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OCULISTS' FORMULÆ FILLED IN OUR OWN WORKSHOP.
The system of conducting the examinations of the past week is in many ways an experiment. Changing the hour for opening the examinations from eight o'clock to nine is a welcome reform. The week is a most trying one, even to the best of students, and every hour of rest is thoroughly appreciated. A three-hour paper will give an instructor quite as good an opportunity to judge a student's knowledge as the old four- or five-hour paper. Especially is this true if the number of questions is increased and the questions are of such a nature as to individually require but a short time.

The plan of allowing those students with term marks above a certain per cent. to pass unexamined will, we think, raise the standard of scholarship in the Institute perceptibly. However, this result can hardly be claimed this term. To make the rule a success the men must understand at the beginning of the term that faithful daily work will be rewarded by release from that bugbear of undergraduate life, the examination. Then will the sluggard study a little each day in order to escape the final grind, and, as a consequence, will have a knowledge of the subjects that will last for at least a week after the final test. One noticeable effect is the increased severity of the marking in many departments.

We would inform Mr. Tucker that Mr. Chase cannot be called on to shoulder the blame for the lack of knowledge of the By-laws of the W. P. I. Alumni Association. These By-laws have never been published, save in the Alumni Report of the year following incorporation; therefore it is hardly fair to blame the Secretary for not circulating them. Again, Mr. Chase's letter was written on his own responsibility, and not in his official capacity.

A word of caution, Mr. Tucker; "Avoid the appearance of evil."

How sweet is revenge! A year ago Brown's poloists defeated us rather badly, and this year Tech's team went in to do or die. They did by a close score. Lack of practice greatly injured our showing, but the team hopes to get in good condition before meeting Brown again.
A Cleveland Alumnus has been kind enough to send several notes concerning graduates, for which our readers will be duly grateful. Would that more would do likewise.

How refreshing, during the past week, has that last hour of sleep been! Many, many thanks.

We were unable to print all of Mr. Adams's article in this number, but the rest will appear next month.

MR. CHARLES G. WASHBURN'S LECTURE. PATENT LAW.

The following are the Points Touched upon in the Discussion of the Subject.

The prerogative of granting monopolies, that is, exclusive trading privileges, the sole right or power of selling something, had long been exercised by English sovereigns, and towards the end of the reign of Queen Elizabeth patents had been granted to her favorites to deal exclusively in such necessary articles as coal, leather and salt, thus greatly enhancing the price to the purchaser.

To such an extent had this gone that, when the list was read in the House of Commons, in 1601, one of the members expressed surprise that bread was not included, and a bill to abolish monopolies would have been introduced at this time had not the Queen promised to revoke all grants found to be injurious.

In 1628, during the reign of James I., the statute against monopolies was enacted which abolished all past monopolies, and the power of the crown to grant them was denied, except in cases where such grants had been or should be made to the inventors of new manufactures, conferring upon them the exclusive privilege of practising such inventions for a limited period of time. This statute is the basis of the English and American patent law, and the first recognition by statute of letters patent. The authority of the United States to grant patents is derived from the eighth section of Article One of the Constitution, which says that "Congress shall have the power to promote the progress of science and the useful arts by securing for limited terms to authors and inventors the exclusive right to their respective writings and discoveries."

In an early case Daniel Webster said, "The whole system of patents rests on statute provisions. There is no common law power or prerogative right in the President to issue a patent. In this particular our law is different from the English; ours is a statute grant, theirs an emanation out of a statute prohibition. With us the foundation is statute, with them prerogative."

Aside from the limitations contained in the Constitution, the power of Congress is absolute. Thus, a patent to Woodward, originally granted under the act of 1793, for 14 years, was, under the terms of the act of 1856, extended to 21 years, and by special act of Congress to 28 years.

In early times in England, when, by reason of the flagrant abuse of the power, there was great hostility to exclusive privileges of any kind, a patent was construed most strongly against a patentee, and advantage was taken of every technical defect, but later a more liberal policy was followed; the grant of a patent was held to be a matter of right, and not a matter of favor, and inventors began to be regarded as public benefactors, and in 1800 Lord Eldon stated that patents "were to be considered as bargains between the inventors and the public, to be judged of on the principle of keeping good faith by making a fair disclosure of the invention, and to be construed as other bargains."

That is to say, a patent is a contract between the inventor and the public, the former disclosing his invention, which he has a right to conceal, and in return receiving the exclusive right to enjoy it to himself and his assigns for a limited time, after which it becomes public property.

A patent, then, cannot be regarded in any sense as an odious monopoly, but as a fair arrangement between the patentee and the public.

The patent itself creates a property right in the invention without which it could not otherwise exist and without which the inventor would be powerless, short of disclosing his invention to others, to control its use.

The States possess the power to grant patent rights, and this power was exercised by the State of New York in the case of Robert Fulton, who in 1803 received the sole and exclusive privilege of making and using boats propelled by fire or steam within the waters of the State for a period of twenty years, and the injunction was granted against James Van Ingen and others engaged in a similar enterprise.

But by the terms of the act of 1793 a patentee of the United States was required to relinquish his State patent. This is hardly a practical question at the present time, as a State patent, because of the limited territory covered, would be comparatively worthless.

The two important sections of the Revised Statutes which relate to patents and which contain the most important provisions of the patent laws are sections 4884 and 4886.

Section 4884 is as follows:

"Every patent shall contain a short title or description of the invention or discovery, correctly indicating its nature and design, and a grant to the patentee, his heirs or assigns, for the term of seventeen years, of the exclusive right to make, use and vend the invention or discovery throughout the United States and the territories thereof, referring to the specification for the particulars thereof. A copy of the specification and drawings shall be annexed to the patent and be part thereof."

The constitutional provision that the grant shall be exclusive to the inventor, and for a limited time, is here strictly followed. The term of the patent is fixed by the act of 1861 at seventeen years; the term had previously been fourteen years.

The right conferred upon the patentee is an exclusive right, and the general proposition laid down is that during the term of his patent he may refrain from using his invention himself and may refuse to allow others to use it upon any terms, although in a case decided in 1886 equitable relief of an injunction was denied, the proof being to the effect that the complainant, the owner, had never used the invention or authorized others to use it.

Of course, self-interest usually compels a patentee either to use his invention or to license others to use it. The right of a patentee is also exclusive as against the Government, and is protected by the Fifth Amend-
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...ment to the Constitution, which forbids the taking of private property for public use, without just compensation.

In a suit brought against Mr. James, then Postmaster in New York, to enjoin him from using an implement for stamping letters, the court, although finding the patent void, said in the opinion:

"The United States has no such peragative as that which is claimed by the Sovereign of England, by which it can reserve to itself, either expressly or impliedly, a superior dominion and use in that which it grants. Letters Patent to those who entitle themselves to such grants."

The mode of obtaining compensation from the Government for the unauthorized use of an invention has never been specifically provided for; the ordinary practice is to sue the officer who is the active infringer.

No State can impose lawful restrictions upon the rights of a patentee; but patented property, like all other property, is subject to the police regulations of a State: For example, a person selling illuminating oil which did not conform to the standard required by a Statute of the State of Kentucky, cannot lawfully claim a right to do so, because the oil is patented. The statute being a mere police regulation, within the power of the State, and not in contravention of the Federal Constitution, the patentee and his assigns must exercise their right to use and vend the patented oil in subordination to such statute.

"The patent for a dynamite powder does not prevent the State from prescribing the conditions of its manufacture, storage and sale, so as to protect the community from the danger of explosion."

But a State statute has been held unconstitutional which is not based upon any obligation in writing for which any patent right shall form any part of the consideration shall, before it is signed by the maker, insert in the body thereof above his signature the words, "given for a patent right."

