Scientific American.

ESTABLISHED 1845.

MUNN & CO., Editors and Proprietors.

PUBLISHED WEEKLY AT
NO. 37 PARK ROW, NEW YORK.

O. D. MUNN. A. E. BEACH.

TERMS FOR THE SCIENTIFIC AMERICAN.

One copy, one year, postage included........................ $3 20
One copy, six months, postage included........................ 1 60

Clubs.—One extra copy of THE SCIENTIFIC AMERICAN will be supplied gratis for every club of five subscribers at $3.20 each; additional copies at same proportionate rate. Postage prepaid.

The Scientific American Supplement

is a distinct paper from the SCIENTIFIC AMERICAN. THE SUPPLEMENT is issued weekly; every number contains 16 octavo pages, with handsome cover, uniform in size with SCIENTIFIC AMERICAN. Terms of subscription for SUPPLEMENT, $5.00 a year, posta e paid, to subscribers. Sin le copies 10 cents. Sold by all news dealers throughout the country.

Combined Rates.—The SCIENTIFIC AMERICAN and SUPPLEMENT will be sent for one year, postage free, on receipt of *seven dollars*. Both papers to one address or different addresses, as desired.

The safest way to remit is by draft, postal order, or registered letter.

Address MUNN & CO., 37 Park Row, N. Y.

☞ Subscriptions received and single copies of either paper sold by all the news agents.

VOL. XXXVI., No. 6. [NEW SERIES.] *Thirty-second Year.*

NEW YORK, SATURDAY, FEBRUARY 10, 1877.

Contents.

(Illustrated articles are marked with an asterisk.)

TABLE OF CONTENTS OF
THE SCIENTIFIC AMERICAN SUPPLEMENT,

No. 58.

For the Week ending February 10, 1877.

MUNN & CO., PUBLISHERS,
37 Park Row, New York.

☞ Single copies of any desired number of the SUPPLEMENT sent to any address on receipt of 10 cents.

FORCE ANALYZED.

We have repeatedly taken occasion to point out the exceedingly loose apprehension which prevails regarding the meaning of the word "force." We doubt if there be another word in the language which is more constantly wrongly used, or which is dragged in to express a greater variety of more wholly different and entirely indefensible significations. We are told of "accelerating force," "moving force," "centrifugal force," "living force," "projectile force," "centripetal force," in mechanics; imaginative biologists wander into such expressions as "psychic force," "odic force," and "vital force." We say a force "may be generated," and that a moving body has such a "force;" and in brief so generally used is the word, anywhere and everywhere, that we carry its wrong meaning into idioms and colloquialisms, and talk of the "force of habit," "force of circumstances," etc.

It will be observed that all these erroneous notions of the term are based on the conception that force is a thing, something tangible and existent; whereas it is nothing of the sort, as a brief consideration will show. The various arguments on this topic are admirably summed up in Professor Tait's latest addition to his excellent work on "Recent Advances in Physical Science;" and we can do no better than to follow the same course of reasoning and adopt the very clear and concise definition of the term "force," to which his views of the subject lead him.

At the outset, we may recall the fact that absolutely nothing can be learned as to the physical world save by observation or experiment, or by mathematical deductions from data so obtained. The exercise of reason is an unavoidable necessity, for it shows us that our senses are merely subjective, that what we call a sensation of color is but an influence upon the eye due to the extent, form, and rapidity of the vibrations of the luminiferous medium; that our classification of sounds, as to loudness, pitch, and quality, is merely the subjective correlative of what in the air particles is objectively the amount of compression, the rapidity of its alternations, and the greater or less complexity of the alternating motion. And thus we may know that light and sound no more exist outside ourselves than does the pain, which a swiftly moving stick is capable of producing on our bodies, reside in the stick itself. Heat, though not material, has objective existence in as complete a sense as matter has. It is merely a form of energy, which, in all its constant mutations, satisfies the test which we adopt as conclusive of the reality of matter, that we cannot in the slightest degree alter its quantity. This test fails altogether when applied to force.

In his endeavor to reach an idea of the meaning of force, Professor Tait first brings forward Newton's laws of motion. Of these the first is: Every body continues in its state of rest or of uniform motion in a straight line, except in so far as it is compelled by forces to change that state. That is, any change whatever in the direction or the rate of motion of a body is attributed to force. This carries with it the upsetting of the old notion that, in bodies moving in a circle, a centripetal force was necessary to balance a so-called centrifugal force, it being imagined that a body moving in a circle had a tendency to fly outward from the center. "If," says our author, "a body is to be made to move in a curved line instead of its natural straight path, you must apply force to compel it to do so; certainly not to prevent it from flying outwards from the center about which it is for the moment revolving. In fact, just as you must apply force *in* the direction of motion to change the *rate* of motion, so must you apply force *perpendicular* to the direction of motion to change that *direction*."

