowd principle.

There are two ways of keeping hostile people out of an open building; one is to fill it with your own supporters, another is to place an armed policeman at every door. The electrons are extremely energetic and forcible, though in bulk mere specks or centers of force. Every speck is exactly like every other, and each is of the size and weight appropriate to the electron. Different atoms, that is, atoms of different kinds of matter, are all believed to be composed in the same sort of way; but if the atoms of a substance are such that each possesses twenty-three times as many electrons as hydrogen has, we call it sodium. If each atom has two hundred times as many as hydrogen, we call it lead or quicksilver. If it has still more than that, it begins to be conspicuously radioactive.

It would seem as if the excessive radiation which follows upon an overcrowded condition were caused by the probability of collision or encounter between the parts of an atom; just as every now and then among the stars in the sky two bodies encounter each other, and a great blaze of radiation, or temporary star, results. Even in atoms of which the parts are sparsely distributed such occurrences are not impossible, though they are less frequent, and accordingly it is to be expected that every kind of matter may be radioactive to a very small extent; a probability which is now justified for most metals, by direct experiment with very sensitive means of detection.

Indeed, so far as radiation necessarily accompanies any change of motion of an electron, and in so far as in every atom some electrons are describing orbits and are therefore subject to centripetal acceleration, a certain amount of atomic radiation is inevitable, on the electric theory of matter. In most cases it is imperceptibly small, but it must be there, and accordingly an atom must be slowly undermining its own constitution by the gradual emission of its internal or intrinsic energy in the form of ether-waves.

Thus, then, it is reasonable to expect that, every now and then, an atom will break up or collapse or divide into parts. This process has been observed by Rutherford, of Montreal. The radiation from many of the radioactive substances, on being analyzed by a magnet, is found to be separable into three parts: 1, the so-called B rays, which are the shot-off electrons already mentioned; 2, some G rays, which appear to represent an ethereal pulse—an analogue as it were of the sound-wave caused by the explosion or act of firing; and 3, more important than either, a third kind of projectile called the A rays, which are newly-formed atoms of foreign matter or new substance. These are pitched away with extraordinary violence as the atom breaks up; they produce by their bombardment of zinc sulphide the bright little flashes seen in Crookes' spinthariscope, and they likewise generate heat when they are stopped by any obstacle. They thus keep the vessel in which they are inclosed at a temperature a degree or two above surrounding bodies, at least in the case of the most active known substances, radium and its emanation. For radium converts its own intra-atomic energy into heat at so surprising a rate that it could, if all of the heat were economized and none allowed to escape, raise its own weight of water from ordinary temperature to the boiling-point every hour.

The number of atoms breaking up in any perceptible portion of radium salt must be reckoned in millions per second; nevertheless, the proportion of atoms which are thus undergoing transformation at any one time is extremely small. If they could be seen individually most of them would appear quiescent and stable. Of every ten thousand atoms, if a single one breaks up and flings away a portion of itself once a year, that would be enough to account for all the activity observed, even in the case of so exceptionally active a substance as radium; hence the apparent stability of ordinary matter is not surprising.

The thus projected atomic fragments were measured by Rutherford, who found them deflected by a magnet in the opposite direction to the electron projectiles, and were therefore proved to be positively charged; but they are deflected so slightly that they must be very massive bodies, 1,600 times as massive as an electron, or twice the atomic weight of hydrogen. A substance with this atomic weight is known, viz., helium; and surely enough the discoverer of helium, Sir W. Ramsay, working with Mr. Soddy, a recent colleague of Rutherford, has witnessed the helium spectrum gradually develop in a tube into which nothing but radium emanation had been put.

Matter, then, appears to be composed of positive and negative electricity and nothing else. All its newly-discovered, as well as all its long-known, properties can thus be explained—even the long-standing puzzle of "cohesion" shows signs of giving way. The only outstanding still intractable physical property is "gravitation," and no satisfactory theory of the nature of gravitation has been so far forthcoming. I doubt, however, if it is far away. It would seem to be a slight but quite uniform secondary or residual effect due to the immersion of a negative electron in a positive atmosphere. It is a mutual force between one atomic system and another, which is proportional to the number of electrons in each. It is quite doubtful whether it is displayed by an isolated, or disembodied electron, but the act of immersing an electron in its attracting atmosphere may develop it. We know too little about electricity, especially about positive electricity, to be able to justify or expand such a guess; but, as a guess and no more, I venture to throw it out; believing it to be a static residual strain effect, inherent in the constitution of each atom.

CONTEMPORARY ELECTRICAL SCIENCE.*

Emission of N-Rays by Ferments.—In connection with the work of Charpentier and Meyer, M. Lambert has inquired whether the soluble ferments, whose action is so important in the functions of most tissues, do not also emit N-rays. The experiments made in this connection gave an affirmative result, especially in the case of the ferments concerned in the digestion of albuminoid matter. Thus, a small morsel of fibrine placed in a tube containing activated pancreatic juice shows an emission of N-rays whose effect disappears shortly after the tube has been removed. A similar effect is produced by placing a piece of fibrine in artificial gastric juice consisting of a 5 per cent solution of pepsine mixed with a 0.4 per cent solution of hydrochloric acid. The tube in which the digestion was going on could be picked out of a number of others containing various substances by means of the luminosity it produced on the screen. The author describes a direct photographic verification of this effect, which is of considerable interest. He took two small portions of the same sulphide screen, and after a short exposure to sunlight placed them on two separate photographic plates, with a digestion tube mounted over one of them. On development it was found that the screen exposed to the digestion tube had produced a darker patch on the photographic plate than the other screen. The author believes that the strains undergone by the fibrine in the digestive process bring the phenomenon into line with Blondlot's experiments on N-rays from strained bodies.—Lambert, Comptes Rendus, January 25, 1904.

Action of a Magnetic Field upon Faintly Luminous Bodies.—C. Gutton has found that the effect produced by N-rays upon a luminescent screen may be imitated by means of a non-uniform magnetic field. If a piece of cardboard provided with several patches of collodion emulsion containing phosphorescent sulphide is shifted along a bar magnet, it is noticed that the patches near the poles are brighter than the patches near the middle of the magnet. To eliminate any possible effect due to N-rays, the author inclosed the magnet in a leaden box but without thereby affecting the result. The action also takes place in a vacuum, for a screen inclosed in a vacuum shows the same effect. If a solenoid is used instead of a magnet, it is noticed that no effect is produced in the center of the coil, though the field is strongest there, but that the strongest effect is produced where the field is least uniform. No effect is produced between the pole-pieces of a powerful Faraday magnet, but a decided effect may be observed just outside. Generally, the screen shines out when placed in a field whose lines of force are not parallel. The effect is extremely sensitive. The slight modification of the earth's magnetic field, produced by a bar of bismuth, a solution of ferric chloride, or a wire traversed by a current of 10 microamperes and placed at a distance of 1 centimeter suffices to produce an increase in the luminosity of the screen. The author announces provisionally that he has thus succeeded in proving the magnetic effect of electric convection. He also states that the non-uniform magnetic field, like the N-rays, produces an increase in the sensitiveness of the human eye. He employed screens of black paper, lead and other substances in order to separate the various effects.—C. Gutton, Comptes Rendus, February 1, 1904.

