being 10 inches, 15 inches, and 28 inches in diameter respectively, all of 2 feet stroke. The high pressure cylinder is placed inverted over the intermediate one, the same piston rod serving for both, and there being space between for packing glands, etc. The cover of the intermediate cylinder is made in halves, so that its piston can be drawn without removing the high pressure cylinder. The crank shaft and screw shaft are forged from Lowmoor scrap, the diameter of journals being 5¾ inches. The surface condenser has 350 square feet of tube surface, the tubes are three quarter inch external diameter, packed with Marshall's patent rings. The air pump is 10½ inches in diameter by 12 inches stroke, and is single-acting; the circulating pump is 6 inches diameter by 12 inches

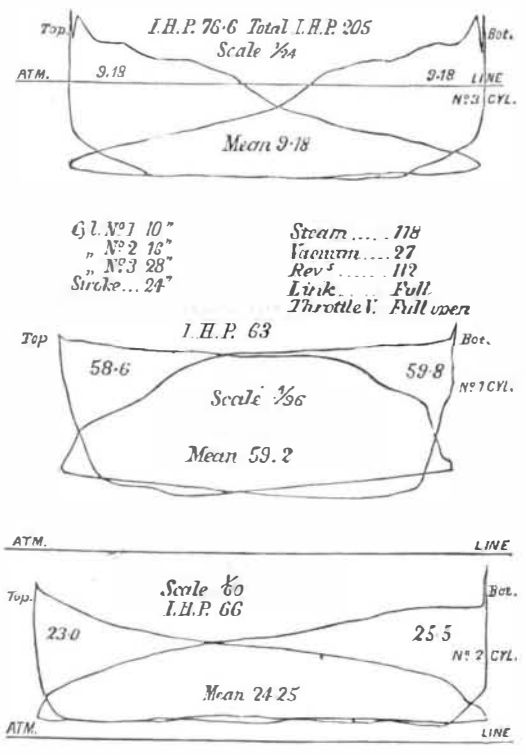

Fig. 2.—DIAGRAMS FROM THE ENGINES OF THE ISA.

stroke, and double acting. There are two feed pumps 1⅞ inch in diameter by 12 inches stroke, and one bilge pump 2⅜ inches in diameter by 12 inches stroke. The propeller has two blades and is of gun metal, polished all over; it is 8 feet 6 inches diameter and 12 feet 3 inches pitch. Steam is supplied by one boiler 8 feet 9 inches diameter by 8 feet 6 inches long, with two furnaces 33 inches in diameter, and 106 return tubes of 2¾ inches external diameter. The shell plates are one inch thick with double butt straps, treble riveted; the boiler was proved by hydraulic pressure to 250 lb. per square inch, and with steam to 150 lb. The working pressure is 120 lb. The accompanying diagrams were taken during a run out to sea, the speed of the yacht being about 12 knots.—*Engineering.*

The Suez Canal.

Mr. Farman, United States consul-general at Cairo, Egypt, furnishes the Department of State with an interesting article on the Suez Canal. His facts are derived from authentic sources. A few of them are selected of remarkable interest. The entire cost of the canal was 472,921,799 francs, or $92,273,907. The stock of the company consists of 400,000 shares, at 500 francs each. These shares have sold as low as 100 francs each. At the opening of the canal they had advanced to only 300 francs. They are now quoted at 717 francs, and are probably worth more. The British government paid about 568 francs. The number of shares bought, in 1875, by Lord Beaconsfield at this price was 176,602. This great purchase, aside from its political and commercial advantages, thus affords a clear profit of 25,000,000 francs at present prices. The balance of the stock is held by a large number of persons, mostly in France. The revenues of the canal have increased from 5,000,000 francs in 1870 to over 30,000,000 francs in 1877. The expenses, including interest, sinking fund, and lands, have been a little over 17,000,000 francs per year. While the revenues steadily increase, the expenses are decreasing or stationary. Deducting the amount paid for interest and the sinking fund, the actual expenses are about 5,000,000 francs annually. The cost of cleaning the canal and its accessories is only about 2,000,000 francs per annum. The small comparative cost of maintaining the canal arises from the fact that there are no locks or lateral embankments to be broken. Except the ordinary cleaning, there is little to be done. Vessels drawing twenty-five feet of water or less pass through the canal. The saving of distance to the British ships going to India is nearly 5,000 miles. Two thirds of all the vessels passing through the canal carry the English flag.

