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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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-