Emission of N-Rays by Plants.—E. Meyer has found that plants emit N-rays whether they are kept in the dark or are exposed to light, and that there is no difference due to the action of light. He kept plants for five days in the dark, and found that at the end of that time all their parts emitted N-rays. Seeds, sown and germinated in the dark, and in a closed vessel, emit N-rays in the same manner as plants germinated in the ordinary way. Nor is any difference made by sowing the seeds in a leaden box so as to avoid the storage of N-rays coming from without. Thinking that the action of the containing vessel might have something to do

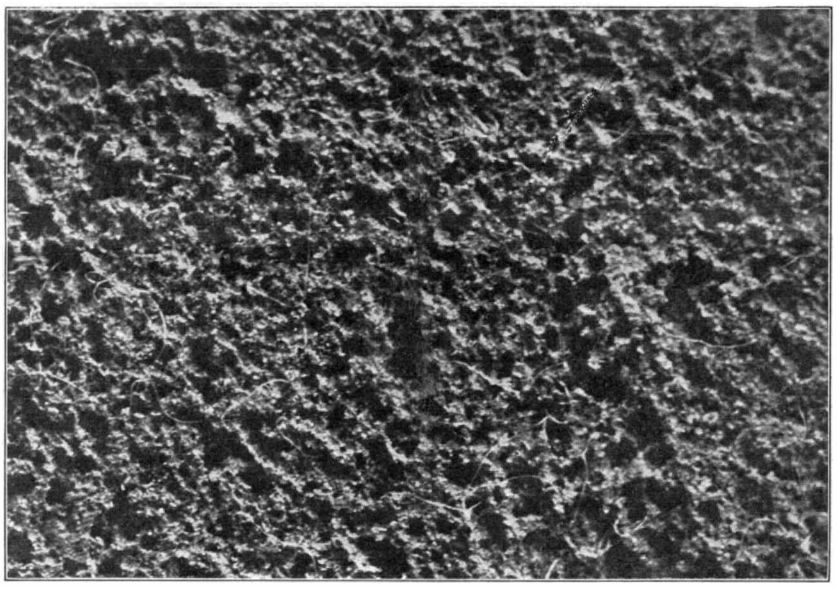
* Compiled by E. E. Fournier d'Albe in the Electrician.

with this uniformity in the results, the author floated the germinating seeds on cotton wool in a large vessel full of water, but the screen shone out in the same manner as before.—E. Meyer, Comptes Rendus, February 1, 1904.

THE JUNGNER NICKEL-IRON ACCUMULATOR AND ITS ORIGIN.

By M. V. SCHOOP.

IN a lecture delivered before the New York Electrical Society several months ago, Mr. M. A. Fliess offered new information about the conception and technical development of the Edison accumulator. From these statements we learn that Edison began his investigations in 1900 and that already, in the course of 1901, he was enabled to obtain ½ ampere-hour per gramme of nickel and 0.57 ampere-hour per gramme of iron, and that these results induced Edison to construct a technically useful accumulator of the same materials. We learn further that the earlier Edison cells, contrary to the present ones, were very sensitive to overloads, and as soon as the current drawn from them became five times as great as the normal one, the cell lost 37 per cent of its watt-hour output. At the same time great difficulty was experienced in finding a special insulating material for the interior of the cell, as the use of ordinary hard rubber caused the formation of considerable foam. By means of a photographic representation, it was shown how two Edison cells on one scale-pan of a balance are equalized by one lead accumulator. Finally Mr. Fliess gave exact data about the weight, capacity, etc., and especially called attention to the length of life of the Edison accumulator.



APPEARANCE OF THE SURFACE OF AN ELECTROCHEMICALLY-FORMED POSITIVE PLATE OF NICKEL.

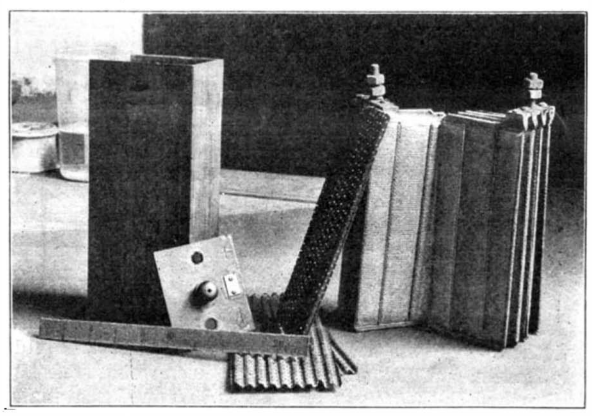
All this would be very interesting if it did not cause the reader who is not in close touch with this field to believe that the true credit for the invention belongs to Edison. I have no desire or intention to belittle Edison's achievements in the development of the nickel-iron accumulator. However, concerning the priority of the invention, the proof is easy to find that others, and foremost among them Dr. Jungner, of Stockholm, have, long before Edison, proposed and attempted the combination of nickel and iron with caustic potash as an electrolyte. Edison began his labors in the field of alkaline accumulators in 1899 or 1900; Jungner, however, in 1892. In consequence, the first of Jungner's patents are of the year 1895; those of Edison, on the other hand, are of the year 1901. Nevertheless, the Edison accumulator is heard of on all sides, while the Jungner accumulator is still little known, a striking example of the value that may be attached to well-managed advertisements. Jungner has devoted an enormous amount of time, industry, and money to the nickel-iron accumulator, and for twelve years has worked with that determination so often found in the Northern type, at the perfection of the alkaline accumulator without a soluble electrode and without variable electrolyte. Jungner is, however, as indicated, averse to all advertisement and thereby not only the geographical antipode of his famous American rival.

I.

The well-known combination, proposed by Lalande, of copper and zinc in a caustic potash solution served Dr. Jungner as a basis for the experiments begun in 1902, and he proceeded as follows:

Sheet copper was coated with copper oxide or some other depolarizing substance. Upon the opposite electrode, where sheet copper also served as support for the active masses, the most widely different oxygen combinations of metals, especially that of iron and nickel, were investigated. Between the prepared sheets of copper was placed a sheet of asbestos soaked in KOH solution, and the whole was pressed together in a letter-copying press. While undergoing this pressure an electric forming current was passed through it. In several combinations these exceedingly primitive attempts yielded very small capacities. However, the value of these early investigations lay in this: that Jungner, without taking account of the current-giving reactions, became more ultimately acquainted with the behavior of the most widely different metals, especially of iron, and their oxidizing and reducing capacities.

In the course of these investigations Jungner noticed at the positive electrode that the substances giving off oxygen became good conductors, and with this idea in view he mixed them with graphite. He noticed, further, that the compression they had previously undergone had an advantageous influence upon the behavior of the electrode during the flow of current from the cell. In the English patent No. 15,880, of October 23, 1895, the experiences in question are clearly stated. In this patent the basic importance of the addition of graphite is dwelt upon. In this connection it should be stated that graphite is mined almost entirely in crystalline form (flakes and scales) and so placed upon the market. The depolarizing mass mixed with graphite was next sewed up into canvas bags and the current led in by means of yoke-shaped copper conductors. The canvas, when put into caustic potash, showed the property of contracting quite strongly, so that considerable pressure was exerted upon the inclosed mass. A zinc cylinder served as opposite electrode, and alkaline gelatine as electrolyte. This possesses the advantages, as well as the disadvantages, of the sulphuric acid-silicate-gelatine of Dr. P. Schoop, that is, it increases the internal resistance of the element and naturally hinders a quick diffusion of the electrolyte. As a result of the invention, a stock company was formed in Stockholm in the spring of 1895; and this company intended first of all to manufacture, on a large scale, dry batteries that could be regenerated, and to bring them into use at a low price. It was not till later that the question of strong current elements was aired and the copper oxide replaced by silver oxide. Practical tests of batteries of this kind were arranged by the company upon a small boat in Noviström near Stockholm. Meanwhile experience demonstrated rather soon that the entailed drawbacks of these accumulators (solubility of electrodes in a condition of rest and conditional regenerative capacity of the zinc electrode) could not be overcome. Moreover, the first cost of the material for the silver electrode was naturally very expensive.*



