removed and others substituted in their places, and the gun kept in working order at all times, on the field of battle. This is a feature of great importance, as the lock mechanism is the most essential part of a machine gun, and is practically the only part liable to get out of order from use. The lock mechanism of many other machine guns forms an entirety, and is so united and encased that, should any part of the same get out of order, a circumstance which is liable to happen in long and continued firing in time of action, the whole machine would become disabled and would have to be taken to a machine shop for repairs. In such a contingency, it is needless to remark, the enemy would not be likely to await the completion of the job.

All the locks in the Gatling gun revolve simultaneously with the barrels, carrier, and inner breech, and the locks have also a reciprocating motion when the gun is revolved. If the barrels had to be brought to a state of rest at the time of each discharge, the inventor considers, the rapidity of fire would be greatly lessened. The Gatling gun, it also may be noted, is the only firearm in which the three sets of parts, namely, barrels, locks, and inner breech (Fig. 3) all revolve at one and the same time, and it is the only gun that loads and fires incessantly while these several parts are kept in continuous motion. It is impossible to load and fire the gun when either the barrels, locks, or inner breech are at rest. Each lock in the gun revolves once, and moves forward and back once, at each and every revolution of the gun.

The piece fires a shot at a time, in rapid succession, and thus by dividing the time in rapid firing into equal parts between the discharges, and preventing an accumulation of recoil, it admits, it is claimed, of large charges and heavy balls, and consequently exceptionally great range. The extreme range of the largest Gatling gun, which discharges half pound solid lead balls, is said to be over two and a half miles.

The peculiarity of no recoil existing is of special value in the defense of bridges, fords, mountain passes, etc., which are frequently attempted during darkness, fog, or storms, as also in the smoke of battle, when the movements of the enemy cannot be accurately observed. Firing a shot at a time also allows a lateral motion of the gun to be kept up during the time of rapid firing, which result is attained by the traversing mechanism connected with the breech of the gun and the carriage, as shown in Fig. 1.

This improved traversing mechanism not only allows the gun to be traversed without moving the trail or wheels of the carriage, but enables the operator at will, and in a second of time, to change the angle of fire so as to play on the enemy should he move either to the right or to the left. In other words, the shots can be spread along the enemy's front, or can be all concentrated to one point or upon one object, at will.

Briefly described, it consists in a horizontal cylinder which carries, on its upper side and near the right hand end, a T flange to enter in a T groove upon the lower side of the breech of the gun (Fig. 2) so that the latter may slide upon the flange and thus gain the necessary sweep. On the lower part of the same end of the cylinder, the ball of the elevating screw is received in a transverse groove. The cylinder extends to the left of and below the breech, and in it is longitudinally inserted a screw which carries a nut, a portion of which projects through a slot in the front side of the cylinder. The screw is actuated by a hand wheel at its extremity, by which means the nut is caused to travel along the slot. The nut has on its projecting side a socket, and in this, held by suitable catch mechanism, is a pin. The crank shaft of the gun, Fig. 3, extends through the breech and terminates in a grooved cylinder, in the channels of which the pin just mentioned enters, except when it is thrown out of gear. It is evident that, when the grooved cylinder is rotated, its curved groove acting against the pin, which is held immovable after being adjusted by the hand wheel, causes the T groove on the gun to slide along the flange on the cylinder first mentioned. By this means, the piece is caused to sweep the horizon by merely actuating the ordinary firing crank. The groove cylinder has two grooves, one curved to correspond with the number of degrees over which it is desired to swing the barrels, and the other straight, the effect of which is, of course, to allow the gun to remain stationary.

We are informed that the smallest sized Gatling gun—which fires over 400 shots per minute and which weighs only 125 lbs.—when mounted on a tripod, can be, in an instant, traversed so as to fire to any point embraced in an entire circle, thus furnishing its own support and precluding the liability of its capture by a flank attack. Finally, the inventor adds that his system admits of either large or small caliber. Eight different sizes of the guns are now made. The smallest size is the only machine gun in existence which admits of being mounted and fired from a tripod, and its lightness and effectiveness specially commend it for cavalry service, mountain warfare, boat service, etc. From Figs. 2 and 3, the two principal divisions of the arm will be easily understood. Fig. 2 shows the frame and breech, and Fig. 3, the barrels, locks, and firing crank, both views being from above.