Monsieur Ferdinand Lesseps, who has been at the head of the enterprise since its beginning in 1854, expresses the opinion that the Panama canal must be constructed without locks to be successful or remunerative.

MATHEWS' BOILER ATTACHMENT.

In our last issue we gave an illustration and description of this simple apparatus. The address of Mr. F. C. Mathews, given at the close of the article, is incorrect. It should be 337 and 339 Canal street, New York.

Scientific American.

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VOL. XL., No. 16. [NEW SERIES.] *Thirty-fifth Year.*

NEW YORK, SATURDAY, APRIL 19, 1879.

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Description of the Stern Wheel Steamer, Montana. Designed for the navigation of the upper Missouri river.

On the Loading of Monster Guns in Modern Iron Clads. By CAPT. A. M. ALBANI, of the Italian Royal Navy, 3 figures. 1. Apparatus for working monster guns: 2. Method of loading monster guns; 3. Barbette turrets of the Royal Italian iron clads, Lepanto and Italia. A valuable and interesting paper.

Heavy Ordnance. Recent progress in gun construction at Woolwich, Eng.

The St. Gothard Tunnel, 1 figure; a sketch of three circular tunnels near the big tunnel. Method of working; difficulties; ventilation. General description, with many valuable particulars of the work.

Firebrick Fireboxes for Locomotive Boilers. Nerdlerber's new construction of locomotive boilers, with account of experiments which led to its adoption by the Hungarian State Railways, 7 figures, and a tabular statement of results. An important and useful paper.

II. TECHNOLOGY.—The Wielicska Salt Mines, described by CHAS. GRAD, Alsacian Deputy to the German Reichstag. How the great Polish salt mines are worked. Character of the salt. Geology of the salt formation, 1 engraving, giving a view of one of the great chamber of the mine.

A good Mounting Material for Carbon and Silver prints, with method of preparation and use.

On a new Chemical Industry established by M. Camille Vin ent. An important method for utilizing the waste products of the beet sugar manufacture, by the preparation on a large scale of useful compounds hitherto known only as chemical rarities, 2 figures. A valuable paper.

Cement for Metal and Glass.—Metallic Packings.—The Distillation of Coal Tar. Description of the Scotch process, 2 figures. A very useful practical paper.

Notes on the Microstructure of Spiegeleisen. From A. MARTENS, report, with 12 figures.

III. PHYSICS.—Cailletet's Apparatus for Determining the Volume of Gases under High Pressure. By G. TISSANDIER. The apparatus figured was used in an unfinished well bored at Butte-aux-Cailles to the depth of 1,680 feet. By this apparatus M. Cailletet has subjected nitrogen to the tremendous pressure of 245 atmospheres, and experiments with other gases are soon to follow.

New Pyrometers. Two new German instruments, 4 figures.

IV. ELECTRICITY, LIGHT, HEAT, ETC.—A New Duplex System of Electric Telegraphy. By S. M. RANKER. 1 figure.

New Sounder, designed by Theiber & Sons, London, Eng. 1 figure.

Spontaneous Combustion. Bing's experiment, showing spontaneous combustion with petroleum and various other substances.

V. NATURAL HISTORY.—Fragrant Woods. The first elaborate grouping that has been made of fragrant or odorous woods, with detailed accounts of their uses, their botanical relations, habitats, modes of growth, commercial importance, etc. A very interesting and useful paper.

A Microscopic Study of Wheat. By MRS. LOU REED STOWELL (continued from SUPPLEMENT No. 159). 5 figures: 1. Epidermis. 2. Hairs found at the end of a wheat kernel. 3. Third fruit coat of wheat. 4. Canals on inner surface of the foregoing. 5. Spiral Vessels. An able and excellent paper.

VI. MEDICINE, HYGIENE, ETC.—The Treatment of Organic Heart Disease. Clinical lecture delivered at the Hospital of the University of Pennsylvania, by Dr. WM. PEPPER. Regards organic heart disease as a systematic disease, requiring careful, thoughtful, but simple treatment.

Suggestion for Preventing the Spread of Scarlet Fever. A Circular from the Massachusetts State Board of Health. Gives a full and specific account of the propagation of this disease, and the means that should be employed to cure the sick and prevent contagion.

The Death Rate in Europe. Tabular statement.

VII. ARCHÆOLOGY.—Explorations in Tennessee (continued from SUPPLEMENT No. 171). By F. W. PUTNAM, Curator of the Peabody Museum. 8 figures of pottery, etc., from burial mounds.