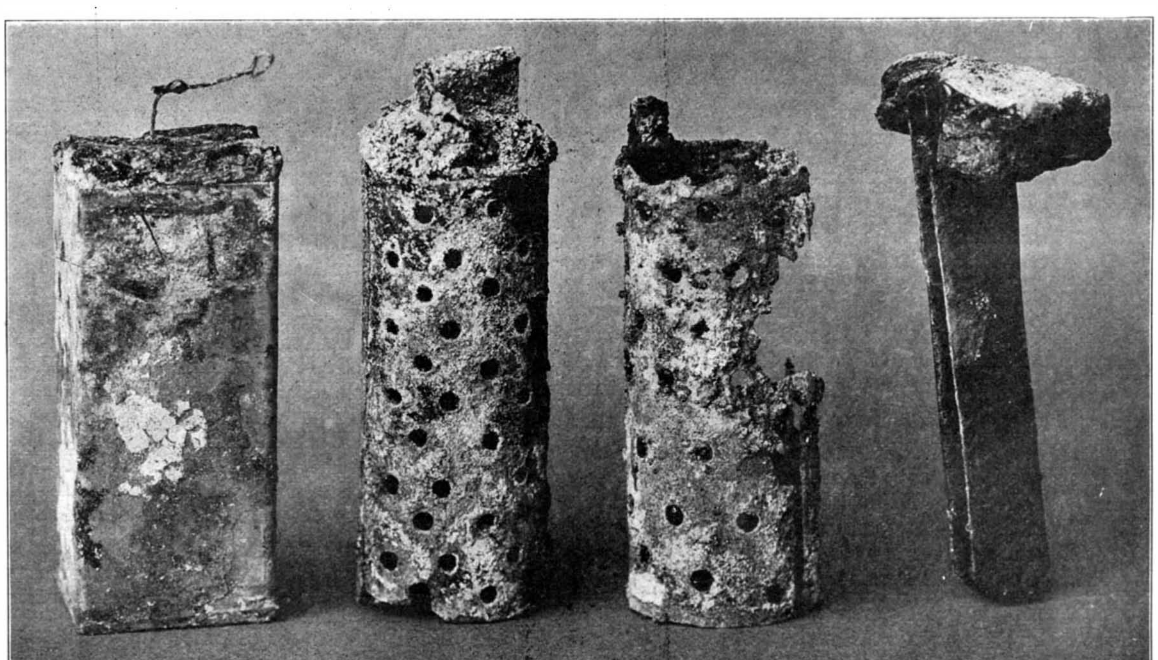
FIRST CELL RECEIVED BY HERR SCHOOP FROM DR. JUNGNER, AND WITH WHICH HE EXPERIMENTED A YEAR AGO.

Jungner now strove to use iron in its many different combinations with oxygen, for the negative electrode, but notwithstanding an immense number of experiments and much painstaking labor, without immediate success and without preventing the company from approaching dissolution. The capitalists declared themselves, as always, ready to keep up the Jungner patents as well as eventually to take over his new inventions by patent right and to utilize them commercially.

In the year 1896, Jungner made the invention of perforating the active masses between the sheet metal plates with many small holes, and already, in 1897, he was in a position to place before a larger public at the Scandinavian Industrial Exhibition in Stockholm accumulators with electrodes of this kind. The corresponding patent (England, France, Austria, etc.) is dated 1897. Jungner must have fully recognized, even at that time, the importance of this arrangement for the alkaline accumulator, for at this period a large number of investigations took place in which he attempted to use perforated pockets of sheet metal, which were filled with various metals in a finely divided state with caustic potash as an electrolyte. At first perforated copper pockets served to contain the materials. Into these the active substances were forced or pressed from above; and not till somewhat later did the investigations with sheet nickel occur. The arrangements with the copper receptacles were naturally still rather primitive, but were sufficient, however, to permit the study of the substances in question, that is, the metallic oxygen combinations which are insoluble in caustic potash. The first great difficulty encountered was that the active mass, notwithstanding the addition of flake graphite, was partly washed out and that the copper was frequently dissolved in considerable quantities. This was easily seen by the blue color imparted to the potash. As it did not seem impossible that under certain conditions the active materials of the alkaline accumulator could be used also with a changeable electrolyte, such as in the well-known example of red oxide of lead and other lead salts, Jungner worked for some time in this direction and first investigated the iron-oxygen combinations as to their capacities for combining and hardening. In the German patent No. 113,726, of August 26, 1899 (chloride of silver patent), as well as in the American patent No. 670,024, of December 5, 1900 (cadmium patent), Jungner clearly stated the names of the materials investigated in order to bring the active masses in combination in caustic potash.

The Jungner iron electrodes produced in the year 1897 were made in the following manner: A mixture of copper oxide and iron filings was spread upon a net of copper or iron wire, and this prepared electrode brought to red heat in a special muffle-furnace supplied with charcoal. By heating to red heat, there occurred in the presence of the iron filings and the carbonic oxide, a reduction of the copper oxide, which became more complete with the consequent electrolysis. Jungner seemed to have reached the desired goal to a certain extent with this method, for the capacity of an iron electrode manufactured in this manner seemed to be considerable.

* A quite complete description of the accumulators with alkaline gelatine manufactured by the Aktiebolaget-Torrackumulator, Stockholm, is found in the book "Upp finningarnas Book," Höft 3, A. Berglund, Stockholm, pp. 103 to 105.



SPECIMENS OF JUNGNER'S ACCUMULATOR AS IT WAS IN 1893.

1. Complete cell sealed with pitch. 2 and 3. Perforated zinc electrodes; the zinc cylinders surround opposite electrode, the active material of which consists of copper protoxide mixed with graphite and contained in a canvas bag. 4. Copper forked conductor for copper electrode, with pitch sealing compound attached.

Jungner experienced great difficulty in finding a metal which could be used as a support for the active material and which should neither dissolve while current was flowing nor while at rest. The inventor seemed to doubt the final possibility of solution of this problem when, in 1897, he accidentally made an observation that was to be of the utmost importance for the further perfection of the alkaline accumulator.

For an experiment Jungner needed a nickel plate which, as there were no new plates of that metal at hand, had to be taken from an old cell (nickel-manganese-superoxide in sulphuric acid gelatine) which had lain for years, neglected, in some dusty corner. The sheet nickel had been attacked by the sulphuric acid and in spots colored black-green. This old nickel electrode was then combined to form a small element with a zinc electrode in a caustic potash solution, and at once the action of this cell, when current was drawn from it, demonstrated with certainty a new reaction: nickel-superoxyhydrate of zinc. For many months this small cell was now uninterruptedly charged and discharged, and from time to time the weight of the sheet nickel compared with the original weight, whereby no diminution was apparent. In another attempt, Jungner used a mirror-like nickel sheet which he similarly treated in caustic potash *a la* Planté and examined for eventual change in weight and with the same result, that is, the nickel sheet remained bright and smooth. By reason of these and other investigations, Jungner became convinced that sheet nickel or steel coated with layers of nickel could be used exclusively as a support for both electrodes, and that highly oxidized nickel oxyhydrates applied in a suitable manner to nickel supports were remarkably good depolarizors. These ideas are already expressed in the chief Jungner patents of 1899 in a brief and precise form. Everything points to the conclusion that at this time the remarkably favorable property of nickel with reference to its ideal capacity for resistance to alkaline electrolysis, used as anode as well as cathode, was unknown. At the very least no such proposal is to be found in the entire technical or patent literature up to this time. Also, Jungner was surely the first who recognized that an accumulator with unchangeable alkaline electrolyte, which during charge and discharge in no wise changed either its chemical or its physical condition, must be far superior in every way to the lead accumulator. The reaction of the accumulator sought and now discovered by Jungner was, in discharging, thus:

$$Ka + AnO = KaO + An,$$

in which Ka and An are metals or metal oxyhydrates. In charging, the opposite reaction takes place. In consequence of this balance of reaction the electrolyte takes no direct part in giving current, but only effects the transport of oxygen from the positive electrode, where one must imagine it under great pressure, to the negative electrode, where one can conceive the oxygen under a very small pressure.

It is easily seen that the whole question is merely one of finding suitable metals with corresponding oxidizing and reducing properties, which are, moreover, completely insoluble in the electrolyte—a question of some difficulty.

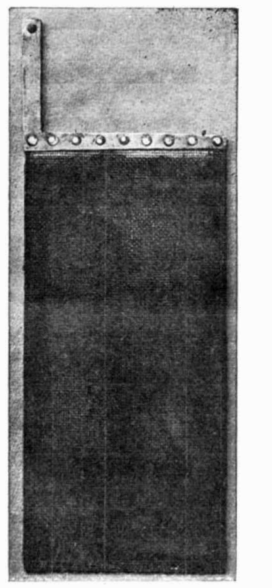
Jungner, in the year 1900, exhibited his first complete automobile batteries at the Scandinavian Industrial Exhibition in Stockholm. These batteries were constructed with silver and cadmium electrodes and possessed an exceedingly good capacity. This had been determined under the auspices of the official Board of Control. According to the report of the Electrical Test Bureau, an automobile provided with a Jungner battery covered 148.5 kilometers (89.1 miles) on one charge, a remarkable performance for that time. The wagon was supplied by the American Bicycle Co., Waverly Factory, Indianapolis, and weighed complete with battery (88 cells) 118 kilogrammes. The highest speed of the wagon was, even toward the end of the test run, 26.5 kilometers (15.9 miles) an hour.