The improved training mechanism was patented through the Scientific American Patent Agency, December 16, 1873. Further information may be obtained by addressing R. J Gatling, whose manufactory is at the Colt Works, Hartford, Conn.

AUSTRALIA has set a good example to many other countries, In that colony it has been decided to attach swimming baths to all the State schools, so that swimming may be taught as an essential part of education.

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Contents:

(Illustrated articles are marked with an asterisk.)

IS VITALITY VITAL?

The line of progress along which Science has come down from the past is thickly strewn with dead and dying terms, the empty husks of theories which have had their day and ceased to be. Many of these terms have dropped entirely out of use. Others have survived in form, but with so many changes of meaning that they remind one of the tenements of hermit crabs, shells whose original occupants have long since gone where good mollusks go.

One of the most significant of recent word demises, real or reputed, is that of "vitality," as the name of the principle of life, a peculiar something in living matter unrepresented in other or "dead" matter. To not a few of our leading thinkers, the word has ceased to harbor its original tenant; and some go so far as to insist that it should be dropped from the vocabulary of Science as useless, if not misleading. Huxley humorously compares the imagined force it represented to a supposable "aquosity," which might be thought to enter the oxide of hydrogen at the moment of its formation to give rise to the properties and phenomena which make water so unlike its constituent elements, and asks: What better philosophical status has "vitality" than "aquosity?" "And why," he continues, with a mildly ironical turn, "should 'vitality' hope for a better fate than the other 'ities' which have disappeared since Martinus Scriblerus accounted for the operation of the meat jack by its inherent meat-roasting quality, and scorned the materialism of those who explained the turning of the spit by a certain mechanism worked by the draft of the chimney?" In his very ingenious discussion of the correlation of "life force," so called, and the other "forms of force," Professor Le Conte insists that the term vitality still lives, for the excellent reason that it stands for, not a vague assumption, but a demonstrable reality. Each "form of force," he says, though what a form of force may be it is hard to conceive, "gives rise to a peculiar group of phenomena, and the study of these to a particular department of Science. And since the group of phenomena called vital is more peculiar and different from other groups than those are from each other, and the science of physiology is a more distinct department than physics or chemistry, therefore the force which determines those phenomena is more distinct and better entitled to a separate name than either physical or chemical force."

The investigations which lead to this conclusion Professor Le Conte bases on the assumption that there are four distinct and separate planes of material existence, which may rightly be considered as lying in vertical order and ranking according to position. These planes are, counting from the first and lowest, (1) the plane of elementary existence; (2) chemical compounds; (3) vegetable life; (4) animal life. Correspondingto these planes of matter are four planes or forms of force, similarly related. The first and lowest, called physical force, operates alone on the plane of elementary matter. A higher form, chemical force, enters upon and operates on the next plane in connection with the first. The third plane is the field of operation for three forms of force; the two already named and the new and peculiar one, vital force. On the fourth material plane, the force peculiarly characteristic of animal life, the will, operates in addition to the other three. A fifth plane, the human, with free will as its characteristic, raises this elaborate scheme into the region of metaphysics.

Each of the groups of phenomena currently called physical, chemical, vital, rational and so on, are thus to be interpreted as determined by distinct and peculiar kinds or forms of force. It is the function of chemical force alone to raise matter from plane No. 1 to No. 2, and to produce the phenomena of No. 2, which together constitute the science of chemistry. Similarly it is the prerogative of vegetable life force to raise matter from No. 2 to No. 3, and to execute all movements on that plane, which together constitute the science of vegetable physiology. But there is no force in Nature capable of raising matter at once from No. 1 to No. 3, or from No. 2 to No. 4, "without stopping and receiving an accession of force of a different kind, on the intermediate plane."