The territory covered by a United States Patent is the United States and the territories thereof, decks of U. S. vessels and also territory of the waters of the United States.

Section 4886 is as follows:

"Any person who has invented or discovered any new and useful art, machine, manufacture or composition of matter, or any new and useful improvement thereof, not known or used by others in this country, and not patented or described in any printed publication in this or any foreign country, before his invention or discovery thereof, and not in public use or on sale for more than two years prior to his application, unless the same is proved to have been abandoned, may, upon payment of the fees required by law, and other due proceedings had, obtain a patent therefor."

"Any person may obtain a patent, excepting officers and employees of the Patent Office during their terms of office, and when a foreigner has the same right as a native, but he must stand on what he has done in this country, and patents may be issued to two or more persons jointly.

The words invented or discovered in the statute mean the same thing, and the improvement sought to be patented must be the result of inventive or must be a discovery. It is very difficult to determine where mechanical skill ends and invention begins. On this point the applicant for a patent encounters objections in the Patent Office and, if he overcomes these and secures a patent, it may be declared invalid by the Courts on the ground that a person skilled in the art, and who is presumed to know everything which has been patented, or printed, or done in the subject, would, in the exercise of the usual skill of his calling naturally make the improvement when the necessity for it should arise.

The Courts have found it much easier to formulate this rule than they have to apply it. — One Judge, on a given state of facts, finding invention where another would not.

In an often cited case, the Supreme Court, in sustaining the patent, which was upon a loom for weaving fabrics, said, upon the question of patentability:

"It may be laid down as a general rule, though perhaps an invaluable one, that if a new combination and arrangement of known elements produce a new and beneficial result never attained before, it is evidence of invention."

In another well known case, in finding a patent upon an improved dredge-boat for excavating rivers invalid for want of invention, the Court said, upon this question:

"The process of development in manufactures creates a constant demand for new appliances, which the skill of ordinary head-workmen and engineers is generally adequate to devise, and which indeed, are the natural and proper outgrowth of such development. Each step forward prepares the way for the next, and each is usually taken by spontaneous trials and experiments. In a single party a monopoly of every slight advance made, except where the exercise of invention, something above ordinary mechanical or engineering skill, is distinctly shown, is unjust in principle and injurious in its consequences.

"The beneficiary must be an inventor and he must have made a discovery. The statute has always been interpreted to the idea that it is not sufficient that a thing shall be new in the sense that in the shape or form in which it is produced, it shall not have been before known and that it shall be useful, but it must under the Constitution and the Statute amount to an invention or discovery."

And as bearing upon the question that an article new commercially may not be new in the patent law, it has been held that:

"A distinction must be observed between a new article of commerce and a new article which, as such, is patentable. Any change in form from a previous condition may render the article new in commerce, as powdered sugar is a different article in commerce from loaf sugar and ground coffee is a different article in commerce from coffee in the berry."

"But to render the article new in the sense of the patent law, it must be more or less efficacious or possess new properties by a combination with other ingredients, not from a mere change of form produced by a mechanical division."

One test often applied to determine if the inventive faculty has been exercised or not, is that of utility, and if an article of manufacture has superseded one previously used for the same purpose, and has gone into general and very extensive use, evidently filling a want long felt, the presumption is strong that such article is the fruit of invention. Such was the fact in regard to the invention of barbed wire, which after the event seemed to be comparatively simple, and in regard to which the Court said:

"Tested by the rule of utility * * * the device in question has been accepted by the public to an extent which has hardly heretofore followed the most successful inventions. From what has already been developed, it is clear that it has made possible the cultivation of the extensive prairies of the west, the
pampas of Brazil, and the steppes of Russia, where, before the introduction of this cheap mode of fencing, it was impossible; and it has even to a great extent already superseded the use of wooden fences in the timbered portion of the country; and the question is, to whom but these inventors is the public indebted for this widely useful device?"

The mere fact, however, that a device has gone into general use and has displaced other devices is not conclusive upon the question of patentability; but, where the other facts of the case leave the question in doubt, is sometimes sufficient to turn the scale.

The improvement or thing sought to be patented must also be new and useful. It is new unless it was known or used in this country or was patented or described in a printed publication prior to its conception by the patentee and is the product of original thought or inventive skill and not a mere formal or mechanical change of what was old and well known. It is useful if it is wanted for any purpose not illegal or immoral.

An art, one of the classes enumerated upon which a patent may be secured, includes what is known as a process, or series of acts, performed upon the subject matter to be transformed and reduced to a different state or thing.

And as a process only requires that certain things should be done with certain substances in certain order, the means employed become of a secondary importance, and may be old or new, patentable or not, without affecting the patentability of the process; and hence it is that a patent on a process may be most comprehensive.

The subject sought to be patented must not have been known or used by others in this country, or patented or described in any printed publication in this or any foreign country before the applicant's invention or discovery thereof. * * * But prior knowledge and intelligent, not accidental, use, by a single person is sufficient to defeat a patent, and proof of the existence of a single prior structure is sufficient; for example: A patent upon a clamp to be used in an electric lamp was declared to have been anticipated upon proof of the prior existence of one clamp embodying the exact invention, although no more were ever made, and this one clamp had only been in use during half months, but the prior invention must have been complete and capable of producing the result sought to be accomplished.

Nor must the subject matter have been previously patented or described in any printed publication in this or any foreign country; but such patent or publication must, to defeat a patent, be sufficiently full, clear and exact in the terms of its description to enable a person skilled in the art to produce the invention contained in the patent sought to be anticipated.

And the subject matter must not have been in public use or on sale for more than two years prior to the application, unless the same shall have been proved to have been abandoned.

Public use, to defeat a patent, is not necessarily a use in public; nor is a use in public necessarily a public use; for example: An inventor used in public twenty-five feet of street pavement for a period of six years before his application for a patent, in order to determine its merits. This was held not to be a public use which would defeat the patent for the reason that it was a use by the inventor himself for the purpose of determining the merits of his invention, and on the other hand, the wearing by one or two women of one or more sets of corset steels, was held to be a sufficient public use to invalidate a patent. And safe bolts, though hidden from view to such an extent that it was necessary to destroy the safe in order to bring them to view, were held to be in public use on the ground that there was no more concealment than was inseparable from any legitimate use of them.

In determining what is experimental use which an inventor can make without losing his right to apply for a patent, and what is not, the rule is that to constitute experimental use the real purpose of the inventor must be the improvement and perfection of the machine, and not its commercial use.

But an applicant loses his right to a patent even if all these requisites have been complied with if it shall be proved that he has abandoned his invention; and the intention of the inventor is a large element in determining this question.

An inventor may forfeit his rights by a wilful or negligent postponement of his claims, and there may be an abandonment as well after as before an application has been made; and abandonment may be proved either by express declaration of an intention to abandon, or by conduct inconsistent with any other conclusion.

But if for unavoidable reasons an inventor is unable to prosecute his application in the patent office, a delay of many years will not work an abandonment.

A patent upon a vulcanite dental plate was applied for in April, 1855, and was finally rejected in February, 1856, and the patent was not granted until 1864. It was shown that the delay was occasioned by reason of the extreme poverty and ill health of the applicant who never relinquished in any way his intention to secure a patent. This was not allowed to defeat the patent, although three of the judges dissented from the judgment of the Court on the ground that the application had been abandoned.

A principle of nature or a bald idea cannot be patented, but only the means of applying the principle; for example:

A claim for "the use of the motive power of the electric current, however developed, for printing intelligible characters at any distance," in Morse's patent upon the electric telegraph, was held to be invalid as being for a principle without regard to the particular method with which it was to be accomplished, a claim in the Bell telephone patent, to the method of and apparatus for transmitting sounds by causing electrical undulations similar in form to the vibrations of the air accompanying such sounds was held to be valid, as covering a method of and apparatus for putting a continuous current in a closed circuit into a certain condition and using it in that condition for the transmission of speech.

