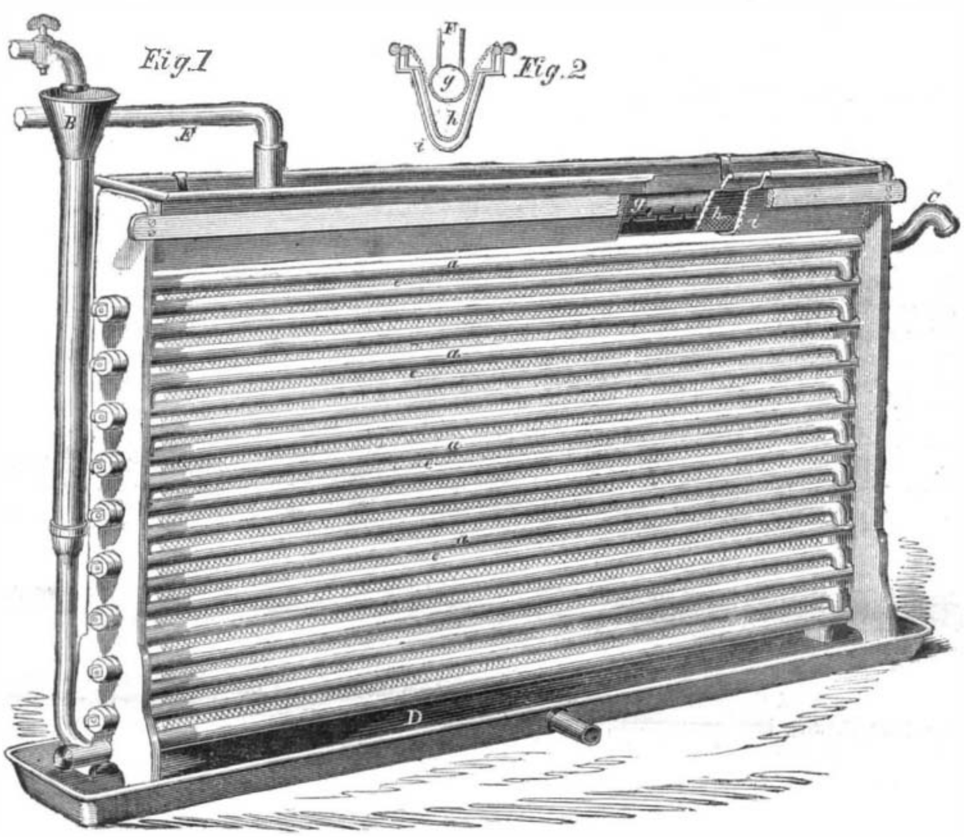
Scientific American.

A JOURNAL OF PRACTICAL INFORMATION IN ART, SCIENCE, MECHANICS, AGRICULTURE, CHEMISTRY, AND MANUFACTURES.

VOL. II.—NO. 4. NEW YORK, JANUARY 21, 1860. NEW SERIES.

THE PROCESS OF BEER-MAKING—MECHANICAL, CHEMICAL AND MICROSCOPIC.

We presume that the invention which we here illustrate will rank among the great inventions of the decade; it is certainly one of the most ingenious. It is an apparatus for cooling beer in the process of brewing, and in order to render its advantages intelligible to our readers, it will be necessary to give a brief account of this process.



BAUDELOT'S BEER-COOLING APPARATUS.

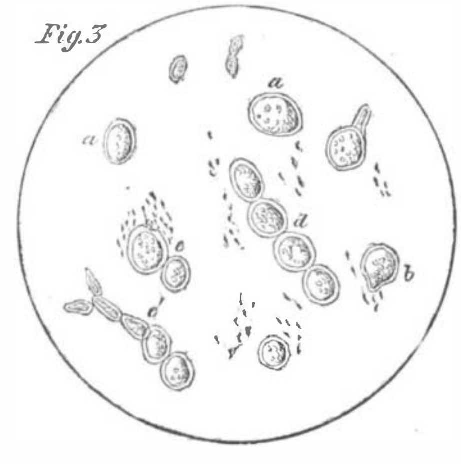
Beer is made of water, barley and hops, and the principal change which is effected in the process of brewing is the conversion of the starch and gluten in the barley into sugar and alcohol. Starch, sugar and alcohol are each composed of carbon, hydrogen and oxygen, combined in slightly different proportions, and the brewer, by the mysterious forces of vegetable life and heat, varies these proportions so as to change the starch into sugar and alcohol.