Newton's second law is: Change of motion is proportional to the moving force and takes place in the direction of the straight line in which the force acts. Motion is here used as a technical scientific term for what we now call momentum, the product of the moving mass into the velocity with which it moves. "Change of motion," therefore, is change of momentum, or the product of the mass of the moving body into its change of velocity. "Of course," says Professor Tait, "the longer a given force acts, the greater will be the change of momentum which it produces; so that, to compare forces, which is the essence of the process of measuring them, we must give them equal times to act, or we must measure a force by the rate at which it produces change of momentum. * * * Thus the measure of a force is the product of the mass of the body moved into the acceleration which the force produces on it." Unit force is, therefore, that force which, whatever be its source, produces unit momentum in unit of time. The earth's attraction for a body in our latitudes produces in that body, if let fall, in one second a velocity of about 32.2 feet per second. Hence, if we take 1 lb. as the standard of mass, the weight of a pound of matter is rather more than 32.2 units. of force, so that the unit of force is rather less than half an ounce.

Unit momentum is that of 1 lb. of matter moving with a velocity of 1 foot per second. Unit force is that force which, acting for one second, produces in unit of mass a velocity of 1 foot per second. Momentum, then, is obviously not force. We may substitute ton for pound, or mile for foot, and the relative values will remain unaltered; but if we take minute instead of second, then the time unit increases sixty fold the nominal value of the momentum considered; while that representing the force is increased three thousand six hundred fold. Hence the two cannot possibly be equated. Now as we have shown that there is no such thing as centrifugal force, and as from the above it follows that the so-called accelerating force is not a physical idea at all, we have yet to deal with the term "living force."

And here we pass to Newton's third law, namely: To every action, there is always an equal and contrary reaction; or, the mutual actions of any two bodies are always equal and oppositely directed. And Newton proceeds further to point out—and here is that grand stumbling block of the perpetual motionist, no matter what form his mania may assume—that if the action of an agent be measured by the product of its force into its velocity, and if, similarly, the reaction of the resistance be measured by the velocities of its several parts into their several forces, whether these arise from friction, cohesion, weight, or acceleration, action and reaction, in all combinations of machines, will be equal and opposite. But actions and reactions here dealt with are no longer simple forces, but the products of forces into velocities; they are rates of work, the time rate of increase, or the increase per second, of a very tangible and real something, for the measurement of which Watt devised the practical unit of a "horse power." Now with a moderate exertion a man may raise a hundredweight, which in its descent might be employed to do work, but he is by any exertion unable to lift a ton; and after all his labor to do so, the weight will not do any work by descending again. Hence it appears that force is a mere name, and that the product of a force into the displacement of its point of application has an objective existence. And a simple mathematical operation shows us that it is precisely the same thing to say: the horse power or amount of work done by an agent in each second is the product of the force into the average velocity of the agent, and to say: *force is the rate at which an agent does work per unit of length.*

THE ENCOURAGEMENT OF INSANITY.

A good many honest but misguided people have expressed the belief that the SCIENTIFIC AMERICAN has been too severe in its remarks about spiritualistic frauds, delusions, and the like. Particularly disagreeable to such people has been our characterization of spiritualism as a mixture of self-deception, knavery, and craze. We are pleased therefore to find our diagnosis sustained by so excellent a medical authority as the London *Lancet*, which goes even further than we have presumed to, and raises a warning voice against those who are in any way party to such spurious manifestations of the psychological instinct. The *Lancet* does not hesitate to say that the practice of gathering neurotic people, at what are politely called *séances*, for the purpose of holding converse with denizens of the spirit world, is so debilitating to the mind and so debauching to the moral sense that it needs to be stigmatized in terms at once trenchant and decisive. "To speak plainly, while strong-brained beings may indulge in this form of dissipation without more serious consequences than perhaps a trifling weakness of memory, minds of less robust mould may suffer severely. Anything more perilous than the custom of permitting young persons of either sex to participate in this abuse of mind power it would be difficult to conceive."