The famous originator of the electrolytic dissociation theory, Svante Arrhenius, and Dr. P. Schoop have passed judgment upon this silver-cadmium accumulator and an abstract of this opinion of July 17, 1899, may be introduced here:

". . . At an average discharge of 8 watts the capacity showed itself to be 30 watt-hours (at 26 deg. C.); per kilogramme of total weight of the cells, about 40 watt-hours could be obtained. A capacity of this magnitude has not yet been obtained, and this circumstance alone is sufficient to insure general interest in the Jungner accumulator."

In 1899 Jungner received in various civilized countries a patent upon an alkaline accumulator with unchangeable electrolyte. In this patent, the action of an accumulator in which the current-giving reaction consists only in carrying oxygen from one electrode to another, is explained, with the silver-copper accumulator as an example, and there can be no doubt that most of the patent offices, foremost among them the German one, did not hesitate to give Jungner a basic patent on the above considerations.

Among other things, Jungner's procedure by which he provides nickel plates with a large surface stratum by electrolytic means is very interesting (compare English patent 1,684 of January 22, 1901). By this method the plate receives an enormous surface of a moss-like condition and form. Nickel Planté electrodes are produced in the following manner: The nickel plates are first acted upon by a current of electricity in a very dilute solution of caustic potash and chloride of sodium, and afterward formed in a 25 per cent solution of caustic potash. After some practice one easily succeeds in providing other metals, for instance copper and iron, with Planté surfaces of this kind. At present this forming action is chiefly of scientific interest. Meanwhile we may conclude with certainty that this invention of Jungner's possessed a far-reaching value in practice, similarly to what was the case in the Planté formative action of lead electrodes. It may be remarked that the complicated surface, resembling moss or cauliflower, naturally does not appear until the nickel hydroxide stratum which is in the pores has been eaten away by dilute hydrochloric acid.



SILVER ELECTRODE OF 1899.

The active material is contained in an elastic case of nickel wire gauze, which exerts a constant pressure upon the active material on account of its elasticity.

Electrodes treated in this manner, which presented to the naked eye even a surface of really ideal formation, were to be seen at the Paris Automobile Salon of 1903, besides a number of similar silver and cadmium electrodes, as well as a complete nickel-iron battery for automobiles. The idea that Edison first proposed the combination of nickel and iron and especially applied it, is a mistake; for, before Edison, Jungner received a patent upon this combination (prior claim of January 29, 1901) and stated the reactions in question.

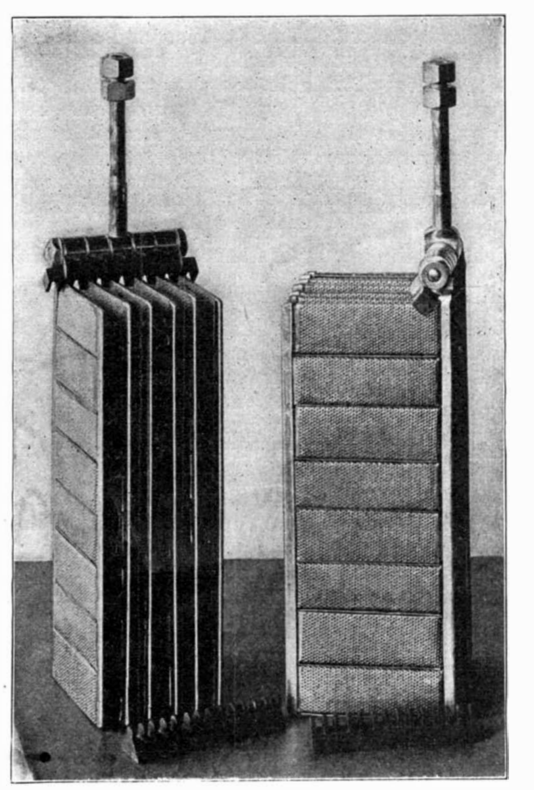
Discharge.

$$Ni\,O_2 + 2\,Fe\,(O\,H)_2 + H_2\,O = Ni\,O + 2\,Fe\,(O\,H)_3$$

Charge.

$$Ni\,O + 2\,Fe\,(O\,H)_3 = Ni\,O_2 + 2\,Fe\,(O\,H)_2 + H_2\,O$$

The attempts to use silver batteries in Stockholm were the cause of the founding of a strongly capitalized company, the Accumulator Aktiebolaget Jungner, whose factory and laboratories are to be found in Kneippbaden, near Norrköping. The manufacture, however, on a large scale was not attempted, as the first cost of material for this accumulator was so great. On the other hand, the silver accumulator proved itself better than the nickel accumulator in that it achieved a much greater capacity for work (up to 55 and 60



PLATES OF JUNGNER ALKALINE ACCUMULATOR, SHOWING METHOD OF ASSEMBLING.

watt hours per kilogramme of weight of cell). Further, the active mass of silver shows an extremely tough, felt-like condition; it does not have the unpleasant property of washing out under heavy discharging and possesses 6 to 8 times as much conductivity as the nickel mass.

I have frequently heard the opinion expressed that the lot of the Wadell-Entz accumulator, which gently passed out of existence, will fall to the nickel-iron and silver-iron accumulators, and that many years must still pass before the much-sought-for light accumulator is a reality. But these incorrect views may before long be disproved by facts.

II.

Concerning the technical construction of the present Jungner accumulator there is in general little to say, as it, with the exception of one or two minor details, differs very little from the Edison accumulator. As in the latter, the active material—a nickel and iron hydroxide compound—is embedded between two nickel plated, perforated, pocket-shaped, sheet metal receptacles, under a pressure of 400 kilogrammes per square centimeter (5,689 pounds per square inch), and, for the purpose of increasing the conductivity, flake graphite is added. Jungner increases the size of the pockets considerably over Edison. Only eight such pockets are used in a single plate. The plate thickness is about 3.5 millimeters (0.137 inch) for the positive electrode and 2.5 millimeters (0.098 inch) for the negative one, the distance between the plates is 2 millimeters (0.078 inch). As electrolyte, 20 per cent chemically pure caustic potash is used.

Jungner seems to have recognized very soon, as remarked before, the value of the addition of graphite. In order to increase the conductivity of the graphite and consequently also of the active substances, Jungner attempted, and with success, to provide the graphite with galvanic, metallic coverings. In some countries this process is already protected; in other countries the patents are applied for.

Comparatively great difficulties were encountered in finding a metal jar that would absolutely resist the action of caustic potash, that was comparatively cheap, fairly light, and yet sufficiently hard. Solders of any kind, as well as pewter, cadmium, or alloys of soft metals, are objectionable. On the other hand, it is possible to produce with ease faultless jars by means of the gas blow-pipe. The body is pressed out of a piece of 4-ply metal, and then the bottom is welded on by means of the oxy-hydrogen flame, that is, soldered on without the use of solder or cement.*

There are, moreover, attempts being made to manufacture the jars out of one piece, 5 millimeters in thickness, of nickel plated sheet steel, by means of the enormous pressure of 50 tons to the square inch.