The first step in the process is to sprout the barley, and convert it into malt. To do this the grain is first steeped in cold water from 40 to 60 hours, which produces the same effect upon it that the moisture of the earth does upon seed planted in the ground, causing it to swell and preparing it to vegetate. The barley is next spread on a floor of stone flags, in square heaps, from 12 to 16 inches high, where, in about 24 hours, it begins to sprout; the radicle, or part that forms the root, first appearing at the tip of each grain, and about a day afterwards the plumula (the part that would grow upward in the air) coming forth from the same end of the seed, and pushing along towards the other end in the form of a leaflet. It requires about a fortnight for the plumula to grow the length of the grain, and as it creeps along, that portion of the seed which is opposite to it experiences the mysterious change in its nature which is produced by the process of malting, the conversion of starch into saccharine matter. When the germination has reached the proper stage, that is when the plumula has reached the end of the grain opposite to that from which it sprung, the malt is dried in a kiln and crushed between cylinders.

The second step in the process of brewing is *mashing*, which consists in steeping the malt in hot water, at a temperature of from 145° to 200°. This dissolves the saccharine matter already formed and converts most of the remaining starch into sugar. The liquor is now called *wort*. It takes about two bushels of malt to make a barrel of ordinary beer.

The third step is *boiling in the hops*. The wort is pumped up into a large copper kettle, and, the hops being mixed with it, is boiled some 5 or 6 hours. The quantity of hops required to the bushel of malt varies from ¼ of a pound to a pound, according to the strength of the beer.

After boiling, the wort is to be *cooled*; and the usual method of doing this is to pump it up into a shallow tank occupying almost the whole of the upper story of the building, where it rests in a stratum about two inches thick, and is exposed to free currents of air passing through windows open on every side of the building. In some establishments the cooling process is completed in the tank, while in others the wort is partially cooled in the tank, and is then passed to some of the numerous refrigerators which have been invented for that purpose.



When the wort is reduced to a temperature of from 55° to 65°, it is run into the "gyle tun," and mixed with yeast to ferment; in general, one gallon of yeast being sufficient for 100 gallons of wort. The process of fermentation is one of the most interesting of the operations of nature, and its investigation has occupied the attention of several of the foremost intellects of the world.

There are several chemical changes operating to clarify the beer, &c.; but the principal one is, as we have stated, the conversion of sugar into alcohol. But these chemical changes are caused, or at least accompanied, by the growth of a vegetable, so small as to be wholly invisible to the naked eye, and which is peculiarly interesting as presenting the very lowest form of vegetable organization, being a simple cell. Fig. 3 is an engraving of this vegetable, from a drawing by Edwards, made expressly for this article, from specimens of yeast obtained at Miles' brewery, in Christie-street. The separate cells are entirely invisible to the naked eye, being magnified in the cut 760 diameters. As the yeast had been several days in fermentation, the plant is shown in the successive stages of its growth; *a a* being the simple cell in its earliest stage, formed of an enveloping membrane of inconceivable fineness, enclosing a semi-fluid mass filled with very small seeds. When yeast is put into a fermentable liquid, like wort, these cells begin to grow in a very peculiar manner; some of the seeds begin to swell and push out buds on one side of the cell, as seen at *b*; and, this development continuing, assumes the appearance of *c*. Meanwhile, another seed, swelling, pushes out a bud on the opposite side of the cell, and both continue to grow till they become of the size of the parent cell, when they bud in turn; and thus form chains, as seen at *d*. From the state shown at *d*, two forms of development take place; a portion of the cells burst, and scatter the seeds into the surrounding liquid, as at *e*; while another portion branch forth, as at *e'*. The yeast plant has been patiently watched by Hassall through the further stages of its growth; but as that represented at *e'* is quite as far as it is allowed to go in the process of brewing, we shall not trace it farther in this connection. It has been named the *Torula cerevisiæ*. It will be understood that the increase in the quantity of yeast by fermentation is owing to the growth of this plant. The process of fermentation occupies several days; the time varying with the temperature, which ranges from 70° to 90°, and after this process is completed, the beer is stored away in the cellar to ripen with age.