VIII. ASTRONOMY.—Relation of Meteorites to Comets. From a lecture delivered in the Mechanic's Course at the Sheffield Scientific School of Yale College, by Prof. H. A. NEWTON. A study of some notable American meteors, with the reasons for holding that meteoric stones and shooting stars differ only in size, and were once pieces of comets.

THE WORLD'S FAIR OF 1883 AT NEW YORK.

That the hundredth anniversary of the acknowledgment of the Independence of the American colonies by the mother country in 1783, will be signalized by a grand world's fair in this city, may be accepted as morally certain.

The occasion will be one demanding especial recognition; and in this industrial age there is no way by which the great events of a nation's history may be celebrated so appropriately or so profitably as by a national or international exhibition of the arts and sciences. From idle pageantry and noise and mock engagements at arms, national celebrations have risen to the higher level of useful exhibitions of industrial achievements, progress in the higher walks of civilization, national resources, and the thousand inducements which commerce offers for the closer interweaving of nations in the arts of peace and mutual helpfulness.

Neither the educational nor the industrial nor the commercial benefits which flow from such exhibitions need be argued now. That lesson was sufficiently learned three years ago, and the coming census will show that Philadelphia alone has reaped a sufficient harvest from the Centennial Exhibition to more than repay the cost of it, had the burden fallen upon that city alone. And not only Philadelphia, but the whole country, even to the smallest hamlet or farmhouse or wayside workshop, however remote from the great centers of trade or manufacture, is to-day enjoying a real and growing prosperity, in which may be traced the influence of that exhibition, either in creating new industries and finding new markets, or in improving, stimulating, and widening the old. And whatever good was accomplished in 1876 will be easily confirmed and surpassed by the exhibition of 1883. The former demonstrated not merely the profitableness, but the possibility of a successful world's fair on this continent; and not only will our own people take a more lively interest in the next one, but millions of our American neighbors, who were but feebly represented, or not represented at all, at Philadelphia, will have the strongest possible incentive to come forward in 1883. The one took place during a period of profound industrial and commercial depression; the other will reap the advantage of the rising tide of what promises to be a period of national prosperity such as the world has never yet seen. The projectors of the Philadelphia Exhibition were met with almost universal doubt and incredulity; and it was not until the show was open that the majority of our people became convinced of its probable success. The vast majority of our West Indian and South American neighbors were not reached by or represented in it at all. Mexico was meagerly represented; Central America not at all. With the exception of the British Islands of Jamaica and Nassau, the West Indies were unrepresented. Brazil was well represented, and Chili slightly; all the other rising States of South America, so rich in raw material, so promising as markets for our manufactured goods, took no part at the Centennial. In organizing the exhibition of 1883, no such obstacles and deficiencies will be encountered. Our productive industries, and those of all the rest of the world, now know for a certainty that representation will pay, and that a failure to be represented will be the reverse of profitable. This will make it possible to secure at once a wider range and a higher grade of exhibits. And the experience gained at Philadelphia should secure also a more critical and judicious selection and arrangement of materials.

It may be said that it is too soon to repeat what was, despite its shortcomings, so admirably done at Philadelphia. True, but not too soon to hold another exhibition which, without repeating what was done in 1876, shall supplement, extend, and crown the work begun there for securing the supremacy of our country in the development of the peaceful arts and sciences. To represent simply the progress of the world between 1876 and 1883, excluding everything exhibited at Philadelphia which cannot show an improvement upon what was shown there, will suffice to make the coming exhibition as wide in scope, as rich in material, and even more valuable and instructive as an exhibition than the Centennial Exhibition was. And the success of American exhibitors, there and since, at Paris, will compel our foreign rivals to send the best they have.

We may be sure that whatever New York undertakes will not be second rate in magnitude nor deficient in thoroughness of execution. The assured character of the gentlemen engaged upon the new project gives good reason to anticipate a successful exhibition. It certainly will not fail through any lack of broad views, practical ability, or administrative capacity.

THE WORCESTER FREE INSTITUTE OF INDUSTRIAL SCIENCE.

The Free Institute of Industrial Science at Worcester, Mass., has now been in operation just ten years. It has graduated eight classes; and the list of the residences and occupations of its graduates shows them to be, almost without exception, engaged in honorable and lucrative occupations. Very naturally the great majority of them are connected with important productive industries. The directors believe that by combining practical work with theoretical study, the student's entrance upon professional life is an expansion of his school life, and not an abrupt transition to a new mode of life, and the results seem to justify the belief.