The different methods of manufacture have been so simplified by Jungner as well as by G. Hagen, of the Kölner Accumulatoren-Werke, at Kalk, near Cologne, which firm, as is well known, last fall acquired the German rights to the Jungner patents, that there can be no doubt that the oft-stated objections that the first cost of manufacture would be two to three times as great as the cost of the transportable lead accumulator, will be overcome. This objection, among others, was brought up by Mr. M. A. Fliess in his lecture before the New York Electrical Society, on April 27 of this year, upon the Edison accumulator. In answer to this is especially mentioned, that Jungner, as well as myself, are decidedly of the opinion that the nickel-iron accumulator can be manufactured at least as cheaply as its much-despised elder brother, with the condition naturally that it is a question of manufacture on a larger scale. Especially have Jungner and G. Hagen been successful in the ideally simple and cheap production of special very finely divided iron dust, so that the expense caused by the nickel electrode is balanced completely by the cheap iron electrode. For a first cost comparison, the capacity for work in watt-hours with reference to the unit of weight is naturally taken as a basis, and it is well to take into consideration that the above opinion is held by people who have been identified with the accumulator industry for fifteen years and are, therefore, not liable to entertain too optimistic an opinion. If the comparison of the first costs were with reference to the total work done by the accumulator during the entire running time, the result would be still more favorable to the nickel-iron accumulator, as the length of life of this accumulator is several times as great as that of the other. As a fact, Jungner already, in the year 1900, made nickel-cadmium cells that easily stood 500 to 600 discharges without suffering in capacity. The exceptionally excellent length of life of the accumulator was confirmed by the German manufacturer, G. Hagen, of the Kölner Accumulatoren Werke, by means of permanence and life tests in the special charging and discharging apparatus. In general the nickel electrode appears to last somewhat longer than the iron electrode; also the nickel electrode appears to be unaffected by peculiar conditions, such as overcharging or change of polarization, while the iron electrode is only slightly affected by similar circumstances. Under normal conditions, however, the iron electrode also, gives no cause for worry. (Formation of ferric acid or passivity.)

III.

Concerning the priority of the invention of the alkaline accumulator with unchangeable electrolyte, the scientists disagree more or less; and even if this is not the place to completely discuss a question of such magnitude, the accompanying short exposé, as well as the chronological arrangement of the patents bearing upon the invention in question, may interest the reader.

* It may be remarked here that the requisite heat necessary to weld iron and especially sheet steel cannot be obtained with the hydrogen-air flame, as the nitrogen in the air must also be uselessly heated and lowers the temperature. The best results are achieved by using gases obtained electrolytically. The proportions of the mixture best suited for iron are 4 parts hydrogen, 1 part oxygen. This is not in the proportion produced by electrolysis. The oxygen of the atmosphere takes part in the combustion of hydrogen. Besides, the flame must have a reducing action, that is, must have a small surplus of hydrogen. (Compare also Dr. Englehardt: The Electrolysis of Water.)

ALKALINE PATENTS.

Name.	Number.	Date of Priority.	Brief Characteristics.
Dun, Frankfort, a. M.	German, P. 38,383	December 11, 1885	Zinc oxide potassium lye is used as electrolyte; as depolarizers, Ag_2 O, Cu O, Mn O_2, N_1 O among others, or their mixtures.
Lalande-Chaperon	American, 274,110	March 20, 1883	Zinc and copper protoxide in potassium lye.
Dr. H. Aron	German, 38,220	June 30, 1886	Mercury and zinc in potassium lye. Iron filings added to mercury.
Demazures	German, 41,995	March 15, 1887	Production of positive plates with porous metal under high pressure.
Dr. E. Böttcher	German, 57,188	March 27, 1890	As the bottom of the vessel is copper oxide, the zinc cathode hangs parallel to bottom. Zinc is deposited in crystalline grains.
Entz & Phillips	German, 66,891	January 26, 1892	Copper protoxide and zinc-covered sheet steel.
Krieger	French, 261,885	December 4, 1896	Nickel sesquioxide as positive electrode with zinc as opposite electrode.
Pollak, Frankfort, a. M.	German, 107,727	1899	Iron is proposed for cathode and anode.
Michalowsky	German, 112,351	April 19, 1899	Production of a porous nickel support by electrolytical means, the active mass, Ni O_2, being afterward placed in the pores of the nickel skeleton.
Dr. Jungner	German, 110,210 (Basic patent)	March 31, 1899	Alkaline accumulator with unchangeable electrolyte.
Dr. Jungner	German, 113,726	August 26, 1899	Silver-cadmium accumulator with unchangeable electrolyte.
Dr. Jungner	German, 6,182	1902	Forming of nickel electrode to obtain a greater surface.
Dr. Jungner	French, 252,491 English, 15,880	December 16, 1895 July 23, 1895	Addition of graphite to increase conductivity.

I do not claim that the table is at all complete, however.

The invention claims protected by patent by Jungner are stated tersely and clearly in the basic German patent No. 110,210 of March 31, 1899, as follows:

1. Use of active material supports made of metals that are not attacked by electrolytes.
2. Use of potassium or sodium lye as electrolyte.
3. The active mass of both electrodes consists of finely divided metals, insoluble in the electrolyte, for instance their hydroxides, by means of which free hydrogen is not given off during the operation of the battery.
4. The purpose, as stated in articles 1 to 3, is to obtain an unchangeable electrolyte, so that, on the passage of current, a simple transportation of hydroxide from one electrode to the other is effected.

As is well known, the German Patent Office demands that the inventor state his claims, where possible, in one sentence; and therefore it is easily understood why the American claims of Jungner, which were granted on September 1, 1903, despite the protests of Mr. Edison, are so much more precise and at the same time more detailed than the German ones. Common to both patents is the fact that they are basic ones on an accumulator with unchangeable, alkaline electrolyte. And that the patent offices of nearly all civilized countries did not hesitate to give Jungner the desired protection is easily an indisputable proof that Jungner can without doubt claim to be the first who announced the steps necessary to make an accumulator with an unchangeable alkaline electrolyte.

Finally may be mentioned that Jungner has received altogether in various countries about 70 different patents.

There is a certain unmistakable analogy between the inventions of Jungner and those of Faure in that the Faure patent No. 19,026, of February, 1881 (which, as known, was of the greatest importance to the general principle of the manufacture of lead accumulators) was immediately protected. C. A. Faure made detailed statements in the patent specifications about the making and forming of the active electrodes, as well as about the use of porous partitions. Meanwhile it is well known that nobody has succeeded in making technically useful lead accumulators by following Faure's directions; this was first achieved by the use of lead grids, an idea not conceived by Faure. (Compare Ger. patent No. 19,928, of December 9, 1881, by E. Volkmer.) But the principle that enabled us to manufacture lead accumulators of high capacity in a short time, was contained in Faure's patent, and every manufacturer who wished to make the accumulators rapidly, that is, not by the Planté process, had to respect the Faure patent.—Translated from the Centralblatt für Accumulatoren Technik und Verwandte Gebiete for the SCIENTIFIC AMERICAN SUPPLEMENT.

AQUATIC LEATHERS.*

By CHARLES H. STEVENSON.

THE crude skins and hides of aquatic as well as of land animals are easily putrescible when left in a green state, and if dried they lack suppleness, and are hard, unpliable, and almost impermeable to air. Leather, on the contrary, is one of the most imperishable of animal products, and is supple and porous to a greater or less extent according to the process of manufacture. To transform the crude skins into leather is the business of the tanner and the currier; the former removes the tendency to putrefaction and incidentally increases its strength, durability, and imperviousness to water, and the currier renders it soft and pliable and at the same time imparts to it such finish and coloring as suit the special purposes for which it is intended.

* Extracted from United States Fish Commission Report, 1902.

Leather is made from the skins of practically all the aquatic mammals and of some species of fishes; but at the present time, except among primitive people whose stock of raw materials is limited, these products rank among novelty or fancy leathers. Ordinarily the supply of aquatic animals yielding skins suitable for tanning is so small or so difficult to obtain, compared with the enormous quantities of domestic animals available, that the leather made from the former can not compete in price with that from the latter. The nearest approach to competition is in the case of seal leather, of which large quantities are produced each year, the value of the annual product averaging $1,500,000; but the durability and choice grain of this article secure for it a much higher price than is obtainable for a good quality of calfskin. The hide of the beluga, or white whale, is one of the best of all skins for leather purposes on account of its durability, strength, and pliability; it is sold as porpoise leather, and probably $200,000 worth of tanned hides are marketed annually. Alligator skins are also obtained in large quantities, and owing to the peculiarity of their markings, are used entirely as fancy leather; the total value of the output amounts to about $500,000 annually. Tanned walrus hides, and especially the thick ones, are in great demand for polishing wheels and other mechanical purposes, and probably $100,000 worth are sold annually. These are the only aquatic leathers which at present have an established position and a fairly constant price in the markets, but they are not the only aquatic leathers obtainable, the writer having collected 31 other varieties, although these are used in such small quantities that no constant market exists for them. Among those used to a less extent may be mentioned sea-lion, porpoise, sea-elephant, manatee or dugong, water moccasin, frog, otter, beaver, beaver tail, muskrat, and a variety of fish skins.