Particularly blamable, the *Lancet* thinks, is the President of the "Psychological Society" and other patrons and leaders of "the last new craze." They ought to know better than to give their countenance and support to a pursuit in which weaker heads are in danger of being turned, to their permanent injury. Already mischief, perhaps irreparable mischief, has been wrought. "Minds that have hitherto done wonderfully well in the world are showing signs of weakness. The worry of trying to be quite sure whether there is a force outside the material world, which will bridge over the gulf between the present and the past—those who now tread the earth, and those who have passed out of normal sight and hearing—is beginning to tell on the mental strength of some who have been lured into the toils of a psychology, which is no longer a science, because it has cast adrift the principles of Nature and elects to run riot in vain imaginings and idle conceits."

These are hard words, but they certainly are neither unjust nor unnecessary. As symptoms of mental degradation, the recent actions and utterances of several once straightforward and sensible English scholars are surely painful enough to warrant any protest, however forcible, against the encouragement of such unsanitary pursuits and speculations.

MEDICAL PROGRESS OF THE PAST YEAR.

In accordance with its custom, the *Lancet* begins the new year with an extended review of the notable events of the past twelvemonth in the world of medicine and its allied sciences. From the thirty-six columns devoted to this valuable summary of progress, the following items are especially worthy of remembrance.

In the department of anatomy and physiology, several important advances may be noted. M. Malasses has continued his researches in connection with the blood, and has introduced the new term *blood-corpuscle capacity*, to designate the quotient obtained on dividing the number of blood corpuscles in an animal by the weight of the animal in grammes. Thus a rabbit, weighing 2,450 grammes and having 919,450 millions of blood corpuscles, has a blood corpuscle capacity of 375 millions. It is worthy of notice that the blood corpuscle capacity of carnivora, in consonance with their more active metamorphosis of tissue and manifestations of life, is much greater than that of herbivora. Heretofore the pressure of the blood has always been estimated by manometers introduced into the larger blood vessels. Dr. Kries has ingeniously shown that the pressure in the capillaries may be determined by applying pressure with a small plate of glass to the fingers, ears, or other accessible parts till pallor is produced. In this way he finds that the pressure in the capillaries of the fingers is ordinarily from 37 to 38 millimeters of mercury; if the veins of the arms be compressed, the pressure in the capillaries is increased three or four fold. Röhrig finds that the secretory activity of the mammary gland varies directly with the blood pressure.

Taking advantage of a fistulous orifice communicating with the larger intestine, Markwald has studied the digestive powers of that organ, and finds that it possesses no power of converting starch into sugar, while fibrin appears to undergo for the most part putrefactive decomposition, only a small part being probably absorbed. The practical lesson to be drawn from these observations is that, in cases where it is necessary to introduce nourishment *per anum*, pancreas triturated with meat is the best material to use.

Perhaps the most important event in therapeutics is the discovery of the power of salicin and salicylic acid over the course of rheumatic fever. Salicylic acid is preferred by some, salicylate of soda by others. They all have the power of wonderfully reducing temperature, and appear to bring the process of rheumatic fever to an end in as many days as it formerly took weeks. These remedies also give the profession new hopes of controlling others of the large class of diseases characterized by high temperatures. Of great importance too, are the notes of Cattaglia of Rome, on the cure of diphtheria by the local use of chloral and glycerin, with the internal administration of chlorate of potash. The local use of carbolic acid and glycerin, in the proportion of one part of the former by weight to six of the latter, has also been highly commended in the treatment of this fearful disease.

Much careful and laborious work has been done in the domains of surgery and pathology, but no important discoveries have been announced in either. The subject of lunacy has received much attention, and in connection with it the *Lancet* makes the pertinent remark that each year it becomes more strikingly evident that what has been miscalled "mental disease," and erected into a specialty, is in fact an essentially component part of general medicine. Mind symptoms cannot successfully or safely be studied apart from the phenomena of physical disease, organic and functional; and if the terrible onslaught of insanity is to be resisted, the battle must be fought at close quarters by general practitioners while cases are still recent and curable.

The International Medical Congress at Philadelphia was one of the important events of the Centennial year. It was attended by many respected representatives of foreign medicine and surgery. The impression made on the British visitors by the members of the profession whom they met here was, the *Lancet* has reason to know, of a very satisfactory kind; and that critical representative of British medicine is glad to believe that the condition of medical education in this country is more advanced than might be supposed from the chaotic state of medical legislation, and from the great number of medical schools purporting to grant qualifications.

WHOLESALE HEATING.

According to the Lockport papers, Mr. Holly's plan of heating cities by steam is soon to be put to the test of practical trial in that place. The scheme involves the division of the city into districts, and the establishment of a separate system of boilers in each district, with mains leading to the houses to be heated. That done, the citizens of Lockport will be enabled to dispense with stoves and fireplaces, as they already have with private wells and candlesticks, and regulate the temperature of their homes by the simple process of turning a faucet.

