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LIQUID GLUE.—One part phosphoric acid, specific gravity 1·120, diluted with two parts water, is nearly neutralized with ammonium carbonate, 1 part of water added, and then, in a porcelain vessel, sufficient glue dissolved in the liquid to obtain a sirupy consistence. It must be kept in well closed bottles. The addition of glycerin or sugar would cause the glue to gelatinize.

AMERICAN PROGRESS—III.—FROM 1840 TO THE PRESENT TIME.

We have now reached a period in which it is practically impossible to follow the progress of the country uniformly in all branches of Science and industry. It is necessary, therefore, to consider each class of invention or each branch of Science separately, and briefly to note the principal advances in each, from 1840 up to the present time. It will be sufficient to point out the fact that, during this period, over 165,000 patents have been issued as against 11,614, all told, previous to 1840, to indicate the difficulty of attempting to arrange inventions in any semblance of chronological order.

Among the most important improvements in the steam engine are the detachable adjustable or drop cut off gear, the invention of Frederick E. Sickels, and the application of the governor to determine the point of cut off made by Zachariah Allen and George H. Corliss, of Rhode Island. The beam engine is a peculiarly American type, and usually embodies the valve gear invented by R. L. and Francis B. Stevens. In 1852, Ericsson brought out a new form of the caloric engine, which machine he was the first to adapt to practical uses. Ericsson's other inventions are so numerous that a mere list would occupy more space than can here be afforded. Among the most prominent were those embodied in the United States steamer Princeton, the first screw man of war. They included a direct-acting engine of great simplicity, the sliding telescope chimney, and gun carriages and new machinery for checking recoil. He has also devised instruments for measuring distances at sea, a hydrostatic gage for measuring the volume of fluids under pressure, an alarm barometer, etc. He was the first to apply the revolving turret to war vessels; and the performances of the famous Monitor, his first essay in armored ships of that description, need no renewal here. Mr. Ericsson has of late been engaged in the construction of one of the most formidable marine torpedoes known, and also has devoted much attention to the construction of solar engines. Among the remarkable forms of recent American engines may be mentioned the Scott and Morton, in which the cylinder rotates with the fly wheel, and the Ellis bisulphide of carbon machine, in which the vapor of bisulphide of carbon is substituted for steam.

Since 1851 over three thousand patents have been granted for harvesters and their attachments. Some of the most important improvements consist in the Sylla and Adams patent, having a cutter bar hinged to a frame, which is in turn hinged to the main frame, this being the principal feature of the Buckeye harvester; the combined rake and reel of the Dorsey machine, sweeping in a general horizontal direction across the quadrantal platform; the Henderson rake, on what is known as the Wood machine, having a chain below the platform which carries the rake in a curved path; the Sieberling dropper, which is a slatted platform vibrating to discharge the gavel, and the Whiteley patents, which constitute the Champion machine of Springfield, Ohio. In threshing machines, American improvements aim at speed and lightness, and spiked cylinders are retained to beat the grain as it passes in a zigzag course between them. There are few implements which at the present time engage a greater share of the attention of inventors than cultivators and plows, which are constantly being produced in endless variety. The first application of machinery to the tying of knots was, we believe, embodied in an American mower.

In printing presses, American inventors have steadily maintained the lead. The Bullock press carries the forms upon two cylinders, requires no attendants to feed it, and delivers from 6,000 to 8,000 sheets per hour. The Campbell press is remarkable for fine points of adjustment. The Hoe web perfecting press is one of the most recent inventions of the kind. It delivers from 12,000 to 15,000 perfected sheets per hour.