It is from its influence on the fermentation that the mode of cooling derives its great importance. How this influence is exerted is yet largely enveloped in mystery, but practice has taught that the wort should be exposed freely to contact with the air, that the cooling should be as rapid as possible, and that the wort should not be subjected to any sudden shock by bringing it at a high temperature in contact with a very cold surface. It will be seen how ingeniously, beautifully and perfectly these *desiderata* are obtained by the apparatus represented in the accompanying cuts.

It consists of a series of horizontal copper pipes, *a a a*, say 22 in number, and $2\frac{1}{4}$ inches in diameter, communicating at their ends so that a stream of water may flow constantly through them. The water is introduced through the vertical pipe, B, and discharged at C; the rapidity of the flow being, of course, adjusted to the hight of the head. The wort is allowed to trickle in fine streams upon the upper side of the highest pipe, which it passes around in an extremely thin sheet, and falls upon the pipe below, passing around that in the same manner; and so on, till it drops from off the lower pipe into the trough, D. Thin sheets of metal, *e e e e*, serrated at the lower edge, are fastened longitudinally to the lower side of each pipe to conduct the liquor in minute streams from one pipe to the other. As the cold water enters the bottom of the series of pipes, and the hot wort is applied to the top of the series, any sudden shock in the process of cooling is avoided; the wort, as it decends, finding each pipe raised to a temperature approximating to its own, and the water, as it rises, absorbing the heat from liquor of a constantly-increasing temperature, until it is discharged almost as hot as the wort when it enters the apparatus. Thus nearly all the heat is transferred very rapidly from the wort to the cooling water.

The liquor is brought to the cooler through the pipe, F, and enters first the horizontal cylinder, *g*, which is perforated with holes to strain it of its coarse impurities. From the cylinder, *g*, it falls into the trough, *h*, the bottom of which is made of very fine wire gauze, which strains the liquor into the lower trough, *i*. This lower trough is perforated along the middle of the bottom by a single row of small holes, through which the wort falls upon the surface of the upper pipe.

This ingenious apparatus was invented by Jean Louis Baudelot, of Harancourt, France, and it comes to this country with numerous recommendations from French *savans* and practical brewers. A cooler has been constructed and tried at the Croton Brewery of W. B. Miles, No. 59 Christie-street, this city. Mr. Miles states that, in the experiment, it cooled 30 barrels in about an hour and a half; that the wort was let on at a temperature of 178°, and came off at 55°; that the water entered the pipe at 40°, and was discharged at 144°, showing how nearly all the heat was transferred from the wort to the water. The quantity of water used was about the same as that of the wort. It is proposed, in using this cooler, to dispense entirely with the large tank at present employed, and to take the liquor directly from the boiler.

The American patent for this invention was issued to Henry Migeon, on November 1, 1859; and persons desiring further information in relation to it will please address Geo. B. Turrell, 626 Washington-street, this city.

OUR CORRESPONDENCE.

THE NATIONAL CAPITOL—WARMING AND VENTILATION—SLEEPING CARS—CITY RAILROADS, ETC.

CINCINNATI, January 7, 1860.