The law has been stated thus:

"Whoever discovers that a certain useful result will be produced in any art by the use of certain means is entitled to a patent for it, provided he specifies the means," be it a machine, apparatus or process.

We have seen that a process may be patented, irrespective of the instrumentalities by which its several steps are effected; and such a patent would be infringed by a process in which equivalent though different instrumentalities were used, and almost as broad a rule is laid down as to the construction of primary or pioneer patents upon machinery.

If a man invents a machine, the first of its kind, for making a certain purpose of a certain article, a certain result, he is entitled to a broad patent upon the several operations which go to make up the final effect.
produced, and while other inventors may make improvements, and may be entitled to patents upon such improvements, their machine will infringe the patent on the first machine, provided they employ substantially the same means to accomplish the same result, and it may very well happen that an owner of a pioneer patent cannot use the best embodiment of his invention because it infringes the patent upon some subsequent patents, and that the subsequent patentee cannot use his invention at all because it infringes the pioneer patent.

If a claim consists of several elements it is not infringed if one of the elements is omitted, but it will be if an element is added. The theory is that in a combination patent it is the specific combination alone—at least as far as that particular patent is concerned—which is new, and therefore one who does not use the exact combination is not an infringer, but a combination may be infringed when some of the elements are employed and for the others mechanical equivalents are used.

One thing is the equivalent of another when it acts in practically the same way and with practically the same result.

In determining the question of infringement a primary patent receives much more liberal construction than a subsidiary patent; the more fundamental the patent the broader the field which it is permitted to cover.

But in all patents the patentee is only entitled to what he claims, and he should be careful to claim everything he has invented.

In commenting upon this subject the Court has said:

"Some persons seem to suppose that a claim in a patent is like a nose of wax, which may be turned and twisted in any direction, by merely referring to the specification so as to make it include something more or something different from what its words express."

A patentee may claim and obtain a patent for an entire combination or process, and also for such parts of the combination as are new and useful, or he may claim both. Again, one may secure a valid patent upon an invention which consists entirely in a new combination of old ingredients, provided a new and useful result is produced by the joint operation of the several elements of the combination, but the combination itself is not new, the inventor must produce a different force or effect or result in the combined forces or processes from that given by their separate parts; there must be a new result produced by their union; if this is lacking there is simply an aggregation of separate elements.

To illustrate: suit was brought to restrain the infringement of a patent for the combination of the lead and eraser in the holder of a drawing pencil.

The patent was held to be invalid as not being for a proper combination, on the ground that:

"The parts claimed to make a combination are distinct and disconnected. Not only is there no new result, but no joint operation. It may be more convenient to turn over different ends of the same stick, than to lay down one stick and take up another. This, however, is not invention within the patent law."

The patentee must be careful to claim all that he has invented, for what he does not claim he implies disclaims as old, and unless he covers it in a subsequent patent within two years, it becomes public property before the petition is entered. A right to use it.

It is not necessary that the scientific theory of an invention should be set out in the specification of a patent, and the inventor need not know the scientific theory, and he may think he knows it when he don't know it all. This will not affect the patent if the thing to be done is set out in the specification and can be reproduced.

Section 4887 is as follows:

"No person shall be debarred from receiving a patent for his invention or discovery, nor shall any patent be declared invalid by reason of its having been first patented or caused to be patented in a foreign country, unless the same has been introduced into public use in the United States, for more than two years prior to the application. But every patent granted for an invention which has been previously patented in a foreign country, shall be so limited as to expire at the same time with the foreign patent, or, if there be more than one, at the same time with the one having the shortest term; and in no case shall it be in force more than seventeen years."

The Theory upon which this statute is framed is that the American people shall be entitled to the free use of a patented invention as soon as the people of any foreign country where the invention may have been patented, and as the term of foreign patents in most foreign countries is less than seventeen years, the life of many American patents upon inventions previously patented in foreign countries, has been abridged.

The law upon the subject seems to be all wrong for the reason that: if an invention is not patented at all in a foreign country, and no restriction is placed upon its use by foreigners, the life of the American patent is not affected; but if a foreign patent is previously secured, and a restriction thus placed upon the foreign use of the invention, the life of the American patent is cut down to the foreign term.

On the other hand, it is dangerous to have the United States patent issue first, for in some of the foreign countries, Great Britain for example, on proof of the fact that the patent has been clearly described in a printed publication before the date of application, such foreign patent is void.

To avoid both dangers, it is customary to apply for the foreign patent on the same day that the American patent is dated, in order that neither patent may affect the life or validity of the other.

Then, too, unlike our law, it is necessary in order to keep a foreign patent alive, to make certain amendments called taxes, failing to do which, the patent lapses, and in some foreign countries, France and Belgium for example, the patent must be commercially worked within a specified time, or it will be void.

The provisions contained in our own statute, and in the laws of foreign countries, have led to much confusion.

An American patent issued under the act of 1870, was dated October 10, 1871; the British patent had been granted November 15, 1860, for a term of fourteen years, and expired November 15, 1874; thirteen days later, an order was made for the extension of the British patent until November 15, 1878, but the Court held that the United States patent expired November 15, 1874, on the ground that Congress never intended to extend the term of the domestic patent beyond the legal term secured to the foreign patentee when the domestic patent was granted.

Later the following case came before the Court:

The American patent was granted October 20, 1874, for fifteen years. A Canadian patent had been procured by the patentee for five years from May 15, 1873, and the Court held that the American patent expired May 15, 1879, although it appeared that in March, 1878,
the Canadian patent had been extended—as it could be under the law—for five years from May 15, 1878, and again five years from May 15, 1883; so that the patent had a legal existence for fifteen years. In the meantime, the English patent had expired before it was renewed; the Canadian patent had not.

The extension of the English patent was a matter of favor; the extension of the Canadian patent was a matter of right.

Another similar case involving a Canadian patent was later decided in the same way, but on appeal it was held in the Supreme Court in overruling the decision below that where, by the Canadian statute, the extension of the patent for Canada was a matter of right, and where the term of the Canadian patent had been continuous, the United States patent would not expire before the end of the fifteen years duration of the Canadian patent.

Another question now arose on these facts: Suit was brought on the patent in the Circuit Court, and plea was made by the defendant that the patentee had neglected to pay the taxes as required by law, and that the patent therefore lapsed in 1889, and hence, the American patent expired at the same time, and the Court so held on the ground that the "term" referred to in the statute was not the original term expressed in the patent, but its period of actual existence; and the Court thought that the decision I have just mentioned involving the Canadian patent, required this conclusion (although on these facts a different conclusion had been reached in previous cases).

On appeal to the Supreme Court, however, it was held that the "expiration of term" in the statute does not mean expiration through a forfeiture by breach of a condition, but means expiration by a lapse of time; that is the lapsing of the foreign patent because of non-payment of taxes does not affect the life of the American patent.

Still another question arose as to whether the date of application or the date of the patent is to govern, in a case decided last year, where it was held that a United States patent expires with a foreign patent granted for the same invention, to the same inventor, prior to the date of the United States patent, but subsequent to the application therefor, and this question is now before the Supreme Court, but so far as I know has not been decided.

I have said enough to indicate the difficulties which have arisen over this provision in our law,—difficulties which could be removed by following the recommendations of the late and present Commissioner, to repeal the last sentence of section 4887.

THE NEW HYDRAULIC TESTING PLANT.

Description by Professor G. I. Alden.