Joseph Dixon, in 1854, was the first to use organic matter and bichromate of potassa upon stone to produce a photolithograph. Latterly the process of photo-engraving has been advanced to a remarkable extent. It is largely employed in preparing engravings for the SCIENTIFIC AMERICAN, and the reader will find some remarkable results of the most recent improved processes in engravings directly reproduced from lunar photographs in No. XX, current volume. Colonel J. J. Woodbury, M. D., has produced microscopic photographs of admirable clearness and magnitude. The finest photographs of the visible spectrum have been obtained by Mr. Lewis M. Rutherfurd, of New York city. The map 82 inches in length embraces more than 2,500 sharply defined lines. Mr. Rutherfurd has also achieved remarkable success in producing finely ruled "gitters" or glass plates, by means of which Dr. Henry Draper has produced a photograph of the ultra-violet rays of the diffraction spectrum, which far exceeds in distinctness any thing previously attempted in this difficult spectral region. Mr. Rutherfurd's finer gratings have nearly 18,000 lines to the inch, ruled by a diamond held in a machine of his own invention, which is driven by a miniature turbine wheel. Magnificent photographs of the moon have been taken by Mr. Rutherfurd, and he also has succeeded in making the sun reproduce its own image. To him is also to be attributed probably the highest application of photography, that of using it for uranographical measurements, and for the study of the solar and stellar spectra.

The first ice machine based on production of cold by the vaporization of volatile liquids was invented by Professor A. C. Twining, of New Haven, in 1850. He used sulphuric ether as the liquid to be vaporized.

By far the most important chemical discovery ever made by an American is that of the demonstration of the anæsthetic qualities of chloroform, by Dr. W. T. G. Morton, in 1846. Dr. Morton's claim as original discoverer has been vigorously disputed, but it is believed that the facts are sufficient to accord him the full measure of honor deserved. It appears that Dr. Wells, one of the opponents of Dr. Morton, observed the anæsthetic effects of nitrous oxide gas in 1844, but it is well known that the practical use of that gas by dentists is of quite late date.

Just before and during the war great improvements were made in fire arms. The principal small weapons are those of Colt, Sharp, Whitney, Allen, Maynard, Remington, Spencer, and Berdan. These include rifles which, in practised hands can be loaded and fired nearly thirty times a minute. In great guns, the Parrott rifles, the essential feature of which is a wrought iron jacket shrunk around the breech, played a conspicuous part during the war. In 1845, General Rodman invented his method of casting guns around a hollow core into which is introduced a stream of cold water, while the outside is kept heated until the metal is cooled from the interior. Rear Admiral Dahlgren also invented the gun which bears his name, and which is distinguished by its exterior form. To obviate the contraction consequent upon cooling the large casting, the Dahlgren guns are made larger than required, and after cooling are annealed and turned down to the desired shape. The most efficient machine gun built on the small arm principle is that of Mr. R. J. Gatling. This fires 400 cartridges per minute, the rapidity depending on the rate of rotation of the crank whereby the mechanism is operated. The inventor of military munitions perhaps best known, both here and in Europe, is Mr. B. B. Hotchkiss. One of his most recent devices is probably the most effective weapon of war ever invented. It is a machine cannon, capable of throwing sixteen 1 lb. explosive shells per minute, to a distance of nearly three miles. Mr. Hotchkiss has also lately devised a remakably simple and ingenious breech-loading rifle musket, beside some new forms of breech-loading field cannon. It may be added that, with a single exception, the needle gun, the main features of all the prominent military rifles originated in the United States.

While the invention of the lock stitch in sewing machines is generally claimed for Walter Hunt, as we have already stated, it is also conceded that the same device was independently invented by Elias Howe. Howe's machine, patented in 1846, used a grooved and curved eye-pointed needle carried upon the end of a vibrating arm, which, passing through the cloth, formed a loop through which a shuttle passed another thread. Following this came many improvements, such as A. B. Wilson's four motion feed and rotating looping hook, the latter of which draws down the needle thread and drops through it the spool containing the lower thread. Over 2,000 patents have been granted for modifications in sewing machines, and inventors still find ample opportunity to exercise their ingenuity in devising further improvements. We may note in this connection that Mr. E. H. Knight, one of our best mechanical authorities, states that the three mechanical contrivances upon which the most extraordinary versatility of invention has been expended are the harvester, the breech-loading fire arm, and the sewing machine; each of these has thousands of patents, and each is the growth of the last forty years. Next after these, it appears to us, our inventors most favor cultivators, churns, car couplings, bee hives, and washing machines.