Practice, in this school, is subjected to three conditions: First, that it shall be a necessary part of each week's work; secondly, that it shall be judiciously distributed; and thirdly,

that the students shall not expect or receive any immediate pecuniary return for it.

At the middle of the first year every student (except the mechanical section) chooses some department under the advice of the instructors, and, until his graduation, devotes ten hours a week and the month of July, to practice in that department—that is, for two and a half years. Students who select chemistry, work in the laboratory; the civil engineers, at field work or problems in construction; those who select drawing, in the drawing room; and physics, in the physical laboratory. The mechanical section practice in the workshop from the beginning of the apprentice half year, and their practice extends over the whole course of three and a half years.

We should be glad to see a similar institution in every American town.

THE BALTIMORE WATER WORKS.

We have given in previous numbers details of the Baltimore water works and the great seven mile tunnel now being bored through solid rock to increase the supply of water, but for the benefit of such of our readers who have not seen the articles referred to we will state that the city of Baltimore, having found its water supply insufficient, is now engaged in constructing an immense addition to their water works, consisting of a storage lake to be known as Loch Raven, about 5 miles long, and from 500 to 1,000 feet wide, with an average depth of 20 feet; an immense dam at the lower end of this reservoir, to raise the water to a proper level; a tunnel 7 miles long, to carry the water to a receiving reservoir, to be known as Lake Montebello; a drainage tunnel, 9 feet in diameter and 2,870 feet long, to divert from the reservoir the impure water of Tiffany's run and the surface drainage; and Clifton tunnel, 12 feet in diameter and 2,975 feet long, to connect Lake Montebello with a series of six lines of 40-inch cast iron pipes, which carry the water to the city limits to connect with the city mains.

To the politeness of Mr. R. K. Martin, the Chief Engineer of the Water Department in charge of the work, we are indebted for further particulars of the progress of the work up to March 1.

LOCH RAVEN.

The work done on this division since our last account consists principally in constructing bridges to span the ten streams emptying into the lake and crossing the road surrounding it, and in excavating the margins of the lake to give it the necessary depth. Of the bridges, four have been built during the past year of white marble in the most substantial manner, which are quite ornamental in appearance, and another one was commenced in November. The greater portion of the excavations of the margins are now completed, but little remaining to be done in order to have the lake ready to receive the water backed up by the dam when finished.

THE DAM

consists of a mass of masonry 34 feet high at its deepest part, nearly 500 feet long, and 65 feet thick at its base, backed by 165 feet of puddle clay, gravel, and riprapping. This work was divided in two parts; the bed of the stream having been diverted to one side, the eastern half of the dam was then begun and is now finished. The course of the stream has again been diverted, this time through a gap in the masonry of the dam, by means of a coffer dam, and the former bed is now being excavated for the foundations of the western portion of the dam and the gate house at the entrance to

THE TUNNEL.

This immense work, the longest tunnel on the continent, has made great progress during the past year, several of the headings having met, and there remained on the 1st of March only 3,321 feet (or about one eleventh of the entire length) to be driven, when the tunnel will be pierced from end to end, which it is believed will be done by next autumn. In six divisions out of the sixteen into which the tunnel is divided by the shafts, the headings have met, and there are several others where they soon will meet. The greatest difficulty appears to be between shafts 1 and 2, where the tunnel runs through limestone rock, through the fissures of which the water from a stream called Mine Run enters the tunnel in large quantities, and has driven the workmen out of the tunnel several times. There remained on March 1st, 1,290 feet of this portion of the tunnel to be driven, which is about three times as much as in the most backward of the remaining divisions. The total expenditure on the tunnel to March 1 has been $1,141,624.50. The next section of the work is

LAKE MONTEBELLO,

on which good progress has been made. The filling in of the bottom of the lake has been completed, and the embankments at the eastern and western ends of the lake are advancing toward completion. The gate house is finished to within a few feet of the top of the embankment or road surrounding the lake.

THE CLIFTON TUNNEL

was completed and arched up during the past year. This tunnel, being driven through soft material of the very worst kind for tunneling, gave the engineers and contractor considerable trouble, and much praise is due them for the successful manner in which the work was prosecuted to its final completion. This tunnel for its whole length had to be lined with brickwork, but the main tunnel was mostly through solid rock, requiring arching only in places.