All this forms a consistent and very plausible system, but what foundation has it in the eternal verities? Is it demonstrably true that the alleged superimposed parallel planes of force and phenomena are not figments of the imagination, and misleading ones at that? The two upper ones certainly approach each other at one edge (to continue the figure) so closely that they seem to be in actual contact. In their lower fields, the animal and vegetable kingdoms come so nearly together that it is quite impossible to discover the line which separates them, if such line there be. Again the products long supposed to be the peculiar work of vital force (as distinguished from the force which determines ordinary chemical combinations) have been so numerously built up from their elements in the laboratory, without the intervention of life, that the supposed necessity for a peculiar force for such work has been greatly reduced, if not quite destroyed. And still further, is it not a sheer assumption to say that the movements of matter in the hypothetical state, which we term elementary, must be due to a kind of force differing absolutely from that which determines chemical compounds?

The real state of the case appears to be something like this. that we find it convenient to group certain varieties of phenomena into arbitrary classes, with boundaries more or less distinct. For like reasons, we are accustomed to say that the impelling cause or causes in one group are chemical, in another vital, and so on; and sometimes we forget that these terms have reference solely to our classifications, and do not necessarily designate separate entities, forms of force or whatever we may call them. The expansion of steam under diverse conditions produces the most diverse and dissimilar results; but it is the same motor all the time.

To denote a broadly characteristic order of activity, the term vitality is useful and convenient. As indicating a force inherent in and wholly peculiar to living matter, something *sui generis*, so to speak, it is evidently doomed.

THE DOVER AND CALAIS TUNNEL.

There seems at length to be a definite project proposed for the construction of a tunnel across the Straits of Dover, between England and France. An Anglo French committee has for some time past had the matter under consideration, with the object of inquiring into ways and means and of discovering the most practical method of accomplishing the work. This body, among the members of which we find the names of Lord Richard Grosvenor, Mr. Thomas Brassey, M. P., Admiral Elliot, and Messrs. Hawkshaw and Brunlees, engineers in the English section, and of MM. Chevalier, Paris, Talabot and other distinguished men of the French delegation, have adopted a plan which calls for a tunnel open only at its ends, and without the intermediate establishment which has been proposed in the middle of the strait. Its length from the South Foreland, 5 miles east of Dover, to Cape Gris Nez, 4 miles west of Calais, will be about 21 miles; and it is stated that, with the new Brunton perforating machines, the bore can be finished in four or five years. The estimated total expense is $40,000,000, and the probable revenue to be desired, it is believed, will reach about $4,000,000 per year. With regard to ventilation, the ordinary arrangements for making a draft as used in mines will be employed. One of the ends of the tunnel will be permanently open; the other will be provided with doors which will have to be opened to admit the passage of trains when necessary. Just within the doors, a large orifice will be opened to the summit of the vault of the tunnel and in communication with a fire. By the draft thus caused, the air will be constantly drawn in from the open end of the tunnel and hence continually renewed.

The demand for a concession presented by the Anglo-French Commission, says *Les Mondes*, is now under public consideration at Arras, in the Pas de Calais, and it is believed that the execution of the project will before long be begun.

THE SIAMESE TWINS.

The celebrated Siamese twins, which for the last half century have been the foremost of living curiosities, both in Europe and America, recently died at Salisbury, N. C. Thes-

remarkable personages were born in Siam in 1811, and constituted part of a family of fifteen children, several of whom were twins, though none save these two were in any wise deformed. Chang and Eng, however, were linked together by a fleshy ligature, which was about a foot in length, two inches broad and four inches thick. Through it ran a large artery and many veins, making their circulation identical. Each brother had, however, an entirely separate existence, and, with the exception of the ligature, which was equally sensitive to both, their senses were totally disconnected.