We have already alluded to Morse's successful completion of a telegraph line between Washington and Baltimore in in 1844. In 1848, Royal E. House, of Vermont, patented an admirable long line printing apparatus, by which messages were sent in Roman capitals in lieu of dots and dashes. The next important improvement was that of Hughes, who patented a telegraph in which the feat of printing a letter with every impulse or wave of the electric current was accomplished. Two years later G. M. Phelps, of Troy, N. Y., combined the most valuable portions of the House and Hughes patents in a combination instrument, which is considered the most perfect printing telegraph for long lines yet produced. To Mr. Cyrus W. Field is due the credit of suggesting the transatlantic cable; and through his persistent labors and energy that great undertaking was successfully accomplished.

Stearns' modification of the Gintl duplex telegraph system was the first practical solution of the problem of sending two messages at the same time on the same wire. Moses Farmer has also devised a way of sending two messages at the same time in opposite directions, by using two auxiliary batteries in combination with two principal batteries. The important researches of Thomas A. Edison have aided greatly in reducing to a practical shape the system of quadruplex telegraphy; and the phonetic system of Gray and Bell aims to increase indefinitely the number of messages which can be sent simultaneously over a single wire, by using tuning forks moved by electromagnets, for sending and receiving the signals. Only one fork at the receiving station is in unison with a particular fork at the sending station, and responds to it. The first system of fire alarm telegraph was invented in 1862, by Channing and Farmer, and shortly after was adopted in Boston.

The first practical steam fire engine was invented by Ericsson; but machines of this description were not actually employed until 1853, when, through the enterprise of Miles Greenwood, of Cincinnati, Ohio, that city was provided with them.

Borings for oil were first made by Mr. E. L. Drake, of Titusville, Pa., in 1859. He originated the practice of driving a tube through the rock instead of excavating and cribbing.

Among the most important railway inventions made by Americans may be noted the Westinghouse air brake, which uses compressed air as a means of applying the brakes,

the entire mechanism of which is under the control of the engine driver. Miller's platform is a device of great importance, since it obviates the danger of the telescoping or crushing of the cars in event of a collision. Sleeping cars were for the first time used on American railroads in 1858; and in 1864 George M. Pullman devised the palace cars which bear his name, and which are regular hotels on wheels. The first street car lines were established in the United States. A recent railway device involves the use of compressed air for shutting gates and signaling; and a remarkably ingenious combination of switch mechanism and electric signals, the invention of Superindendent J. M. Toucey, Mr. D. M. Rousseau, and others, has been applied on the underground section of the New York Central and other joining lines in New York city. Hall's system of signaling by telegraph at bridges and railroad crossings was the first introduced, and to him should be awarded the credit of its first application.

In astronomy the work of American scientists has covered a wide field. The first approximately correct theory of the motions of Neptune were wrought out by Professor Sears C. Walker, in 1847. This labor, together with its subsequent reconstruction by Professor Simon Newcomb, resulted in the magnificent discovery of the planet by purely mathematical means. Professor Newcomb has also made some splendid investigations relative to the perturbations of the moon by the planets. To Professor C. A. Young is due the discovery of the chromosphere surrounding the sun, one of the most valuable contributions to solar physics ever made.

Professor A. M. Mayer has presented strong evidence to show that the antennæ of insects are their organs of hearing. He has also determined the law which connects the pitch of a sound with the duration of its residual sensation, and deduced principles applicable to the study of harmony and musical composition. Professor Mayer's investigations in acoustics are all strikingly original, and have placed him in the front rank of contemporary scientists.

To the great engineering works of the United States, we can only briefly allude. The prominent ones are the Croton aqueduct in New York, the Pacific railroad, the Hoosac tunnel, the East river and St. Louis bridges, the Hell Gate excavations, and (more important than either of the others) the operations of Captain Eads at the mouth of the Mississippi, by which that stream, besides the prevention of its overflowing its banks, is to be rendered accessible to vessels of the deepest draft, thus opening the whole Western section of the country to direct commerce.