It is impracticable, in an ordinary laboratory, to do satisfactory work in the testing of hydraulic motors, and in other experiments involving the handling and measurement of large quantities of water. For this reason there has been established by the Institute, upon a water-privilege near Worcester, a plant equipped in the most thorough manner for complete and thorough tests of a turbine water-wheel and for other hydraulic experiments. The water-privilege was a gift to the Institute from its constant benefactor, Mr. Stephen Salisbury. It consists of a pond of about 200 acres, which supplies enough water to give, with the 30-foot fall available, about 75 H. P. for the greater part of the year. There is also upon the land conveyed to the Institute by Mr. Salisbury, a dwelling-house and a small mill for grinding woolen rags. Upon the land above referred to, the Institute has erected a wooden building, and installed an 18-inch horizontal turbine, known as the Hercules wheel, and built by the Holyoke Machine Co., of Worcester. The wheel is set about 18 feet below the level of the water in the pond, and has a draft-tube about 12 feet long. The wheel receives the water through a pipe 362 feet long by 40 inches in diameter. Just before it enters the wheel, the water passes through a 36-inch Venturi Meter, by means of which the quantity of water supplied to the wheel is measured. The meter is provided with a recording apparatus and also with pressure tubes of glass, which show the variation of the water as it passes from the larger to the smaller section of the meter. Pressure tubes are also provided, showing the loss of head due to friction in the 40-inch pipe referred to above. This gives opportunity for an accurate determination of the loss due to friction in a pipe of known length and diameter, under varying velocities of flow. The water discharged from the wheel passes over weirs in the tail-race and is again measured by means of these weirs. A friction dynamometer of improved design and steady and automatic in its action, absorbs and measures the power of the wheel.

Thus the wheel is completely under control for tests of efficiency under such varying conditions as may be desirable to illustrate methods and principles, and to furnish instruction and practice for students in this most important branch of engineering work.

The Venturi Meter and automatic recording apparatus are also a gift from Mr. Salisbury. The plant includes also a 12-inch Ball & Fitts Water Meter, the gift of Mr. Phinehas Ball of Worcester. This meter is so installed in connection with the Venturi Meter and the weirs, that it can be compared with either.

A large hydraulic ram is used to supply water to an air pressure tank, which tank furnishes water pressure for operating the friction dynamometer on the shaft of the turbine. The plant is nearly completed and is intended to furnish instruction and practice in the use of all the apparatus and methods for the most thorough and accurate work which is done in connection with the standard testing flames of the country.
It also offers an opportunity to utilize the water power by a system of electrical transmission, which will give the Institute—which is only about four and one-half miles distant—electric power for lighting or for motive power, and at the same time illustrate to students the working of such a system. Such use of this power is included in plans for the development of the resources of this portion of the laboratory facilities of the Institute. The magnitude and perfection of this testing and experimental plant puts the Worcester Polytechnic Institute decidedly in advance of all other Engineering Colleges in the matter of facilities for the practical investigation of problems in hydraulics.

VENTILATION AND ITS RELATION TO HEATING AND HOUSE DRAINAGE.

"Pure air, pure water and a pure soil," was the health motto of Hippocrates, the father of medicine among the Greeks two thousand and more years ago; and to-day, the best sanitary authorities use the same motto.

Though many men of great learning and large minds have given years of careful study and patient investigation to the problems which this simple, yet priceless, object has required to be solved, yet to-day the difficulties in the way of the solution of the problems and the accomplishment of this object are no greater,—yes, very much greater, than they were in Greece twenty centuries ago. A colder and more severe climate, a closer crowding together of habitations in and around cities, and the ever-increasing wants,—the conveniences and comforts required by our rapidly advancing civilization,—have made these difficulties.

The ancient Greeks lived much in the open air; we must house ourselves for three-fourths of the time, or we suffer from the cold. Their workshops, and their schools also, were open to the "free air of heaven,"—they studied and received instruction often in gardens always green; our workshops and our schools are closed places where human beings are crowded together within doors day in and day out,—where pure air is unknown.

The clothing of the Greeks, permitted by the mildness of their climate, hung so loosely upon them that the air might freely circulate around their bodies, and the luxury of frequent baths was common with the poorest of their citizens; not so with us, our climate requires clothing both firmer in texture and closer in fit, while by the needless, but (it would seem) slavishly obeyed, acquisition of fashion, nearly the half of our race is bound by bands that not only keep out the refreshing air from under them, but displace or hinder the healthy action of the blood and of all their vital organs; and as for baths, not a quarter of our people know the luxury of a daily morning bath or the value for health it is, and there are many, even in our highly civilized cities whose true skin is, like many an ancient city, literally buried under its own ashes. But this cannot be laid to the climate, nor is our civilization responsible for it, except that as it fails to educate the people in the simple hygienic laws.

To keep us safe from the severity of the "elements"—that we may be warm and comfortable, we build houses, heat them, and live in them. Here begin our difficulties in maintaining a pure air to breathe.

And the value of air—the absolute necessity of it for continued life and health—has never yet more than just begun to be duly appreciated. We will not drink from a cup from which another has been drinking unless it first be washed; we would not be so uncleanly as to wear underclothing that another had worn; but air which another had breathed, carrying with it still more impurities, we breathe and breathe again, we take it into our very life and do not flee from the contamination. We cannot see it, but it is there.

Many of our most fatal diseases are due to breathing impure air,—notably consumption, that fell, insidious disease which has more victims than any other disease which visits us. There is only one sure preventive of consumption, and that is the breathing of pure air only and plenty of it.

To conduct away impure air as rapidly as possible and bring in its place air as pure and fresh as we can find it out of doors, sufficiently changed in temperature, but not in purity, to make it comfortable, is the province of ventilation. In this ventilation, heating has an important place, as we shall see.

But it is not alone by the air we exhale that we render impure the air we breathe. For within us seven millions of pores give out a constant flow of moisture which carries to the surface the matter no longer needed in the system. The evaporation of this moisture serves to cool the body but at the same time carries into the air the volatile organic impurities. The daily morning bath washes away the impurities not volatilized, keeps the pores open and their healthy action unhindered.

The water from the bath and from the washing of dishes and cooking utensils, the refuse or garbage from the kitchen and the table, and the urine and excrements from our bodies are the other refuse and impurities which we must dispose of, and that quickly, lest they decompose and give off fowl and dangerous gases that would poison the air we must breathe.

To properly remove these refuse matters is the province of house drainage and garbage removal. Yet their disposal, when once removed from the house, is a subject for serious consideration; for they should by all means be prevented from contaminating the soil about our houses, as it is extremely difficult to do if the polluted water from them soaks away into the earth below the influence of the air and vegetation to purify it.

House drainage also includes the removal of subsoil water around the house-site, with the prevention of dampness and polluted air from the soil coming through the walls or the floor of the cellar.

This then is the connection between the branches of our subject. By heating, our habitations are made comfortable at all seasons, so that we need not suffer by the severity of the weather. By ventilation the air in them is kept pure, that we may keep our health. By house drainage and proper disposal with garbage removal, all refuse may be carried away from possibility of harm to us.

For proper heating some ventilation is necessary. We cannot heat a close, unventilated room, as some have found out with surprise, when they have attempted it. For ventilation, heat is necessary to produce a difference of air pressures; and, that it may not be without avail, house-drainage must be attended to. House drains require ventilation; for, if not ventilated, they will become dangerous by the unsealing of their traps. And, in the best disposal of garbage, namely by burning, heat is requisite. Thus are they all hinged together. One cannot be wholly effective without the others.
What is perfect ventilation? Dr. John S. Billings, who is an eminent authority on this subject, says, "Perfect ventilation can be said to have been secured in an inhabited room when any and every person in that room takes into his lungs, at every mouthful of air of the same composition as that surrounding the building and no part of which has recently been in his own lungs or in those of his neighbors, or which consists of products of combustion generated in the building, while at the same time, he feels no currents or draughts of air, and is perfectly comfortable as regards temperature, being neither too hot nor too cold."