From this it will be seen that the new water works are being pushed rapidly toward completion. When finished they will give Baltimore, it is believed, in addition to its present supply, 150,000,000 gallons of water per day, with a head of 170 feet above mean tide.

Those of our readers who would like to see fuller details of this great work may consult No. 19, vol. 36, of the SCIENTIFIC AMERICAN, and No. 135 of the SUPPLEMENT, where a sketch of the old Baltimore water works is given, together with a full description of the works now under way, together with a profile of the seven mile tunnel.

AN EXAMPLE FOR YOUNG INVENTORS.

The remark of the English builder, Mr. Frederick Smith (SCIENTIFIC AMERICAN, March 29, page 202), that everything about the American thumb latch "proves that brains were used when it was designed and made," calls out from an old friend of the inventor the following account of the circumstances under which the invention was made. Our correspondent gives the story in the words of the inventor, Mr. Blake. After telling how his previous business—the manufacture of tooth brushes—had proved unprofitable, Mr. Blake said:

"I found it was necessary to invent something. Going to the city of New Haven I went into a hardware store and asked the salesman to show me the worst made article of general use. He at once handed me a Norfolk latch. I bought it, took it home, and in a short time made the present latch. In the first year I sold 30,000 dozen."

The Blake latch was patented about 1830. Our correspondent says that the last Norfolk latches he saw were being worked up in a rolling mill at Philadelphia in 1845. Our correspondent adds:

"That in 1879, nearly 50 years after the American latch was patented, it should be considered a wonder by the intelligent Englishman, is perfectly marvelous. That the Blake latch has never been improved by the active American, proves that Mr. Smith is correct when he says brains were used in its design and construction. Having been 33 years in the retail hardware trade, I know whereof I speak, and that Mr. Smith has not overdrawn the picture, nor has he told one half the truth. If he would take up the padlock branch, the matter would be even more astonishing."

Our young readers will readily understand why we have called this an example for young inventors. To use a common phrase, Mr. Blake wanted to make some money. Yankee-like, he decided that the surest course open to him was to invent something. Even more Yankee-like, he went to work in the shrewdest possible way to find out where invention was needed. Given something of general utility badly made, his problem was comparatively simple. He used his brains, and produced something that everybody needed—for thumb latches were in every house in those days; and he did his work so well that he need have no fear of rivals.

But this is not the only lesson that may be drawn from this simple invention. Our article might as appropriately be headed "An Example for Statesmen." The Blake thumb latch is a type of countless Yankee notions, which in the aggregate have swelled enormously the conveniences of American households and the materials of American industry. Their inventors, like Mr. Blake, believed it would pay to invent something. However small in itself, any invention they might make could be patented and protected as property. The fee was small, and the protection fairly good. The humblest and poorest was encouraged to invent; and we see the results everywhere. Under a patent law like England's, we should still be using the Norfolk latch in its pristine clumsy ugliness.

With heavy patent fees and the systematic discouragement of small inventions—amendments(!) which short-sighted politicians would like to impose upon our patent system—not only the thumb latch order of invention, but much that ranks above it, would be wiped out. Not even the Senator from Minnesota or the attorney of the Western Railway Association would dare assert that such a result would prove advantageous to the country, however hard they may covertly work for its realization.

GOOD TIMES FOR AMERICAN FARMERS.

A citizen of Carrollton, Mo., sends to the *Evening Post* the following comparison of the prices of staple articles in that part of the country, as they are now, as they were before the war, and again at the height of "flush" times:

WHAT WESTERN FARMERS SELL.

	1860.	1873.	1879.
Corn, per bbl	$1.00	$1.50	$1.25
Wheat, per bush	75	1.15	85
Beef, per cwt	2.00	4.50	5.50
Pork, per cwt	2.50	3.25	3.00
Wool, per lb	30	45	22
Butter, per lb	10	20	10
Eggs, per doz	6	20	8
Beans, per bush	1.00	1.75	1.05
Dry hides, per lb	10	16	10
Green hides, per lb	4	7	5½
	$7.85	$13.28	$10.20½

WHAT FARMERS BUY.