From the struggling and destitute band of colonists in 1776, to a great and powerful nation of forty millions of free people, such has been the work wrought in the hundred years now closed. History offers no more marvelous spectacle, no loftier example of the might and grandeur perpetuated in republican institutions. Not by conquest nor by war has this glorious result been reached, but by the peaceful development of the genius and energy implanted in the people themselves. Our true standing army is one of inventors, not of soldiers; and to the former alone, under God, do we owe our national prosperity. It was the inventor who, when the first war for national life left us prostrate though victorious, gave us the means to throw off our dependence on other nations, and stand forth, not merely politically but industrially and commercially, a free and independent people; it was the inventor who taught us how to utilize the vast resources of our territory; it was the inventor who, in the hour of need, converted our workshops into gigantic magazines of war material, who equipped for us the greatest army that modern times has ever seen, and who gave us weapons wherewith to wage the terrible conflict in which, for a second time, the nation's existence was imperiled. Therefore most fitting is it that, on this great anniversary, we ask mankind to witness triumphs of genius and of industry, not those of the statesman nor of the warrior, nor the work of the pen nor of the sword, but that of the hammer and the loom, the engine and the lightning spark, the labor of men who are at once the leaders and the supporters of American progress, the American inventors.

THE PRESENT CONDITION OF THE CENTENNIAL.

There is one verdict which will be unanimously agreed upon by all who complete a review of the Centennial Buildings at the present time, and that is that the Centennial Commission has worked wonders. It is only necessary to recall the unfinished grounds and dreary expanse of empty space and packing boxes, both at Paris and Vienna, to add still further emphasis to the assertion. True, the Exposition is not complete, but enough so to excite the wonderment and admiration of every beholder now.

The erection of the main buildings and their preparation to receive their contents necessarily delayed work on the grounds; but this is being vigorously pushed forward, and an army of laborers is planting lawns and flower beds, making roads, and otherwise beautifying the surroundings. Least advanced of any part of the Exposition is Machinery Hall; and in this respect, the visitor who may have expected to enter into a vast room, filled with whirring machinery, will be disappointed. The fault, however, lies not with the Commissioners, but with our own exhibitors, for their contributions vastly outnumber those of all other nations combined. It follows that the chances of comparing American machinery with that of foreign make are to be limited; as 1080 American machines against 98 English shows a great disparity between the two greatest machine-making nations in the world. The great cotton mills of Great Britain are represented by one loom, and the best thing in that is an electric brake arrangement. There are a superb Jacquard loom weaving silk book marks, some gigantic armor plates, and the Walter printing press. These are the principal British exhibits which catch the eye. Nothing from the Napiers, or the Penns, or the Maudslays, or any of the great engine builders and founders whose celebrity is worldwide. The German display is at present a heap of rough packing boxes, some fine rifled guns, armor plates, and locomotive wheels from Krupp at Essen, and a huge pyramid of spiegeleisen. France has treated the Exposition with as much indifference as England. She has about 92 entries, and the most notable now are soap making machines and a tapestry loom. French machinists have been greatly progressive of late, and we looked with much interest, though fruitlessly, for many of the machine tools, notably those by Abbey of Paris, which our Parisian contemporaries have described. Belgium has an engine of the Corliss pattern, which is worth careful examination. Brazil shows a small stationary engine of antiquated appearance, and some fair ironwork. Sweden, another great iron-producing country, has a narrow gage locomotive, and nothing else at present worth mentioning in this general review. Spain and Italy, Holland and Russia, have not arranged their exhibits. In the American section, the Corliss engines are in motion and are driving a few machine tools which are familiar to all our readers. Otherwise the display is not sufficiently advanced to admit even of a general idea of its future magnificent proportions.