Very few attempts have been made to secure such perfect ventilation. In the house of the late Thomas Wilmans of Baltimore, the floors were perforated all over uniformly, in the same manner as was done for the House of Commons in London by Dr. Reid. "This made the floor a gigantic register or grate through which the fresh, in-coming air, having been previously warmed and moistened in the mixing chambers below, was to stream steadily upward at a uniform velocity, sufficient to remove all the products of respiration or of combustion as rapidly as formed."

But to thus thoroughly ventilate a room requires at least thirty times as much coal as to heat a room of the same size with the ordinary heating and ventilating arrangements.

"What would be considered by all sanitarians as good ventilation," writes Dr. Billings, "would not require nearly as much air as this. Good ordinary ventilation is to be secured by keeping the vitiated air constantly diluted to a certain standard."

Pure air is (as you all may know) composed of about four-fifths nitrogen, with 75/100 of 1 per cent. carbonic acid gas and a little watery vapor.

In respiration, part of the oxygen taken into the lungs is exchanged for carbonic acid. The extremities of the fine air passages of the lungs have been likened to minute bunches of grapes, each grape being like a little bunch of carbonation. No. I. I put on a rubber balloon with gas, by a well-known law of gases, diffusion immediately commences, the gas comes out into the air and the outside air enters the balloon; until, in a comparatively short time, the gas and the outer air are of nearly the same constitution.

Some gases pass through much more readily than others, owing (it may be) to the smaller size of their atoms.

The same thing is continually going on in our lungs. The blood corpuscles, or disks (both red and white), like little boats, come floating in the tide that comes through our veins. The red corpuscles particularly (and they are many times the more numerous), each comes laden with carbonic acid, the refuse from our tissues, and arriving at the little balloons of our lungs, exchanges its carbonic acid for a cargo of oxygen, which it carries to some part of our system and again makes an exchange for carbonic acid—which is only oxygen which has done its work and taken into combination the carbon given up by our tissues. Thus every breath adds carbonic acid with organic impurities to the air about us, diminishing as the same time the amount of oxygen; and it has been found that when there are even 6 parts of carbonic acid gas in 10,000 of air (2 parts more than the normal amount), the air is noticeably close to a person coming from the fresh air.

Some writers on ventilation speak of carbonic acid as if it were the special impurity to be provided for—they speak of the "deadly nature of this subtle poison," and of the collection of this gas in the lower part of the room owing to its greater specific gravity. But in every one of these points they are in error. Carbonic acid is not the principal impurity. Far more important are the emanations from our bodies or from decaying vegetation, minute portions of diseased tubercles from the lungs, and the inorganic impurities—carbonic oxide, the product of incomplete combustion; and hydrogen sulphide, formed by the decay of organic matter.

There are no proofs that carbonic acid is actually a poison, though it will not support life or combustion. Dr. John S. Billings is authority for the statement that "in those establishments where sparkling mineral waters are bottled or soda fountains are charged, or in vaults where champagne is bottled, in certain rooms in breweries, or in some celebrated baths and health resorts, pure carbonic acid gas may be present in the air in proportions as high as 150 parts in 10,000 without producing discomfort or giving any special evidence of its presence."

Quoting from Dr. Billings: "Offensive or poisonous gases of all kinds, such as sulphuretted hydrogen or carbonic oxide, can be diluted by fresh air, just as solutions of arsenic or strychnine can be by pure water; until a month or even 10 years of later dilution is neither specially hurtful or unpleasant. The dangerous impurity in some air, such as that in a hospital ward for contagious diseases, or in air from a sewer or a collection of filth of any kind, is not a gas, and does not possess any marked or unpleasant odor. It consists of minute particles of organic matter, which are capable of producing disease when introduced in the living human body, some of which are capable of growth and multiplication under certain circumstances.

Dilution cannot render such air certainly harmless. "In view of this fact," he continues, "one of the first things to be done in arranging the ventilation of a building is to prevent, as far as possible, the admission into it of these particulate contagia,—these noxious living germs of disease, which are as hard to dispose of, if they have once gained entrance; and that it is, therefore, worth while to examine closely the details of the plumber's work in connection with this question."

That carbonic acid gas, though heavier than the air, does not settle to the bottom of the room. For far from there being more carbonic acid gas at the floor of a room, there is slightly more of it, not at, but near the ceiling; and this is especially the case where there are gas jets burning in the room. For the air expelled from the lungs and the product of combustion from lamps and gas jets are sufficiently higher in temperature than the air of the room to be more expanded and lighter, and ascend before they have time to diffuse. It is only when carbonic acid gas flows into a confined space too fast to be diffused that it settles to the bottom. In the rare air the proportion of this gas has been found to be practically the same on the highest mountains and at the level of the sea.

"What then is the importance of this gas?" you may ask, and "why do sanitarians lay so much stress upon the results of chemical tests of air with reference to this substance, and on what may seem very small variation in the proportions in which it is present?" "It is because," says the eminent authority I
have already quoted, "carbonic acid is usually found in very bad company, and that variations in its amount to the extent of three or four parts in ten thousand indicate corresponding variations in the amount of those gases, vapors and suspended particles which are really offensive and dangerous, and also because we have tests by which we can with comparative ease and certainty determine the variations in the carbonic acid, while we have no such tests of recognized practical utility for the really dangerous impurities." The culture tests probably came later than the date of this.

Since the variations in the proportions of carbonic acid in the air is of great importance, for the reason just given, it becomes necessary to have some means of testing this proportion. It is true our sense of smell detects impurities in the air, and our nose might be an all sufficient detector if we always obeyed its warnings. But the sense of smell often disregarded, like a dulled conscience, soon ceases to make any noticeable impression.

Thus it becomes necessary to have some test independent of individual peculiarities, and the results of which can be demonstrated to others,—that is, a chemical test.

"The man who has a patent sanitary stove, or an automatic ventilator will rarely find any disagreeable odor in a room fitted with his appliances."

This that I shall now show you, is a test that is simple, yet fairly accurate. It is by the use of lime water, and any one here might make this test without expensive apparatus; though like all chemical tests, it requires some care to give reliable results.

We have here several glass stoppered bottles which contain a known quantity of air. This one, for example, contains 250 cubic centimeters. This we fill with the air of the room by means of a rubber bulb syringe. We introduce 15 cubic centimeters of lime water—a saturated solution—by means of this graduated pipette; then close the bottle with the glass stopper, and thoroughly shake. If the lime water becomes clouded, so that looking through it we cannot see a pencil line on the strip of paper which is glued to the bottle, there are, at least, ten parts of carbonic acid gas in 10,000 of air. By using several bottles in the same way, we can determine the proportion of carbonic acid gas to within one part in ten thousand.

A bottle containing 460 c. cm. will indicate a little less than six parts of carbonic acid gas in 10,000 of air; 300 c. cm., 8 parts; and 200 c. cm., 12 parts; 100 c. cm., 16 parts.

This method is, of course, only approximate. The chemist uses other more exact methods. In the culture test the relative number of micro-organisms, especially bacteria, is a valuable criterion of the foulness of close air. A measured volume of the air to be examined is passed through a tube coated inside with beef jelly. "The germs are deposited on the nutrient jelly, and each becomes in a few days the centre of a very visible colony."

In a different way, by carefully measuring the amount of air entering by the registers, and noticing their position, a person of experience can decide on the effectiveness of the ventilation of a room.

Edward F. Adams.

To be continued.