The art of the tanner has been so developed that the preparation of certain skins in imitation of others is by no means a difficult process.

The hides of walrus, sea-lion, sea-elephant, etc., are generally so damaged by the animals fighting among themselves, and from other causes, that, while the raw pelts may be abundant and cheap enough, it is difficult to secure them sufficiently free from defect to permit of their use as fancy leathers with economy. On this account, seal skins, which are comparatively free from the objection noted, are generally used to imitate those leathers, the tanning and currying process being so modified as to develop the peculiar grain desired; and while there is much genuine walrus leather, sea-lion leather, etc., the great bulk of that on the market sold under those names is made from seal skins.

The skins of fish are generally glutinous and soluble in water, but the texture of most of them is sufficiently firm and strong to permit of their use as leather, although their employment for practical purposes is rather limited. Skins of cusk, cod, eels, flatfish, and the like, have been converted into leather suitable for gloves, purses, boot tops, etc. The tubercular skins of many sharks, rays, and allied fishes are largely employed under various names for polishing purposes and for covering boxes, sword grips, etc. All of these miscellaneous skins are valued principally because of their peculiar grain or markings, and are tanned so as to bring the grain into prominence. Their use is principally in small articles as belts, cardcases, pocketbooks, and the like. Recently they have been applied to the artistic binding of books, planned at the suggestion of Mr. George F. Kunz. Among these was the catalogue of the Izaak Walton exhibition at the Grolier Club, New York city, in 1894. Beautiful effects have been secured by the use of various colored shark skins, polished to a smooth surface and frequently inlaid with some other material. The possibilities for the development of this use of fish skins are remarkable.

Fish skins are employed extensively in the preparation of glue and fertilizer stock. Especially notable in this connection is the waste from the New England factories engaged in preparing boneless codfish in the forms of bricks, and thousands of dollars' worth of skins of cod, hake, haddock, etc., are annually converted into fertilizer and glue.

HOISTING.

DOUBTLESS many people who look down into the depths of hoisting shafts or watch the rapid ascent and descent of cages during the busy hours of hoisting at a mine, would hesitate about accepting an invitation to step aboard and make the trip into the underground workings. These same people probably ride daily in elevators in office buildings without giving the matter a thought; and yet the conditions of operation of some of the "express" elevators in some of the highest skyscrapers approach those met with in mine shafts. Many elevators are, however, intrusted to mere boys to run, while, as a rule, the men who handle the throttle of hoisting plants are among the most reliable of the employes about the works. Occasionally we read about an accident such as the recent catastrophe at the Independence Mine, in Cripple Creek, Colo., or at the Dorrance Shaft, Wilkes-Barre, Pa., in both of which instances men were being hoisted out of the mine, and through some disarrangement of the mechanism, control of the engine was lost, the cage crashed into the head-frame, and then, with its load of human freight, dropped into the shaft with a distressing loss of life.

When we consider that thousands of men are daily lowered into, and hoisted from, the mines, the infrequency of such accidents is one of the best possible commentaries upon the excellence of the engines used and the skill and care of the hoisting engineers. Such accidents will doubtless be of less frequent occurrence with the improvements constantly being made in hoisting engines and the greater care exercised in the selection of men and their greater fitness for the position. Some states and countries allow certificated men only to handle hoisting engines, and the system has much to commend it; for intelligence, steadiness, and experience are necessary qualifications for those who may be confronted by an emergency and have to do the right thing instantly.

The contrast between one of the complicated hoisting engines used in the mile-deep shafts of the Lake Superior region or at the nearly equally deep shafts of Johannesburg, South Africa, and the hand windlass of the prospector, or the carrying of the ore to the surface on the backs of peons in Mexico, is very great; and a history of the gradual development of hoisting practice from stage to stage would be most interesting, but our space permits of only the merest mention of some of the most striking improvements during the last twenty years or so.

A study of the various forms of hoists, or rather the different kinds of power employed to operate hoisting engines, would be most profitable and interesting. Mines are becoming deeper and many deposits are now being worked, the development of which was only possible on a profitable basis by reason of the advance made in hoisting appliances, and in the transmission of power. For example, how well adapted the gasoline hoist is to remote sections where water is scarce and coal expensive. Or, again, when ore must be hoisted from mines remote from fuel, but with abundant water-power available within a radius of one hundred miles, an electric power station is capable of furnishing current to a number of hoists and other machinery about a plant. Numerous examples of this solution of the problem in the Rocky Mountain region both in the United States and British Columbia attest to its practical working.

While on the subject of electricity and in connection with stage hoisting, the deep-level mines on the Rand present a most attractive field to the designer of electric hoists; not to mention conditions in the Lake Superior region. Electric hoists placed underground to feed main shafts hoisting in stages is the plan engineers have advised for hoisting from great depths.—Mines and Minerals.

The engineers engaged in the work of constructing a telegraph and telephone line in the Belgian Congo country had to surmount several engineering difficulties in the negotiation of numerous broad rivers. The total length of the line is 750 miles. At Underhill, in order to carry the wire across the river, two steel pylons had to be erected. They were each 50 feet in height and were placed 2,620 feet part, and placed respectively 237 and 206 feet above high-water mark. The crossing of the Kasai River was, however, the most difficult feat. The work was hampered by the fact that the waterway had to be kept clear on account of the exigencies of the summer traffic. There was, however, an island in midstream, and advantage was taken of this. A pylon was erected here with others on either bank, the crossing of the river thereby being accomplished in two spans of 1,472 feet and 2,198 feet respectively. The river-bank ends of the spans were supported also upon pylons.

ELECTRICAL NOTES.

A great deal of thought and effort have been expended upon the recovery of tin from the vast number of tin cans and the tons of tin plate scrap that are annually rejected. Mr. John B. C. Kershaw reviews a number of the processes in the Electrical Review. The Germans lead in this work and may be said to almost monopolize it. They have eight factories which treat tin scrap electrolytically and reduce about 30,000 tons annually. Much of the tin scrap of this country goes to Germany, and in 1898 it brought as high as $5 a ton in New York. Tin scrap contains on the average 3.5 tin and 96.5 iron. The great drawback to the successful prosecution of this enterprise is the large proportionate cost of collection and frieght.

According to recent reports, the city of Berlin is to be provided with a new subway system which will use electric trains. The municipal commission charged with the question of city traction approved the new project for the subway at a recent meeting. According to the present project, which is due to the engineer, M. Krause, the line will connect the northern and eastern quarters of the city with each other and also with the central part of town. The total length of the line reaches about 5½ miles. It will no doubt take several years to construct the subway, probably four years, as it will be necessary to displace a large quantity of gas and water piping and also reconstruct several tramway lines which will need to be moved. The total cost of construction is estimated at $12,000,000. The trains will be made up of second and third class cars, like the present overhead lines.

It is reported that wireless telegraphy apparatus is now being used extensively by the Russian and Japanese fleets. All the Russian war vessels which are proceeding to the extreme Orient, as well as the portion of the fleet already there, are equipped with home-built apparatus of the Popoff system. The experiments which have been made with the Popoff apparatus on the different warships of the Baltic fleet have given very satisfactory results and show that the vessels can easily communicate at a distance of 60 or 70 miles. These experiments were carried out some time ago, and accordingly the Minister of the Marine decided to install a set of aerial telegraphy apparatus on the principal vessels of the war fleet. Several coast stations were also included in the system. To carry this out to the best advantage the Marine Department has now organized a special establishment or aerial telegraphy school at Cronstadt. The operators who are to take charge of the apparatus on board the vessels are put through a course of training in the school and become well acquainted with all the most recent developments in wireless telegraphy. In connection with the school there are also construction shops, where the Popoff apparatus is built. These shops have now equipped most of the vessels of the fleet. The Japanese have been quick to perceive the value of aerial telegraphy in military operations, as will be remarked by the fact that Admiral Togo is now in communication with the different vessels of his fleet, as well as with the different detachments of the army which lie in various parts of Corea. It is not stated what system of wireless telegraphy the Japanese are using.