In 1850 Barnum exhibited them throughout the country, and out of their salaries they managed to amass some $40,000. With this money the brothers purchased two adjoining plantations in North Carolina, assumed the surname of Bunker and, strange to say, married. The courtship, it is stated, was done by proxy, and the wives, English women, who had only seen their husbands once at a show in London, were selected by the twins from likenesses forwarded by an agent. At the time of their marriage the brothers were forty four years of age and their wives, who were sisters, respectively twenty-six and twenty-eight. Their domestic life is said to have been very peculiar. The wives lived in separate homes and the husbands alternated, staying one week at Chang's house and the next week at Eng's. Each looked after his plantation and other business during the weeks of his living at his own place, and the visiting brother was not supposed to interfere. The families increased rapidly, Chang having six children and Eng five; of these four were deaf mutes, though not deformed, while the rest were strong and healthy. The domestic life of the brothers was not happy, and serious difficulties occasionally took place, resulting in the estrangement of the families for long periods. They were slave owners and cruel masters, and during the war manifested strong southern proclivities. At the end of the rebellion, their wealth was very much reduced, and they again went into the show business, with only partial success.

The brothers were of medium size and of peculiarly repulsive faces. Chang was the most robust and good natured, while Eng was often sick and morose. Chang also was the mental superior, although both were ignorant and had intelligence that scarcely rose above low cunning. As they grew old, the almost certainty of the death of one resulting in that of the other rendered them fretful and nervous. While in Europe, they consulted the best physicians regarding the possibility of a separate existence; but when the ligature was compressed so that all transfusion of blood between them stopped, Eng fainted, proving that neither could sustain a separate circulation. About a year ago Chang had a paralytic stroke which rendered his health the worse of the two; and as a relief from suffering, he drank freely. His death occurred first; and the shock, or more probably the cessation of circulation, affected Eng so strongly that delirium, followed by stupor, almost immediately set in. At the end of two hours, he also expired.

THE ONE HUNDRED THOUSAND DOLLAR CANAL REWARD.

The Canal Commission of the State of New York, charged with the duty of trying and examining the various boats that were presented last year in competition for the reward of one hundred thousand dollars, have lately made their report to the Legislature. They say that, owing to the technicalities contained in the law under which the reward was offered, they have been unable to make an award to any of the competitors. They ask that the law may be modified and new trials allowed. They report that two of the competing boats very nearly filled the requirements. These were the steam canal boat William Baxter and the steam canal boat William Newman. The requisition was that each boat should be able to carry 200 tuns of cargo besides motive power, and make an average speed of three miles per hour.

The William Baxter was built especially to compete for the prize. She is 96 feet long and 17 feet beam, and has much sharper lines than the ordinary canal boats. Her bottom is perfectly flat, and her sides, stem, and stern, vertical. The outlines of the immersed portions of her bow and stern are the same. She has an overhanging deck at the stern to protect her propellers, and with 200 tuns of cargo she draws 5½ feet of water. Her machinery consists of a Baxter upright boiler, and a pair of Baxter compound condensing engines, 7x12 and 12x12. Her boiler is 6 feet high, 46 inches diameter, and has 152 two inch flues, and a grate surface of 7 feet. She is propelled by 2 three bladed twin screws of 4½ feet diameter and 4 feet pitch. The amount of coal consumed in running from Syracuse to Utica, a distance of 56 miles, was 830 pounds.

The William Newman has a Hubbard hydraulic propeller. She has a horizontal tubular boiler, 8 feet long and 44 inches in diameter, and a grate surface of 13 feet; and she is driven by a single 12x12 upright engine. The propeller is 4 feet 8 inches in diameter and 3 feet long. The amount of coal consumed from Syracuse to Utica was 4,500 pounds.

The time for competition has now expired. If the Legislature at its present session should renew the reward, we shall promptly inform our readers.

THE TURNER CAR BRAKE.—APPLICATION FOR AN EXTENSION.

An application for extension of the car brake patent of Charles B. Turner, dated November, 1848, and extended in 1862 for seven years, is now before the Senate Committee on Patents. Messrs. Batcheller & Thompson, the assignees of the inventor, submit their claim on the ground that they have received no adequate compensation for the use of the device, having been opposed so strenuously by railroad combinations throughout the country that they have been compelled to expend in litigation about as much money as they have received.