The Y. M. C. A. meeting of Jan. 16, was conducted by R. S. Riley, '96; subject, "Our Guide."
Templets were made of each floor to a scale of a quarter inch to the foot, some of the more thickly settled and important ones a half inch to the foot, by which to mark off rapidly plans showing inside faces of the walls, posts, etc., and templets to outside dimensions of each tool, showing position and size of driving pulleys and marked with their distinguishing numbers from the list. Blanks were prepared and filled out by conference with the foreman, as illustrated in the following example:

**Form A.**

**John Openbelt, foreman.**

<table>
<thead>
<tr>
<th>No. of men now,</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of assuming job,</td>
<td>1894</td>
</tr>
<tr>
<td>Men besides self then,</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1. Changes in No. of men</th>
<th>2. Tools used exclusively</th>
<th>3. Floor space used exclusively</th>
<th>4. Tools used portion of time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Largest, Engine lathe No. 76</td>
<td>14x28</td>
<td>Upright drill No. 180</td>
<td>6</td>
</tr>
<tr>
<td>19 Engine lathe No. 76</td>
<td>28</td>
<td>Milling mach. No. 129</td>
<td>2</td>
</tr>
<tr>
<td>18 Engine lathe No. 77</td>
<td>112</td>
<td>Slotting mach. No. 199</td>
<td>0</td>
</tr>
<tr>
<td>Increase of Engine lathe No. 76</td>
<td>28</td>
<td>Speed lathe No. 11</td>
<td>0</td>
</tr>
<tr>
<td>Chuck lathe No. 78</td>
<td>322</td>
<td>Upright tapping machine No. 81</td>
<td>0</td>
</tr>
<tr>
<td>Speed lathe No. 136</td>
<td>28 ft. bench</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

**Estimate of time (Col. 4).**

- One-half David Cam
- One-half Henry Burr
- One-quarter Geo. Mill
- One-sixth Cam-Mill
- 3 hrs. a week Ezra Punch
- One-sixth Burr R. Smith

**Estimate of floor space required to double product.**

- Double present space, or about 800 sq. ft.
- Actual working space.
- Storage in process.

**Remarks, etc.**

Another blank was prepared, copies of which were filled out by conference with the foreman, for a large number of the individual parts in the product of the works, as shown in these examples:

**Form B. Example No. 1.**

**Foreman, J. Openbelt.**

**Work, Upright Shaft Fittings.**

<table>
<thead>
<tr>
<th>Name of Pattern Reed.</th>
<th>Operations part.</th>
<th>Tools delivered</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cylinder 700-01 Scratch</td>
<td>Ch. 1. No. 88</td>
<td>2 to loom</td>
<td></td>
</tr>
<tr>
<td>Shaft 704-5 rough</td>
<td>Eng. 1. No. 76</td>
<td>2 to loom</td>
<td></td>
</tr>
<tr>
<td>Miter 706-7 hand tool</td>
<td>Sp. 1. No. 12</td>
<td>(All)</td>
<td></td>
</tr>
<tr>
<td>Gears etc. Polish</td>
<td>Sp. 1. No. 11</td>
<td>Knowles</td>
<td></td>
</tr>
<tr>
<td>Stab</td>
<td>S. M. No. 109</td>
<td>(heads)</td>
<td></td>
</tr>
<tr>
<td>Drill for set sc.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tap</td>
<td>T. M. No. 84</td>
<td>Smith</td>
<td></td>
</tr>
</tbody>
</table>

**Form B. Example No. 2.**

**Foreman, J. Openbelt.**

**Work, Cam Selvage Motion from Upright.**

<table>
<thead>
<tr>
<th>Name of Pattern Reed.</th>
<th>Operations part.</th>
<th>Tools delivered</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selvage 488</td>
<td>Eng. 1. No. 88</td>
<td>2 to loom</td>
<td></td>
</tr>
<tr>
<td>487 rough</td>
<td>Eng. 1. No. 11</td>
<td>(All)</td>
<td></td>
</tr>
<tr>
<td>and turn</td>
<td>Sp. 1. No. 11</td>
<td>Knowles</td>
<td></td>
</tr>
<tr>
<td>Polish</td>
<td>Sp. 1. No. 11</td>
<td>(heads)</td>
<td></td>
</tr>
<tr>
<td>Drill for set sc.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tap</td>
<td>Sp. 1. No. 108</td>
<td>mostly</td>
<td></td>
</tr>
<tr>
<td>Tap</td>
<td>T. M. No. 84</td>
<td>put up</td>
<td></td>
</tr>
<tr>
<td>put up</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Form A was used first to determine from columns (3) and (7) the proportionate floor space to be devoted to each job. Columns (2), (4), and (5) furnished the basis for the distribution of new tools added to the plant and the data from which lists of the tools to be located in each job were made up.

The returns from each foreman on Form B were sorted into groups with reference to columns (3) and (6) and the results summarized on cards with an estimate from column (7) of the volume of work comprised in each group, thus:

John Openbelt, foreman,

Receives from Scratch room and delivers to B. Smith about one-tenth of the work comprised in his job.

These summary cards were used to test trial allotments of the space to be devoted to each job, as determined by columns (3) and (7). Form A, the space being marked off on floor plans made by marking around the templets of the buildings. Several groupings of the returns on Form B, with reference to the received and delivered columns (3) and (6), were made by exchanging between different foremen on the list, or by taking work from several foremen to form new jobs, and new trial plans made until the best possible location and make-up of the different jobs seemed to be reached.

The returns from each foreman on Form B, modified in some cases by changed distribution of the work, were re-sorted into groups having the same, or nearly the same, order of operations. From these groups course cards were made out with an estimate made from column (7) of the volume of work that followed the course.

Foreman John Openbelt follows this course with about one-twentieth of the work comprised in his job.

1. Chuck on No. 78
2. Rough cut on No. 19
3. Hand tool on No. 72
4. Polish on No. 11

These course cards were used to locate the tools, benches, etc., within each job, each tool being placed and marked on the final space allotment to each job, by means of the tool templets. The tools, etc., were shifted about until that arrangement which seemed best to fit the largest proportion of the work was reached. Drawings of the final plans were furnished the millwrights for setting the tools, putting up benches, etc. The location in the new plant of each tool was added to the list, indicated by the job to which it had been assigned and also by the number of the line shaft or counter from which it was to be driven, and from the completed list, each tool, on or before its arrival at the new shop, was marked for its destination on the floor.

It is not to be claimed that the final arrangement is an ideal one. I do not believe that goal
can be kicked in a shop built in the form of a hollow square. It, however, has stood the test of four and a half years' business, half that time with the works crowded to the full capacity, and no job has been removed from its location in the final plan, no tools has been moved except to make room for more, and so far as I know the arrangement of departments and tools has not been the subject of complaint from any quarter. November, 1894. WM. L. CHASE.

THE ABSOLUTE ZERO.

In McClure's Magazine for November, there is an interesting and instructive article on this subject, and, as it occurs both in the study of Chemistry and Physics, we publish an abstract from it, trusting it may also be of interest to graduates.

The temperature of the absolute zero, is supposed to be the lowest point of cold, existing or possible, in the universe. It is the supposed starting point of that molecular motion called heat. To attain it would give us the basis for a new and absolute thermometer, which would, in itself, be an enormous advantage in many branches of natural science. All our present measurements of heat are relative. A Fahrenheit thermometer merely marks the height in a tube attained by a column of mercury at the temperature of melting ice, and the height it attains at the temperature of boiling water. Between these two points the tube has been arbitrarily divided, the expansion of the mercury by heat being uniform, into one hundred and eighty equal parts, called degrees. The division is also continued below the freezing point of water, and thirty-two more degrees are marked off, creating an arbitrary zero. In the Centigrade thermometer, the zero is assumed at the freezing point of water, and one hundred degrees are marked off between that and the boiling point. Hence, our measure of heat, in general use in all the laboratories, has nothing absolute about it, but is merely a convenient means of comparing the heat of any object or place with the effects of heat upon water. To discover the absolute zero, and to make an absolute thermometer, would change all this. The zero of absolute temperature has long been indicated as a mysterious and important point in two ways. The first is the contraction of gases, which in all known gases is uniform as the temperature is lowered. As long as they retain the gaseous state, gases shrink in volume so uniformly, with each degree of cold, that an exact unvarying line of diminishing volume is established. If the shrinkage continued, since the proportion of loss of volume never varies, the gas would shrink to nothingness, which could not happen, of course. As long as they remain gases, they mechanically point their figuative fingers in one direction, and all these indicate a point which is 461° below the zero of the Fahrenheit thermometer.