Plows, each	$10.00	$13.00	$ 9.00
Wagons, each	90.00	90.00	60.00
Spades, each	1.25	1.50	1.00
Axes, each	1.25	1.40	1.00
Salt, per bbl	3.00	2.75	1.75
Coffee, per lb	20	30	20
Sugar, per lb	12	14	10
Boots, per pair	4.00	5.50	3.50
Calico, per yard	12	10	7½
Jeans, per yard	75	75	50
	$110.69	$115.44	$77.12½

From these figures it appears that the purchasing power of farm products is now nearly double what it was before the war, and considerably greater than it was in the flush times of 1873. For this the farmers are chiefly indebted to the development and perfection of the manufacturing industries of the country—especially the West; a development traceable mainly to the patent system, since the manufactures of the West are almost exclusively based on recently patented inventions. Yet in spite of evidence like this, demagogues in Congress and elsewhere have the effrontery to declare that the patent system should be emasculated (and the progress of manufacturing interests arrested) for the benefit of the farmers who are oppressed and devoured by "patent monopolies!"

A POSSIBLE IMPROVEMENT IN SUGAR MAKING.

A correspondent suggests the following method for securing a portion of the sugar lost in the usual treatment of sugar cane. Whether the process would prove economical on a large scale is by no means certain. It might pay, however, to give it a trial.

"Comminute the bagasse as it leaves the mill (by slicing, cutting, or tearing), and drop the mass immediately into milk of lime; leach out with steam of about two atmospheres. Decompose the solution of sucrate of lime with carbonic acid gas, let settle, and decant, evaporate, etc. My reason for bringing the (cane) juice in contact with milk of lime is based on the fact that even as little as one half per cent of lime prevents the conversion of cane sugar into invert sugar, etc."

ART AS AN AID TO INDUSTRY.

A mechanic working in the blacksmiths' shop of the Phœnix Iron Company, at Phœnixville, Pa., visited the Pennsylvania Museum and School of Industrial Arts in Memorial Hall, and took a fancy to the quaint and beautiful work in wrought iron there exhibited—vines, flowers, tendrils, and leaves, wrought by hand on the anvil by the skilled smiths of foreign lands. He not only admired them, but saw in that sort of work the opening of a profitable industry. So at night, in his own house, at a forge improvised for the occasion, he and his brother worked out designs in forged iron—oak leaves, acorns, and the like. Having finished his work, he took specimens to the trustees of the museum, told what he could do, and borrowed models for the continuance of his work. There is already a considerable demand for such ornamental iron work in the decoration of buildings, and it is safe to predict for the new industry and its originators a successful and profitable development.

A Valuable Mineral and Metallurgical Collection.

The American Institute of Mining Engineers lately presented to the Pennsylvania Museum and School of Industrial Art the large collection of metals and minerals obtained from foreign nations and from numerous States in this country at the Centennial Exhibition. Some idea of the worth of the collection may be gathered from the statement of William W. Justice, the managing director, who says that it "could not be duplicated to-day for $100,000, and is of inestimable value to the mining and manufacturing interests of Pennsylvania."

In this collection not only Pennsylvania and other States are represented, but also Germany, Sweden, Russia, Spain, Austria, Portugal, Italy, Belgium, England, Victoria, South Australia, Tasmania, Queensland, Canada, Nova Scotia, New Zealand, Brazil, and Mexico. Those who studied these admirable collections in 1876 will appreciate their importance to the students of the institution which has become their possessor.

The Cincinnati Industrial Exposition.

Cincinnati is making great preparations for an exhibition of the industrial and fine arts next fall. Two large wings are to be added to the Springer Music Hall for the purpose of the exhibition, making the building four hundred feet square. The grounds for the extra buildings have been donated by the city, and already about $1,000,000 have been contributed to insure the success of the enterprise. The loans already secured for the fine art department promise to make the exhibition equal, if not superior, to anything of the sort thus far held in this country.

A Snail that Would not Starve.

An Egyptian desert snail was received at the British Museum on March 25, 1846. The animal was not known to be alive, as it had withdrawn into its shell, and the specimen was accordingly gummed, mouth downward, on to a tablet, duly labeled and dated, and left to its fate. Instead of starving, this contented gasteropod simply went to sleep in a quiet way, and never woke up again for four years. The tablet was then placed in tepid water and the shell loosened, when the dormant snail suddenly resuscitated himself, began walking about the basin, and finally sat for his portrait, which may be seen of life-size in Mr. Woodward's "Manual of the Mollusca." Now, during those four years the snail had never eaten a mouthful of any food, yet he was quite as well and flourishing at the end of the period as he had been at its beginning.

A Long Lived Brewery.

One of the oldest breweries in the world is that of Dobrau, near Pilsen, in Austria. It was founded in 1378, when it had granted to it a prescriptive right to brew "old" and "white" beers. The five hundredth anniversary of the establishment of this brewery was lately celebrated.