The railroads, which are represented by Mr. Wm. D. Bishop, President of the New York and New Haven R. R. Co., and Mr. Joseph Howard, counsel for the Pennsylvania R. R. Co., contend that adequate compensation has been received, and that the patent is invalid by reason of a prior invention. This last assertion seems to be in direct variance with Judge Drummoud's decision in a recent infringement suit brought by the assignees against certain railroads in Illinois. A master in chancery reported adversely to the defendants, who had associated themselves together, and found heavy damages. The railroads filed a bill of exceptions, but the opinion of the appellate court, as delivered by Judge Drummond, sustains the master in every particular. The decree is that the patent is good and valid; that the inventors have never neglected or abandoned such patent; that the instrument covers the connecting of all the brakes of a car with windlasses, so that a brakeman, by operating any one of the latter, can apply all the brakes to the wheels; and that the Stevens brake, used by the defendants, contains all the covered combination.

The railroads, as represented before Congress, are strongly opposing the extension; and after the presentation of the case by Mr. S. D. Cozzens, of counsel for Messrs. Batcheller & Thompson, a postponement was obtained by Messrs. Bishop and Howard, in order to afford necessary time for consultation as to the nature of the reply they will make to the application. The matter, therefore, is adjourned for some days.

THE NEW ENGLAND ASSOCIATION OF INVENTORS AND PATENT OWNERS.

To the Editor of the Scientific American:

Many of your subscribers were surprised to see, in your issue bearing date January 10, 1874, a leading article mentioning the New England Association of Inventors and Patent Owners in a spirit tending to mislead your readers. I would ask you to amend what evidently proceeds from insufficient information. I have sent you a prospectus of the Association, and trust that its perusal will lead you to see that its objects are neither as limited nor as selfish as you state them to be.

The objects aimed at are "to collect and diffuse statistics tending to demonstrate the usefulness of patent laws, and the growth of our arts and manufactures under their influence; to draw from the Congress of the United States such recognition of their general value as shall secure a just and liberal basis of patent protection; to bring together all persons interested, and reconcile their differences, and to take such action as may best promote the general prosperity of the classes represented in its membership."

As no inconsiderable number of your subscribers are members of this Association, and there seems to be no question of its being able to be put to good uses, and assuming that you desire to give only reliable intelligence to your readers, I would ask, on behalf of the Association, that you correct the impression created by the strange *animus* of the article in question. Very respectfully,

THEO. A. DODGE, President of the Association.

REMARKS BY THE EDITOR.—In respect to the above association, our language was as follows (see page 16 of our current volume): "The objects of this Association, so far as we can gather them from the proceedings, are to render mutual aid and benefit to the members in the management of their patents, to secure the extension of their several patent monopolies, compel the payment of fair prices for patents by railway companies, and in other ways to promote the general prosperity of the country."

We have received the prospectus above referred to, which consists of a report signed by Mr. Dodge, upon the expected scope of the Association. It is a very creditable document, and contains various excellent suggestions, to which we shall hereafter have occasion to allude. It does not, however, purport to be a statement of the proceedings of the original meeting of the Association, and has therefore no bearing upon the question of the accuracy of our remarks concerning those proceedings.

We think, if Mr. Dodge will refer to the reports of the meeting once more, as contained in the Boston daily papers, he will find that our statement was substantially correct. The "strange *animus*," the impression of which Mr. Dodge, on behalf of the Association, asks us to correct, refers, we presume, to the objections we presented to the Hill resolution. This resolution covered, indirectly, as we thought, an endorsement by the Association of one of the Vienna propositions, to the effect that governments ought to fix the prices at which patents shall be sold; in other words, that the inventor, after he has received a patent, ought to be deprived of its control. Now, if there is any one point which imparts a distinguishing excellence to the American patent law over the continental system, it is that we give *to the inventor* the free, untrammeled right to make use and dispose of his patent during the entire term for which it is granted, according to his own best judgment. We permit no government interference with him, and have no sneaking government detectives to dog his footsteps, as in some parts of Europe. The mere suggestion of an alteration of our patent laws, to authorize such interference, is abhorrent to the feelings of American inventors, and contrary to public policy.

These views of ours we believe to be fully in accord with the feeling of the great mass of our readers. Mr. Dodge is mistaken if he supposes that many of our subscribers, in the Association, were surprised at seeing the expression of them.