This point is also indicated by all pure metals, as the conductivity of electricity in these varies exceedingly at ordinary temperatures; however, as they are cooled, a change takes place in all. The poorest conductors, under the increasing cold, become better conductors rapidly, and, the lines of alternation in electrical resistance of the several metals converge, in the same strange way as the gases, to the point 461° below zero Fahrenheit; that is, there is a point at which the electrical conductivity of all pure metals would be the same.

These two processes are merely to show that there is an absolute zero, which, having been determined, the next thing is to attain it. Scientists have long sought this goal, but, till recently, it has been so distant that there was scarcely hope that it might be obtained. Not long ago, 112° below zero was considered a marvel, and frozen carbonic acid occupied the proud position which solid air occupies to-day.

Professor Dewar of the Royal Institute, London, has carried the work 150° farther downward than anyone before him, and even he is 115° distant from the great and ultimate end of his work. In his first field of investigation, liquid oxygen gave him a working temperature of 280° below zero. To go farther downward, oxygen must be solidified and hydrogen liquefied, and once hydrogen is liquefied, the end will be near, as only 48° will remain for conquest. Nitrous oxide and ethylene have given Professor Dewar liquid oxygen, and liquid oxygen has enabled him to reach solid air and 346°, the lowest temperature yet known. Beyond this he cannot go till invention or discovery opens a way that is for the present impassable.

Solid air, which is a transparent glass in which the nitrogen is solid, and the liquid oxygen is held mechanically, is obtained in test tubes consisting of three compartments. The outer is the vacuum chamber, and the second contains liquid oxygen, which is boiled off rapidly by exhausting the air. This produces such intense cold in the third tube, which is inserted in the liquid oxygen and is open to the air, that the air from without first liquefies and runs rapidly down the sides of the innermost tube, forming a clear liquid like water at the bottom. As the cold is increased the liquid grows thicker and thicker and, in a few moments is a solid, looking exactly like ice or glass. When the tube
containing it is taken out, it liquefies and vaporizes rapidly, and more air from the atmosphere liquefies on the outside of the tube, and drops freely from the bottom, passing into vapor, however, before it reaches the floor.

Liquid oxygen is obtained, not by freezing mixtures and ice, but by steam engines and compressors; in fact, the whole idea is pressure. Nitrous oxide gas is first liquefied by a pressure of 1,400 pounds per square inch. When it evaporates again it creates a cold of 130° below zero. Within the chamber is a chamber of ethylene gas under a pressure of 1,800 pounds per square inch, and the cold from the evaporation of the nitrous oxide liquefies the ethylene at this pressure. Within the ethylene chamber is the pipe from the oxygen compressor, the oxygen being compressed to 750 pounds per square inch. When the ethylene gasifies or evaporates, it reduces the temperatures to 229° below zero, and, at this point, the compressed oxygen liquefies freely, and is drawn off in quantity at a cost—including the waste which is inevitably 90 per cent.—of, perhaps five hundred dollars per gallon.

Ice, our ordinary freezing medium, is often frozen, and, as a solid, shrinks, cracks, splits up, and goes to pieces on sudden cooling, exactly like hot glass in cold water. Liquid ozone, that eccentric indigo-blue, twin sister of oxygen, is being observed and studied in all its moods. And, with Dewar working at 346°, and Moissan, at Paris, investigating nature at 6,300° above the Fahrenheit zero, the world may expect to gain startling knowledge of that comfortable, yet inexplicable phenomenon, to which we have given the name "heat."

W. '97.

TECH DEFEATS BROWN AT POLO.

Saturday, Jan. 19, our ice polo team defeated the Brown University team at Lake Quinsigamond by a score of 2 goals to 1. Each team made 2 goals, but Brown lost 1 goal on fouls, thus giving the game to Tech. A crowd of about 150, mostly Tech men, watched and shivered while the game was in progress. A space had been cleared of snow just below the Wachusett boat-house, and poorer ice for skating could hardly have been had. It was made up largely of snow ice, through which the skates cut as through cheese, until at the end of the game only a few patches of ice were visible. The teams lined up at 3 o'clock, Tech defending the south cage. The first rush was taken by Hale of Brown, and there was some fast playing for a few minutes, many falls being taken owing to the wretched condition of the ice. It was soon seen that Brown was playing a clever team game, their passing being superior to ours, although had the ice been in good condition we should, without doubt, have equalled them at this. But individually we showed up much stronger, our men taking the ball away from them with ease many times. After about 8 minutes of play Hale scored a goal for Brown on an easy chance in front of the goal. Gordon missing his chance. Knowles played finely, and Harris made many stops, some of them extremely difficult. No more scoring was done in this period. Sibley had a foul called on him near the close of the half, the ball striking his hand.

The second period was started after a 5-minute rest, Carroll going in at rush in place of Warren. Hale again took the rush, and the ball was carried toward the Tech cage. After a few minutes Carroll took the ball up toward the Brown cage, and made a long drive at a bad angle, Watson tried to kick it out, but the ball struck him on the shin and bounded into the cage, tying the score. A foul was called on Jenks just before the goal was made. Carroll won the next rush, and after a few minutes' play Knowles scored another goal for Tech on a fine piece of playing, which called out a "P. I." from the crowd. Knowles and Carroll came down with the ball and Knowles made a long drive which was kicked out, but Knowles secured the ball again and passed to Carroll, but the latter instead of driving waited until Knowles had slipped in between him and the cage and then passed to Knowles who drove it in.

No more scoring was done until the next period, when Brown began to force matters, and scored a goal after a few minutes' play, Hale caging the ball. Brown then had the misfortune to make two fouls in short order, which, with the one made earlier in the game, caused the canceling of one of their goals. There was still eight minutes left to play, but the great goal tending of Harris and Gordon's blocking, in fact, the defensive work of the whole team, kept Brown from scoring again. Knowles and Warren took the ball up to the Brown cage several times, but the goal tend kicked it out successfully each time. The game ended with the ball in Brown's possession near the center of the surface.

Had our team had a chance to practice during the week, or had the ice been in anything like decent condition, we would have, no doubt, made a much better score; but when we consider that this same team, which Brown showed, played a tie game only a week ago with the New Bedford league team, we need only congratulate ourselves that we have won a well earned victory over a good team.
His curiosity was aroused, and he went to inquire who the occupant might be. He found it to be the house of Prof. N. A. Cobb, head professor in the Department of Agriculture, New South Wales.

They had a long and pleasant interview, during which the speaker found that Prof. Cobb was a New England boy, and more than that, received his training at the W. P. I., being graduated in the class of '81. This announcement was received with loud applause by the students. Continuing, the speaker spoke of the peculiarity of some plants, which on being transplanted from their native places to foreign countries, so multiply and flourish that, while in their former home they were mere harmless weeds, they become intolerable and ruinous pests. Also, animals in the same way, as for instance, the Australian rabbit pest. He spoke of the many useful things for which we owe thanks to Australia, among them the Australian ballot system.

He then described the character of the country, the climate, and territorial divisions of Australia. Australia and New Zealand lie not far from the 180th meridian from Greenwich, hence their seasons are exactly the reverse of ours. A very large part of Australia is a waste desert.