An interesting little electrical appliance has been devised by Mr. B. H. Thwaite for automatically detecting hot bearings. A tube is applied to a receptacle on the bearing containing oil, and in the oil is placed a small electrical contact thermometer. When the temperature of the bearing rises sufficiently to expand the mercury to the contact point, says the Mechanical Engineer, a solenoid comes into action, which causes a red disk to appear in an indicator and at the same time lights a little incandescent lamp and rings a bell. Any number of bearings can be connected upon the indicator board, and the beginning of trouble is thus at once made known audibly and visibly, rather than at a subsequent period by the smell of burning oil. The device is simple and scientific, and enables the attendant to detect the trouble and apply suitable remedies. Many bearings quickly cool when the thick oil has been sufficiently liquefied by the heat to flow sufficiently free, as in the thrust bearings of electric motors. When cold, the oil in the bath may be quite thick and the lubrication imperfect, which causes the bearing to become hot, and remain so until the whole of the oil has also become hot, when it is better liquefied and appeases the trouble. The heating of the bearing therefore is not always to be taken as a sign of danger, but it is well to know it, and it should be closely watched and its progress noted. If only due to thick oil, it will speedily cool automatically. If due to more serious and permanent causes the Thwaite indicator will continue to sound. Apart from bearings, the principle is obviously applicable to many other matters, and the delicacy of adjustment is capable of being regulated to any degree of nicety required.

A writer in the Electrical Review (London) asserts that the one redeeming feature of the carbon brush for dynamos is its non-sparking tendency, which, in his opinion, does not compensate for its bad features. The carbon brush practically necessitates large commutators and extra expense of brush gear, large shafts, and longer machines, and therefore, must increase the cost of production by a large amount. Especially is this the case where large currents have to be dealt with. This practice results from the designer's doubt of the efficacy of metal brushes. Carbon brushes not only increase the first cost, but lower the efficiency, so that it frequently happens that this might be increased 2 or 3 per cent by the use of metal brushes. Consulting engineers demand carbon brushes, unmindful of the fact that so long as sparkless commutation is secured it is immaterial of what the brush be made. Comparing the design of a commutator for a six-pole 88-kilowatt parallel-wound armature for carbon and for metal brushes, it is found that the use of carbon necessitates three times as many brushes as the metal. For the former the commutator must be 17 inches long, and for the latter only 6. The watts lost, due to the friction of the carbon brush, number 1,025, as against 205 for metal. The watts lost, due to the resistance of contact of the former, are 1,260, as against 434, making the total loss 2,285 watts for carbon and 639 for metal. The watts lost per square inch are 2.51 for carbon and 2 for metal. The commercial efficiency with the carbon brush is 91.8 per cent; with metal, 93.4 per cent. The chief virtue of the carbon brush is its high specific resistance, which facilitates sparkless commutation. To secure a similar condition with metal brushes they may be subdivided with an insulating partition between the portions; or the central layers of metal may have a higher specific resistance. Where a reversible motor is employed a radial brush is necessary, but it would not be impossible to construct a satisfactory brush of this type out of metal.

TRADE NOTES AND RECIPES.

Plastic Metal Composition.—When soft, this composition adheres so firmly to all metals, as well as to glass, porcelain, and other substances, that it can be usefully employed as cement. In ten hours the mass becomes so hard and firm that it can be polished like silver or brass. The composition is prepared in the following manner: Copper oxide is reduced by means of hydrogen or copper sulphate by boiling a solution of the same in water with some zinc filings, in order to obtain entirely pure copper. Of the copper powder obtained in this manner, 20, 30, or 36 parts by weight, according to the degree of hardness desired for the composition (the greater the quantity of copper used the harder will the composition become), are thoroughly moistened in a cast-iron or porcelain mortar with sulphuric acid of 1.85 specific gravity; 70 parts by weight of mercury are then added to this paste, the whole being constantly stirred. When all the copper has been thoroughly amalgamated with the mercury, the sulphuric acid is washed out again with boiling water, and in twelve hours after it has become cold the composition will be so hard that it can be polished. It is impervious to the action of diluted acids, alcohol, ether, or boiling water. It maintains the same specific gravity, alike in the soft or the hard condition. When required to be used for cement, it can at any time be rendered soft and plastic in the following manner: A piece of the hard mass is heated to about 300 deg. R. and triturated in an iron mortar heated to 100 deg. R. till it becomes as soft as wax. If applied while in this condition to the deoxidized surfaces of two pieces of metal, these latter will unite so firmly that in about 10 or 12 hours the metal may be subjected to any mechanical process. The properties of this composition render it very useful for various purposes, and it forms a most effective cement for fine metal articles which cannot be soldered in fire.—Der Metallarbeiter.

Composition of Special Alloys.—Certain alloys or compound metals, called by the name of their inventor, or by the name of the factory where they are produced, or by some other name, are not found catalogued in chemical or metallurgical works. A list may be found useful.

Other alloys are designated by their properties, as fusible alloys, alloys resistive to acids, friction, etc.

Darcet Alloy.—This is composed of 8 parts of bismuth, 5 of lead, and 3 of tin. It melts at 80 deg. C. This is the reason of its being called fusible alloy. To impart greater fusibility, 1-16 of mercury is added; the fusing is then lowered to 6. deg. C.

Newton alloy melts at 100 deg. C., and is composed of 5 parts of bismuth, 2 of lead, and 3 of tin.

Bidery metal is composed of 31 parts of zinc, 2 parts of copper and 2 parts of lead; the whole is melted on a layer of resin or wax to avoid oxidation. This metal is very resistive; it does not oxidize in air or moisture. It takes its name from the town of Bider, near Hyderabad (India), where it was prepared for the first time industrially for the manufacture of different utensils.

Magnolia metal is composed of 40 parts of lead, 7½ parts of antimony, 2½ of tin, ⅛ of bismuth, ⅛ of aluminium, and ¼ of graphite. It is used as an anti-friction metal, and takes its name from its manufacturer's mark, a magnolia flower.

Aich Metal.—This alloy, which has a beautiful yellow-gold color, resists the action of sea water; it is hard and tenacious. Its composition is as follows: 58 to 60 per cent of copper, 36 to 40 of zinc, 0.75 to 1.75 of iron, and sometimes 1 of tin.

Albata Metal.—Copper, 40 parts; zinc, 32 parts; and nickel, 8 parts.

Alfenide Metal.—Copper, 60 parts; zinc, 30; nickel, 10; traces of iron.

Alger Metal.—Tin, 90 parts; antimony, 10 parts. This alloy is suitable as a protector.

Argusoid Metal.—Copper, 55.5 per cent; zinc, 23.2; nickel, 13.4; lead, 3.5; tin, 4; traces of iron.

Bobierre metal is nothing other than brass with 66 parts of copper and 34 of zinc. It is used in leaves for the lining of vessels.

Bibra alloy contains 8 parts of bismuth, 9 of tin, and 38 to 40 of lead.

Babbitt metal is composed of 4 parts of copper, 8 of antimony, 96 of tin.

Baudoin metal is composed of 72 parts of copper, 16.6 of nickel, 1.8 of cobalt, 1 of zinc; ½ per cent of aluminium can be added.

Ashberry metal is composed of 78 to 82 parts of tin, 16 to 20 of antimony, 2 to 3 of copper.

Ruoltz metal comprises 20 parts of silver, 50 of copper, 30 of nickel. These proportions may, however, vary.

Bourbon metal is composed of equal parts of aluminium and tin; it solders readily.

Retz Alloy.—This alloy, which resists the corrosive action of alkalies and acids, is composed of 15 parts of copper, 2.34 of tin, 1.82 of lead, and 1 of antimony. It can be utilized in the manufacture of receivers, for which porcelain and ebonite are usually employed.—Translated from the Revue de Chimie Industrielle.

SELECTED FORMULÆ.

Metal Polishing Soaps.—The following recipes give good polishing soaps:

(1) Twenty to 25 pounds liquid curd soap are intimately mixed with about 30 pounds of fine chalk, and ½ pound Venetian red.