In the Main Building, the progress has been greater, and the exhibits are already grand in variety and excellence. By all odds, the most magnificent display in the entire Exposition is the Japanese. It is the complete history of the country, told by object teaching. We know of no metal work that can compare with the bronze vases and ornaments displayed, nor were such collections of oriental pottery and lacquered work ever seen in this country before. Not only is every industry of that most industrious people represented by its choicest products, but we are shown every natural resource of the Empire. The mineralogical exhibit alone is superb. The various educational systems are explained down to the daily records of the pupils, and the collections of scientific apparatus used in the colleges are exhibited. Certainly, not merely in the intrinsic value and magnificence of her contribution, but for the admirable skill and discrimination shown in its selection, Japan outstrips every other nation yet represented. The second place must be allotted to England, whose display, as far as can be judged, is destined to be extremely interesting. Its most prominent features at present are the pottery, decorated ware, and textile fabrics. The British colonies offer exhibits notable for excellent selection and suitability for illustrating the resources of the various localities. The French exhibit also superb pottery and a magnificent show of objects of industrial art, laces, and textile fabrics. Austria, as yet incomplete, has a case of Vienna goods, which are models of exquisite taste. The beautiful display of Bohemian glass attracts the greatest share of attention among the ladies. Germany sends an exhibit which noticeably includes some exquisite porcelain and a superb display of scientific and educational books. It is blemished by the bronzes, which are inartistic, and by the many cheap chromos which already have been imported by thousands into this country. It is but just to add that the German display is not complete, and that, when it can be examined in its entirety, it will probably be found worthy of the great nation that sends it. The Egyptian exhibit is excellently arranged, and on the whole will give a fair idea of Egyptian industries. The Spanish contribution will excite considerable astonishment. It certainly is one of the finest in the building, and is notably rich in the number and variety of textile productions. It is well calculated to dispel the idea that Spain's industries have been severely paralyzed by her recent internal troubles. Norway and Sweden send displays, well advanced toward completion and admirably arranged. We note especially the life-like figures in wax, dressed in costumes of the country, and some fine specimens of silver and iron work.

Italy, as might be expected, has a larger representation in the portion of the Exposition devoted entirely to art than in the general concourse of nations. Still, in the Main Building, her exhibit bids fair to be one of great beauty. There is an exquisite collection of Genoese silver jewelry, wood carvings of superb workmanship, and a curious selection of antique and modern pottery, which, perhaps more than all else, will will excite admiration. The Netherlands, also, has some remarkable examples of Flemish and Dutch woodwork. China exhibits her famous porcelain and marvelously intricate ivory and teak carvings. The prominent feature in the Chinese exhibit is a table of *cloisonné* ware (copper enamel), of exceptional beauty and value.

The American display is admirable. In silver ware and jewelry it is unexcelled; and in no part of the Exposition is furniture exhibited which can compare with that of the New York manufacturers. The representation of pianos and organs includes specimens from all our celebrated makers, many of whom have introduced the excellent innovation of building glass-inclosed rooms for their instruments, so that, when the latter are performed upon while other pianos are being played, there will not be the confused Babel of discord which in so many fairs has formed an objectionable feature. The book display is elaborate, and, in general, the American section compares most favorably with the exhibits of other nations.

Of the very varied and interesting contents of the Agricultural Building, no fair estimate can yet be formed. The unroofing of the structure during a storm delayed its completion and prevented an early arrangement of exhibits. As near as can be judged from such as are already in place, this department will form one of the most complete and interesting parts of the Exposition. Horticultural Hall is beautiful, and later will, without doubt, embrace a large variety of specimens, some of them being of rare species. The forcing houses are quite well filled; and probably after many of the foreign plants have been started therein, the display in the large edifice will be improved. It should be remembered, however, that the horticultural display includes the plants growing in the beds as well as under cover.

We are not exactly clear as to the principle which governed the selection of exhibits for the Women's Pavilion. It appears that only a portion of the female handiwork exhibited is located therein, while the rest is scattered among the entries in the other buildings. This rather detracts from the completeness of a display which is otherwise very creditable. Women are making Waltham watches in the Machinery Hall, and women have contributed handmade laces, robes, and needlework to other departments. Had all been gathered under one roof, the objects of the separate building would have been furthered, and the visitor would have obtained a better idea, of the variety and skill embodied in female labor, than he perhaps can now. Still the exhibit as it stands is good, and to the fair sex especially will doubtless prove the principal attraction.