MESSRS. EDITORS:—As this is my first "breathing-place," I take the opportunity to drop you a few lines. I left Richmond, Va., for Kansas Territory on the 2d day of the new year, by way of Washington; and having a few hours to spare in that city, took occasion to visit what some irreverent wag has termed the national *gas* factory, *i. e.*, the capitol. An esteemed friend connected with the "extension" acted as my guide on the occasion, and I am constrained to believe that to his talent is in some part due the perfection of detail which everywhere meets the eye.

Any attempt at general description being quite out of place, I will merely remark that the warming and ventilating arrangements alone are well worthy of a visit; and as it was to them that my attention was mostly directed, they shall receive the first mention, and that a very cursory one. The fresh air is driven in by two large fans, one for each side of the building, between a great number of steam pipes, supplied from several tubular boilers in the basement. From these pipes the incoming draft derives its heat, the amount of which can be regulated, according to circumstances, by throwing out of connection with the boilers one or more sets of pipes. There is an abundant supply of thermometers to indicate the varying temperatures, but I did not notice a single hygrometer to tell its tale, and some are badly needed. The fresh warmed air is conducted to various apartments, principally to the Senate Chamber and House of Representatives, by appropriate passages and conduits; into the rooms it is generally admitted through the floor by handsome registers (in the Senate and also in the House, I believe). Each senator has one in front of his chair, so that he can warm his feet at will—a good arrangement to keep the blood from their heads, but it does not always seem to have this happy effect. The air having fulfilled its double object of supplying warmth and pure breathing material, is conducted away through various apertures in the ceiling. There does not appear to be any special sucking apparatus to help the foul gases to escape (excepting the heat of the gaslights overhead, and these are intended to give light as their primary and perhaps sole object, and therefore are not arranged with much design towards that end); dependence being placed on the driving power of the fans.

It is astonishing how little steam heat is required to keep the temperature of the two legislative halls abundantly high, when many people are in them. The lowest temperature, the morning in question, was $2\frac{1}{2}$° above zero, and at the time of my visit it was still very cold out of doors, yet the heating apparatus was by no means worked up to its capacity. The whole affair is very ingeniously contrived, and reflects credit in many points on its constructors. Yet I cannot give it unqualified approval; I allude more to the system than the actual details. 1st, The air is *too dry*—that almost universal fault to be found, when the attempt is made to warm the room by the admitted pure air. My friend stated that when the incoming current was dampened by steam jets, the moisture was condensed on the windows, &c., of the halls, and therefore they abandoned it. Well, suppose it was, what matter? Better to have it so, than injure the lungs of the people who, as it now is, are condemned to breathe that unnatural air. 2d, The foul air escapes are not arranged in the best manner, the whole of this part of the matter is not as well done as it might be, especially in the committee rooms; indeed, there are several apartments and passages *without* any foul air escapes—an omission I was quite unprepared to find. 3d, The galleries for the spectators are badly supplied with pure air. There should be an abundant amount furnished for them, as, from the nature of their arrangement, they are liable to be somewhat infected from the chamber below. I got a severe headache there in a short time, at all events.

The building is, with great judgment, made fire-proof. It is better to expend a few thousand dollars more on any public edifice than leave it at the mercy of a spark or a friction match, and so lose immense wealth that often cannot be gathered again. It is almost incredible that we, who, as a nation, annually lose more from conflagration than any other people on the globe, should persist in putting up such inflammable structures as we do, year after year. Possibly it may be from the notion that iron is such a "very combustible substance" (lately expressed opinion of certain architects!) that people are afraid to employ it more extensively in their houses. Or can it be that the more buildings are burned the more others are built, and the more work for the builder?

Of the beauty and magnificence of the capitol I have nothing to say. Descriptions of decoration are out of my line; it will amply repay a visit, however; if for nothing more than to let the universal Yankee nation see how some of its money goes. "More regal than republican," will be the verdict of many, doubtless, after gazing on its splendors. It is a bare question, whether it is absolutely necessary for good legislation that the senators should have baths hewn out of *solid marble*, like the sarcophagi of the Egyptian kings, or whether all this gilding and bronzing and statuary are essential to the safety of the country. Is it to help to pay for this that it has lately been decided that blank books, letter paper, &c., are to be charged *letter postage*, while hundreds of tuns of useless matter goes through the mails scot free? But let it pass! we must "grin and pay," I suppose.