The plan is undoubtedly feasible, and, if properly carried out, cannot fail to effect an enormous saving in trouble and fuel. It is open to the serious objection, however, that the general introduction of steam for household purposes will necessitate the abandonment of almost all the appliances for heating and cooking now in use. Besides, the number of local boilers and attendants required to supply a town of any considerable size with the necessary steam must make the system altogether too complex and costly. Obviously a cheaper and more economical system of wholesale heating could be established by means of gaseous fuel. Gas is already supplied to most houses in towns of any size; and but few and comparatively inexpensive changes would be required to carry this self-propelling fuel to existing fireplaces, stoves, and cooking ranges, and burn it there. Now that gas can be manufactured for less than twenty cents a thousand cubic feet, the economy of its use for domestic heating is beyond question. No other fuel can be burned so completely or to so good an advantage, while nothing can be simpler than the means required for its distribution. Once introduced, the gas required for heating our houses and cooking our food need not exceed what is now paid simply for the cartage and handling of the coals we burn, after they have been laid down at the door.

Among the minor advantages of gas over steam for household uses, not the least are the facility with which the amount taken by each consumer can be determined, and the ease with which the supply can be adjusted to the demand, without waste. Gas will keep indefinitely without loss of heating power: steam will not; and it is not easy to see how provision could be economically made with it for any sudden increase or diminution of the amount of heat which consumers individually or collectively might require. Besides, with gaseous fuel, it would be possible to retain and increase the number of our cheerful and sanitary open fires, compared with which steam radiators present few attractions. Every charm of a hickory fire—the bright blaze and the radiant embers—can be had from a grate burning gas, with none of the evils and inconveniences of a wood fire; while with the use of the same ever ready and perfectly controllable fuel in the kitchen, all the uncertainties and no small part of the common mishaps in cooking might be entirely obviated.

It is surprising that Lockport, which has the credit of taking the lead in the matter of public lighting with gas, should not have given it the preference for public heating. Are there no more natural wells in that neighborhood to draw upon? It would be a good plan for some of the towns near flowing gas wells to immortalize themselves and lessen their expenses by utilizing in this way the precious products of Nature's laboratory, now going to waste. A large iron manufacturing company in Western Pennsylvania write us that all their smelting is done with gas brought from a natural well nineteen miles away, through pipes laid down by themselves. Any enterprising town, in the neighborhood of one of those splendid natural reservoirs of fuel, might do likewise, tapping a gas well for a public fuel, supply, just as other towns tap a lake or a river for a public supply of water. The example, once set, would be sure to be followed elsewhere, with public gas works where no natural source is to be found. It is one of those inevitable advances in public economy which it is safe to predict; and men now living may see it carried out in all well regulated towns.

PROPELLING VESSELS.

It is probable that many who have recently joined the noble army of subscribers to the SCIENTIFIC AMERICAN have no knowledge that there are many other methods of propelling vessels besides the use of the oar or paddle, the sail, the screw, the paddle wheel, and animal towage; and that many who have been our readers for years have no idea of the variety of styles of propellers devised by the ingenuity of the many inventors who have labored in this field. We therefore think that a brief description of some of the most prominent varieties may be acceptable to our readers and prevent the re-invention of many old and exploded notions.

Leaving out of further consideration the ordinary use of the means mentioned above, as too well known to require description, we would state that many patents have been obtained for different forms of and arrangements of the buckets in paddle wheels, some having them adjustable on the arms to give them the proper amount of dip, others having them set at an angle diagonal to the shaft, others showing pointed paddles; others have the paddles set obliquely to the central line of the spokes or arms of the wheel, and still others show the paddle wheels made in the form of drums to assist in floating the vessel; but the favorite change from the ordinary style is that known as the feathering paddle wheel, which consists in such an arrangement of the paddles as will allow them to enter and leave the water perpendicularly, so as not to beat it when entering or lift it when leaving, as do the fixed paddles. This is accomplished generally by journalling the paddles to the arms of the wheel, and providing them with guides of various descriptions that compel them to retain a vertical position on entering and leaving the water. A few of such wheels have been and are still used, but have met with comparatively small favor from practical men, as the loss from the beating and lifting of the water is not near so much as is generally supposed. Some of these feathering paddle wheels are submerged and run on vertical shafts, in which case the paddles are set vertically during that portion of their revolution when they act on the water and lay horizontally during the remainder of their motion.