In so far as the New England Association shall actually *do* anything to promote the interests of inventors, or encourage the progress of the useful arts, its members well know that they may always count upon us as being with them, heart and soul. But when they go for the approval, even indirectly, of government interference in the sale of patents, we are not with them, because we believe it to be a wrong policy.

THE PHILOSOPHY OF THE SAND BLAST.

At first sight, the cutting of a diamond or other hard substance, by another so much softer as sand is, seems flatly contradictory to common experience. Still, to any one who has ever fired a rifle ball against a rock, the fact that a flying soft body will bruise or crush a harder one is neither surprising nor new. The possible perforation of a pine board by a tallow candle, fired from a musket, is an illustration of the same fact, familiar to every school-boy. In the sand blast, however, the effect seen is so manifestly disproportionate to the momentum of the individual particles that the explanation usually given in the grosser cases fails to hold good. Grains of sand, of very unequal size, appear to do precisely the same work when moving at the same rate, thus directly contradicting what has hitherto been an unquestioned law of impact.

Whence arises the discrepancy between what is and what might be expected? To answer this question, an English investigator has reconsidered the laws of impact, and finds that one of great significance and importance has heretofore been entirely overlooked. It is this: At the moment of first contact, the pressure between impinging bodies is independent of their size.

This law has been undetected heretofore, simply because the laws of impact have been considered mainly with reference to the centers of gravity of the bodies, while little or no attention has been paid to the points of impact and what goes on there between the instant of first contact and the time when the center of gravity is changed. Even with the compacted bodies, it takes time for the pressure to extend to the inner particles.

Hence, on the instant of impact, it is only those particles in contact which are affected, and the rest of the body might be removed without altering the effect. In other words, the effect of impact is independent of the quantity of matter behind the particles which actually impinge.

That the effect of the sand blast is—as this law indicates—a battering, not a grinding, action is clearly shown by the microscope. A polished glass surface, that has been exposed for an instant to the blast, is spotted with points from which scales of fractured glass have been broken away in irregular direction. Each spot appeared as if a pellet of glass had been driven in by the collision, and the wedge-like action thus set up had driven away the surrounding glass. The polariscope confirms this inference. When thus tested, each spot shows a colored halo, proving that the surface of the glass is under strain.

SCIENTIFIC AND PRACTICAL INFORMATION.

THE VULCANIZATION OF HYDROCARBON COMPOUNDS.

In treating bituminous substances, such as asphaltum, grahamite, petroleum residuum, the different mineral resins, coal tar, etc., with sulphur, chloride of sulphur, or sulphur in combination with various bases, such as sulphuret of iron, etc., a definite chemical compound is formed, differing from its constituent parts in many material respects, being harder, tougher, and more capable of resisting heat. The sulphur should be in just sufficient proportion to form this compound, as an excess would mix mechanically with the mass and render it too brittle for use. Difficulty is usually experienced in determining the proportion of sulphur, as it varies according to the hydrocarbon used. To overcome this difficulty and to avoid all danger of having an excess of sulphur, it is best to use in addition some metallic oxides (such as litharge, for example), which will combine with any free sulphur, forming a metallic sulphuret. The hydrocarbons are first heated till the water is entirely evaporated, and the sulphur, chloride of sulphur, or metallic sulphuret, is then added. The sulphur may be dissolved in bisulphide of carbon or any of the ethereal or fatty oils, or it may be mixed directly with the mass.

ANTIMONY BLUE.

C. Kraus obtains this color by boiling tartar emetic with yellow prussiate of potash, and adding hydrochloric acid. The antimony does not enter into the composition of this color, but merely facilitates its formation.

WHITE COAL.

A new kind of fuel has recently been discovered on the Australian continent, which has received the name of white coal. It consists of felted vegetable fibers, like peat, which contain, interspersed between them, fine grains of sand. It is easily combustible and burns with a light flame. The white coal covers large tracts, requiring no mining, and is already used in large quantities as fuel.

CYMOGENE (? chymogene) writes to say that our correspondent, I. S. Peet, is wrong in adding rhigoline to the list of products of coal tar, as this body does not exist in the coal tar, but belongs to the highly volatile portions of petroleum, being second in the list.