As King Frost ruled supreme over the Potomac, the boat had to acknowledge his supremacy by keeping holiday. It does not speak much for the enterprise of the people that there is no direct line from Washington to Richmond; as it is, we had to go round by Gordonsville. If the individuals in charge of the baggage would look a little better after their business it would be also well; the arrangements for checking through from Richmond to Washington are not good.

On the Baltimore and Ohio Railroad they had a good sleeping (berth) car attached to the night train to Wheeling. This should be a permanent institution on all lines, and doubtless will be after a time. If there was some way of *eating* leisurely in the cars while proceeding on a journey, as well as sleeping, it would be a vast improvement over the present method of producing dyspepsia, at 50 cents a head, though no doubt a loss to the obliging gentlemen who keep the so-called "eating (*cheating?*) houses" along the various railroads. In addition to the regular sleeping car on this line, there were cars with good comfortable sleeping *seats*, on which persons can enjoy very tolerable rest without the extra charge which must be paid for admission into the sleeping car. I wish as much could be said for the warming and ventilation of the cars as for the resting accommodations; but really one stove is not enough to keep a car warm in such severe weather as the present, and as for the breathing "fixings," they were "few and far between." Fortunately, there was not a great crowd, and the carbonic acid gas was not generated in very alarming quantities.

Though there was some snow we were "up to time" at the Ohio river, and the track also seemed in fair order, considering the bad weather, as far as could be judged by the motion of the cars over it.

About 15 hours from Washington suffices to reach Cincinnati over the Central Ohio and the Little Miami railroads. The further to the West we went, the rougher the tracks seemed to become.

The city railroads of Cincinnati appear to be a success, and a great boon there, as in all cities where they are introduced. The profile of the track is not good; at least, in some places, there are very unnecessary undulations of the grade line, which will be severely felt if they ever make use of steam instead of horse power, as I trust will be done sooner or later, not only there, but in all other localities where city railroads exist. It is hard to overcome prejudice and ignorance in such matters. May it be the mission of the SCIENTIFIC AMERICAN to contribute in no inconsiderable degree to this result. You are right—we must have steam on the city railroads before we run the steam carriage on common (unrailed) streets; and we must have steam carriages and steam wagons for a long time in daily use in our large cities before they can be used profitably on our suburban roads. The location and construction of these are both so atrocious that one is almost driven to despair of ever hearing the steam whistle on them. England is better adapted to common road engines than this country, and will take the lead in this matter. We ought to show the way in steam plowing, but we have not as yet done so.

A substitute for wood engraving is in use at the Phonographic Institute of Cincinnati, which promises much to illustrated papers, &c. It gives a more accurate outline at about one-half the cost of wood-cutting. It is an application of electrotyping, and consists in coating ground plate glass with a composition resembling wax; on this the engraving is traced *down* to the ground glass plate; it is then electrotyped, and when "backed up" with type metal, is ready for the printer. This method has been used by Mr. Pitman, in the production of phonographic outlines, for the past four years, but the details have only lately been perfected.

E. M. RICHARDS.

PATENT EXTENSION CASES.

Screw Machine.—Solomon Merrick (deceased) of Springfield, Mass., obtained a patent on March 7, 1846, for an improved feeder for screw machines. A. D. Briggs, administrator, has applied for its extension for seven years. The case is to be heard on the 6th of March, at the Patent Office. The testimony closes on the 23d of February; opposition testimony must be sent in writing.

Register for Stoves.—Washburn Race, of Seneca Falls, N. Y., has applied for the extension of a patent granted to him on April 4, 1846, for an improved stove register. The case is to be heard at the Patent Office on the 19th of March next, and the testimony closes on the 5th of the same month.