This is being reclaimed by the raising of sheep, which are hardy enough to subsist on the scant herbage of the desert.

The territory of the Australian colonies and their population are in an inverse ratio, Victoria, the smallest of the colonies, having much the largest population.

Now, in Australia the raising of wheat was found to be attended with great difficulty and loss, owing to the prevalence of rusts of various kinds which formed on the ears and destroyed them. In order to study into the nature of this, and devise a remedy, Prof. Cobb was sent for; and as a result of his investigation and methods, Australia has now a practically rustless wheat. Again, sheep raising on these deserts was found to be almost impossible, owing to the appearance of destructive parasites upon the sheep which destroyed them by wholesale. Prof. Cobb is now engaged upon the study of these and their habits, and to further him in his work the government has equipped laboratories for his use, on a scale never before attempted in that country.

The speaker here showed the students a copy of an illustrated paper he had received a few days before from N. S. W. illustrating these laboratories, and an article upon Prof. Cobb’s work on the sheep parasites. He left the paper in the Institute reading-room for the use of the students.

He also spoke of the value of museums and
cabinets, and the care which the Australians bestowed upon these matters. He then spoke of the field open to graduates like Prof. Cobb who wished to do something to benefit the human race in its struggle against adverse conditions, such as in Australia, and showed that the result could be attained by those who worked for it.

The prolonged applause at the end showed the speaker that he had the interest and thanks of his audience.

To the Editor of the WPI:

In your issue of Dec. 15, 1894, appears an interesting communication from brother Wm. L. Chase concerning a recent dinner indulged in by the Washington Branch Alumni Association. As Mr. Chase expressed certain misgivings as to the source of our enthusiasm on that occasion, I have thought it advisable to try to allay his misgivings by a short note of explanation, which, by the way, is written entirely on my own responsibility. Without attempting an apology for the introduction of wines on the menu cards I will say that on my personal observation at the dinner, and inquiries since made, the brother may be assured that his _bête noire_, Mumm's Extra Dry, got no farther than the menu cards. In other words, none was taken at the dinner.

As to the accusation that our Branch has disregarded an established principle of the parent organization I shall not take issue with the brother in his partial acknowledgment that the home organization should have made its principles more widely known. I, for one, had no idea of the existence of such an article in the By-laws of the Alumni Association as Article X., mentioned in the communication and printed in the WPI. And I have yet to meet an alumnus who did know of its existence. Personally speaking, the Article meets my unqualified approval and I regard it as deplorable that so good a thing should have remained so long in obscurity.

In conclusion, let me caution brother Chase in his further efforts as a discoverer, that, in the slightly changed words of Bill Nye, or one of "them funny fellers" it is better not to discover so much as it is to discover so much that isn't so.  

George P. Tucker, '87.

Washington, D. C.

SPECIAL LECTURES IN MECHANICS.

Still another innovation in the way of lectures is promised the Seniors next half. Prof. Alden announced to the divisions in an informal way a few days ago, that it had been decided to commence a course of lectures in Mechanics during the next half year; the lectures to be delivered by prominent men outside the Institute. These lectures will take place before the Senior class, Wednesdays at 11 A. M., and will be delivered in the Mechanical Model Room, in the Laboratories, with the exception of that by Mr. Henning of New York, which will be in the Chapel, as one of the regular Monday morning lectures. These lectures have been under consideration for some time, but the Faculty were unable to properly arrange for them until now. They will be appreciated greatly by the Senior class, and should prove of great assistance to their study of Mechanics.

Y. M. C. A.

The State Secretary of the Y. M. C. A., Robert E. Lewis, will be in this city, Feb. 2d and 3d, and conduct meetings Saturday evening and Sunday afternoon and evening. It is proposed to secure a larger hall than any available at the Institute, in order to accommodate the large number of men who will attend. The district conference will be held at Clinton, Jan. 26th and 27th, it is hoped that we will be represented at that time.

COLLEGE NOTES.

The Seniors held a class meeting Wednesday, Jan. 16, at which several matters in reference to the class-book were discussed. The book is progressing rapidly and the material will be all in by the middle of March. The matter of haste in class photos was also urged, as photos must all be in by the first week in March in order to get cuts for the class-book. It was voted that any past members of the class who wished to have their pictures in the class-book might do so by paying for cost of same.

The next lecture will be given February 4th, by Mr. Edward S. Morse, who has wide reputation as naturalist and biologist. His subject will, in all probability, be on some topic connected with his profession. He will be followed by Mr. Gustavus E. Henning of New York City, an expert on the use of testing machinery. Mr. Henning will be followed by Prof. N. S. Shaler of Harvard University.

President Elliot of Harvard sailed for Europe January 5th, to be gone till April. Prof. Dunbar will act as President of the University during Dr. Elliot's absence.

D. K. E. at University of Michigan has given a prize valued at $50 for excellence in the running high jump, to be competed for five years in succession.

Two new courses in Latin have been added at Wellesley, as has also a course in newspaper work.
At the University of Chicago, the attendance for the quarter just closed was 1,000, a gain of 33\% per cent. over the corresponding quarter last year.

The Faculty of Pure Science of Columbia College has arranged for a course of lectures on the "Evolution of Plant Life," to be held on Tuesdays throughout the months of January, February and March.

"Tim" Keefe will do the baseball coaching at Harvard this year.

The annual dinner of the Hamilton College Alumni Association of New York, was held at the Hotel Savoy, January 7th.

A college paper is published by the students of St. John's College, Shanghai, China. The paper is printed in English.

The first college paper in the United States was published at Dartmouth. Daniel Webster was editor.

Harvard won the Intercolligate Chess Tournament during the recess. Yale and Princeton tied for second place, and Columbia was third.

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A LEGACY FOR THE W. P. I.

The will of the late Phinehas Ball has just been probated, and contains a legacy for the Tech. The W. P. I. is made residuary legatee. The provisions are that the sum be divided into two equal parts. The first is to be put at interest, and the interest used as the Institute Trustees direct. The second part is to be put at interest, and the interest added to the principal till the amount is sixty-four times the original sum.

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NOTES ON THE SHOW.

During the recess, much has been done towards the Burlesque to be given by the Athletic Association.

Mr. Harry W. Doe has kindly consented to write the libretto of the show, and has taken as his title, "A Burlesque on the Merchant of Venice." Mr. Doe's abilities in this line are well known, and, it is safe to say, that the Burlesque will exceed the greatest expectations of the students. Mr. W. S. B. Dana has finished several very catchy songs and choruses, and is hard at work on others.

Mr. Phinney, ex-'93, of the committee, on the '93 show, has given the present committee the full benefit of his experiences in this line, and will continue to do so to the end.

The voices of the students will, in all probability, be tested in the Laboratories during examination week. Places in the ballet will be competitive. Notices will be posted from time to time giving any announcements that may be deemed necessary. The committee earnestly requests that the students give their combined assistance for the furtherance of the show.

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TECHNICALITIES.

'78. Harry C. Babbitt has lately assumed the position as chemist at The River Furnace of Corrigan, McKinney & Co., Cleveland, O.

'82. The works and plant of Bardous & Oliver at Cleveland were recently entirely destroyed by fire.

'90. After March 1st Chas. F. Treadway expects to be located in Boston, where he will represent Nicola Bros. Co. of Pittsburgh, in the New England lumber market.

Prof. in Calculus: What is a parameter?

J-fiks: The distance measured on the outside of a figure.

Students of Division A '96: Prolonged laughter.

Student: Dass Ihr mir den Kindern nichts zu leide hat, das Meerkasse.

Prof.: Mr. St. ne you omitted the word mir intentionally in your translation?

H-gg-ns: Meer (mir) means monkey.

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