In concluding this brief general review of the present condition of the Centennial, the highest credit must be given to the authorities for the excellent manner in which the great enterprise is governed. Where many abuses might creep in, it is surprising to note how few really exist. The restaurant charges have been extortionate, but these are now reduced. We hope for the substitution of a better catalogue for the present rather cumbrous volume, which will afford the visitor the information he needs, and not a mass of glaring and useless advertisements. We would also suggest that allowing a juggler to perform at a prominent stand directly inside and in front of one of the principal entrances, and then to peddle his wares, is not calculated to add to the dignity or value of the Exposition. These, however, are but minor and, perhaps, unavoidable blemishes.

Living at Philadelphia is rather high; and those who live within a hundred miles of the city will find it to their advantage, both economically and in point of convenience, to avail themselves of the railroad facilities in going and coming every day. The daily excursion is not fatiguing, since there is no need of the visitor walking a step inside the exhibition grounds and within the principal buildings, except in the art building (the Memorial Hall). Rolling chairs and attendants are furnished for 60 cents an hour, and the visitor, comfortably seated, is wheeled from point to point, and thus can inspect the exhibits at his leisure. For long distances, a steam railroad, which runs around the circuit of the grounds, is always available. Although, as we have stated, the Exhibition is not fully complete, the present will be preferred by many as an opportunity to make the visit. The cool weather and absence of a crowd will be found much more conducive to a pleasant examination of the immense number of beautiful objects now ready than will the same work performed during the sweltering heats of July and August.

Ivory.

The apprehension that ivory would become one of the products of the past, as we have often heard our cutlery and billiard ball manufacturers maintain, does not seem to be justified by the facts. According to the following, from the *British Mail*, Messrs. Lewis & Peat, colonial brokers, have issued a very interesting report of the modern ivory trade, which, though showing great improvement since 1842, is a mere shadow of what it must have been in the ancient times. The total quantity imported into Great Britain in 1875 was 680 tuns, the largest in any year between that time and 1842, when it was only 297 tuns: the lowest being 1844, but 211 tuns. The fact of there being an appreciable increase in last year's imports over 1874 of 70 tuns is, says the report, "of the greatest interest, because in this article especially, much more than any other known, there is no reason to apprehend any falling off in the demand." In one important article of manufacture—billiard balls—there is not any other substance which can be used as an adequate substitute. The public sales are held four times in the year. Prices last year were, on the average, much lower than the previous one, which is attributed to the general commercial stagnation. The prices of good teeth, weighing from 50 lbs. to 160 lbs., varied from $275 to $335 per cwt.; "scrivelloes," $120 to $270. Walrus teeth, sound, weighing from 1¾ lbs. to 5⅝ lbs., were worth 60 or 62 cents per lb.; defective, 40 or 44 cents. Rhinoceros horns, of which 3½ tuns were imported in 1874, realised from 34 to 72 cents. The probable value of the ivory imported last year could not be less than $2,500,000. A larger portion came through Egypt than in the previous year, and less from Zanzibar and Bombay, from South Africa a little more, and from West Africa a little less.

The Great Strike of Miners.

There are, it is stated, something like 30,000 men out, in South Yorkshire and Derbyshire, England, besides a number of topmen, enginemen, and other employees. The main body of men are still stoutly determined to stand out against the drop of 15 per cent, and the employers are quite as firmly resolved not to make any concessions. At a few collieries, the men have turned in at a reduction of 7½ per cent on the understanding that they will make further concessions in order to bring them to the general level of the district after the strike is settled.

TO PREVENT THE CRACKING OF GLUE by heat or extreme dryness, the addition to the solution of some calcium chloride is recommended, which retains sufficient moisture to obviate this inconvenience. Thus prepared, glue can also be used upon glass and metallic surfaces.