(2) Twenty-six pounds liquid cocoanut-oil soap are mixed with 12 pounds tripoli, and 1 pound each of alum, tartaric acid and white lead.

(3) Twenty-five pounds melted cocoanut oil are saponified with 12 pounds soda lye, of 38 to 40 deg. B., after which 3 pounds rouge, 3 pounds water, and 2 ounces ammonia are crutched in.

Polishing soaps are generally cut into cakes and stamped or pressed, and brought into commerce with directions for use. The directions generally state, a small quantity of the soap is put on the metallic article to be polished with a damp flannel, and rubbed until the desired polish is obtained.

Good recipes for polishing pastes are the following:

(1) Five pounds lard, or yellow vaseline, are melted and mixed with 1 pound fine rouge.

(2) Two pounds palm oil and 2 pounds vaseline are melted together and then 1 pound rouge, ½ pound tripoli, and 1 ounce oxalic acid are stirred in.

(3) Four pounds vaseline, 2 pounds oleic acid, and 1 pound tripoli, and sufficient kieselguhr are mixed together to form a paste of suitable consistence.

(4) Four pounds vaseline and 1 pound lard are melted and mixed with 1 pound rouge.

The polishing pomades are generally perfumed with essence of mirbane and filled into tin boxes.

Polishing powders are advantageously prepared according to the following recipes:

(1) Four pounds magnesium carbonate, 4 pounds chalk and 4 pounds rouge are intimately mixed.

(2) Four pounds magnesium carbonate are mixed with ¼ pound fine rouge.

(3) Five pounds fine levigated whiting and 2 pounds Venetian red are ground together.—Farben Zeitung.

Perfume for Bath Water.—A heaping teaspoonful of the following paste will perfume 12 to 15 gallons of bath-water:

Sodium bicarbonate	150 parts
Tartaric acid	125 parts
Starch, powdered	210 parts
Oil of sweet almond	90 parts
Attar of rose or ylang-ylang q. s.	

Mix the soda, acid, and starch, and make into a paste, with the almond oil, working in the perfume. As to the latter, 20 drops of attar of rose and 8 to 10 drops of clove oil to each pound of paste will be sufficient. It is claimed that the paste also softens the bath-water.

Massage Application.—The following is a favorite application among professional German masseurs:

White potash soap, shaved	20 parts
Glycerine	30 parts
Water	30 parts
Alcohol, 90 per cent	10 parts

Dissolve the soap by heating it with the glycerine and water, mixed. Add the alcohol, and for every 30 ounces of the solution add 5 or 6 drops of the Mistura oleoso-balsamica, German Pharmacopœia. Filter while hot.—Der Seifenfabrikant.

Varnish for Back of Silvered Mirrors.

Dammar gum	20 parts
Asphalt	3 parts
Gutta-percha	5 parts
Benzol	75 parts

Mix and dissolve.

To use this varnish pour it over the silvered surface and move the plate back and forth until it is distributed evenly over the face.—Nat. Drug.

Counterfeiting American Products.—American products find such a ready market in Hungary that they are often imitated (counterfeited is a better word) by unscrupulous persons. I am writing by this mail to a Boston house notifying it that its well-known brand of patent-leather polish is now being counterfeited and sold by a dealer—one Weinberg—of this city. I would most earnestly recommend that our exporting manufacturers be publicly advised to patent or register the trade-marks of their special products. All patenting and registration for Hungary can be done here in Budapest, and I will always be glad to render whatever aid I can to our manufacturers in this connection.—Frank Dyer Chester, Consul at Budapest, Hungary.

ENGINEERING NOTES.

A recent patent, says the Mining Reporter, covers a novel use for copper in the manufacture of an anti-fouling ship's paint. The surface to be treated is coated with a quick-drying paint and finely-comminuted copper is blown into it. This surface is burnished and a second application of still finer copper is continued until a surface of copper is obtained.

We have no doubt, says Machinery, that many draftsmen will be interested in the way blueprints are (not) made, as intimated in a story in the June issue of the Ladies' Home Journal. The hero visits an architect's office with his rough plan of a house, and finds that the architect is already committed to nine, "of which an amazing number of young men were drawing the details in white ink on sheets of blue paper!"

An instance of a great invention being made and allowed to drop into obscurity to be reinvented later, is, incidentally, mentioned by Mr. Andrew D. White in the July Century. More than forty years ago, while with friends examining curios in the Imperial Museum at St. Petersburg, they found among the relics of Peter the Great, a lathe for turning irregular shapes and another for copying reliefs. These machines had been built for Peter by some ingenious mechanic from Holland fully one hundred and fifty years before and perhaps one hundred years before the date of Blanchard's famous invention.

The temperature of combustion of nitro-glycerine compounds or powders containing a large proportion of nitro-glycerine is said to be higher than the fusing point of steel. Hence the deteriorating effect of such powders on the bores of heavy guns. At each discharge a thin layer of the bore is actually fused and carried away with the discharge, which accounts for the rapid erosion of guns using such powders. The temperature of the nitro-cellulose used by the United States government is considerably lower than that of the nitro-glycerine compounds, and consequently the erosion of our guns is much less than of British guns for the same number of discharges. For this reason perhaps more than any other the British government is abandoning the use of nitro-glycerine in favor of nitro-cellulose.—Machinery.

At a recent meeting of the North Staffordshire Institute of Mining and Mechanical Engineers Mr. William Lockett read a paper describing the failure of a "lock-coil" winding rope 1¼ inches in diameter, 1,460 feet long, weighing 5,880 pounds, and having a theoretical breaking strength of 156,000 pounds. The average load carried by the rope when hoisting was 12,500 pounds. Six broken wires were found in one place and five in another, but fortunately the defect was discovered before an accident occurred. Owing to the peculiar construction of lock-coil wire rope the author intimated that the outer strands, or those forming the lock-coil, were subjected to a greater stress than those forming the core, there being, it is believed, a lack of the mutual grip of the strands as found in ordinary wire rope. Another fault found with the construction is the difficulty, which amounts to a virtual impossibility, of lubricating the inner wires.

The international congress of arts and sciences which will be held at St. Louis on September 19 to 25 will be an assemblage of eminent men in applied as well as pure science. Its purpose will be, in fact, the better aquaintance of those engaged in research and those who utilize the results of such investigations. "Leading representatives of theoretical and applied sciences will set forth those general principles and fundamental conceptions which connect groups of sciences, review the historical development of special sciences and discuss their special problems." One of the departments of the congress is devoted solely to technology. Chancellor Chaplin, of Washington University, is its chairman, and the speakers who will discuss the general subject of the department are Prof. H. T. Bovey and Mr. John R. Freeman. It is subdivided into six sections. Section A, on civil engineering, will be presided over by Prof. W. H. Burr, and Dr. J. A. L. Waddell and Mr. Lewis M. Haupt are the speakers scheduled. President Humphreys, of Stevens Institute, will be chairman of Section B, on mechanical engineering, and the speakers will be Prof. A. Riedler and Prof. A. W. Smith. The chairman of Section C, on electrical engineering, will be Prof. A. E. Kennelly, and the speakers Signor C. Marconi and Prof. M. I. Pupin. Section D, on mining engineering, will be presided over by Mr. John Hays Hammond, and the speakers will be Prof. R. H. Richards and Prof. S. B. Christy. Section E, on technical chemistry, will have Dr. C. F. Chandler as chairman and Prof. O. N. Witt and Prof. W. H. Walker as speakers. Section F, on agriculture, will have as its chairman Secretary James Wilson, of the Department of Agriculture, and for speakers Prof. Leon Lindet and Prof. L. H. Bailey. The purpose of this congress, the unification of interests of those engaged in investigation and in practical work, is highly commendable, and it is to be hoped that those who are giving so much time and thought to the details will feel repaid by the results. But it really seems as if the scientific and professional congresses which are scheduled to take place this fall in St. Louis lap over each other so much that steps should be taken to present in a clear manner just what each will take up. If something of this sort is not done pretty soon we will have to move out to St. Louis for the entire fall in order to avoid missing unwittingly some of the good things which these gatherings will present.—Engineering Record.

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