One of the favorite ideas of would-be improvers on the paddle wheel is to convert it into an endless chain of paddles passing over two drums at a considerable distance apart so as to have more action on the water than the ordinary wheel. In some cases, the chain is very long and is supported between the drums by friction pulleys; and in other cases the chain is made so short or is so constructed as not to require the pulleys. In some forms of this device for propelling, there is a single chain of paddles, passing over the center of the vessel and underneath its center in a channel between two keels.

Several attempts have been made to displace the paddle wheel by substituting disk wheels, or solid wheels without paddles, acting only by friction as they revolve in the water. These wheels have sometimes been made with single plain disks, others have been provided with corrugated or undulating surfaces; in other cases, two or more disks, set at varying distances apart, have been employed; and in some instances these wheels have been formed of one or more disks, set in an inclined position on the shaft.

Vibrating and sliding paddles have also received much attention from inventors, some of whom so arrange their devices, that, like oars, the paddles descend into and pass through the water, and then rise clear of it before returning to the starting point; others, usually called duck's foot propellers, have their motions all the time in the water, but open out when travelling in one direction, and close up when going in the other, in the manner of a duck's foot; and still others are made of flexible material and work like the tail of a fish. In connection with vibrating propellers, we may state that several patents have been granted for devices for operating oars arranged in such a manner as will allow the oarsman to face the bow of the boat that he may the more readily see in which direction he is travelling.

Screw propellers have been made in almost every imaginable shape and arranged in almost every conceivable way and place. Many patents have been granted for using the screw as a means of steering as well as propelling, which is usually accomplished by connecting the screw to the shaft by a universal joint, and providing it with appropriate guiding mechanism so that it may be turned at any desired angle to the keel of the vessel.

Hydraulic propellers have also had their full share of attraction for inventors, and especially for those who wished to pocket the $100,000 canal boat prize. These propellers are made in many different forms, but consist essentially in the use of a tube through the boat provided with some means (usually a screw) of drawing in water at the bow and expelling it at the stern. Sometimes the tube forks at the stem and stern, so that the water may be expelled at either side for steering purposes. By reversing the water-forcing apparatus, and in some cases by changing valves in the tube, the course of the water is reversed, for backing the vessel. Something on the same principle as the above is the use of a wheel or screw in a channel beneath the boat between two keels, many different styles of which have been patented.

Several patents have also been granted for pneumatic propellers, in which air pumps are employed to draw in air and force it out against the water at the stern. In some cases steam from a boiler, or the force of gases generated by the firing of some explosive substance, is substituted for air and air pumps.

In addition to the above there are various styles of propelling devices adapted to shallow or small bodies of water, as rivers and canals, among which may be classed rope or rail traction, in which a rope is laid from one end of the route to the other, and is acted on by a wheel or drum on board the boat around which the rope is usually passed. The rope generally lies on the bottom of the canal or stream and either passes over the bow of the boat to the driving power and drops into the water at the stern, or over a wheel at the side of the boat. Sometimes the rope is suspended above the water, and then is usually clamped between two driving wheels, or between a driving wheel and an idler; and in other cases a chain or a fixed rail (either over the canal, or on its bank, or the canal bottom) is substituetd for the rope, In some cases the rail takes the form of a rack, on which runs a pinion driven by power on the boat. As somewhat analogous to this, we may mention that some inventors have proposed to lay rails on the tow path on which a light locomotive, driven by a boiler on board the boat, shall run and tow the boat by means of the flexible steam tube connecting the boiler with the locomotive.

Ground traction propellers of various styles have also been tried, some of which show driving wheels running in self-adjusting frames, so that they will always bear on the bottom of the canal or stream; others have poles driven by cranks or eccentrics; and still others have legs with shoes pivoted at the bottom: but the two last styles are essentially the same in principle.

Air propellers, or screws which act in the air instead of the water, have also been tried and patented, the object being to avoid the washing of the banks in steam propulsion on canals.

Windmill propellers, or rather the use of windmills to drive screws or paddle wheels, have also received some attention; and one of the patentees of such an arrangement has provided an endless chain horse power as an auxiliary force.

Several patents have been granted for wave power propellers, in which the waves, in rocking the vessels, are supposed to drive the screw or paddle wheel. The force of a running stream has been availed of to drive a boat across it with considerable success. In one case, there is a rope stretched across the river, on which run two pulleys connected with the bow and stern of the boat. The pulley at the bow is connected by a very short cord and the one at the stern by a longer one, thus holding the boat obliquely to the rope and the current, so that the force of the latter acting on the side of the boat will propel it across the stream. Another plan that has been suggested consists in attaching one end of a rope to a boat and the other end to an anchor located in the middle of the stream, at some distance above the place where the boat is to cross, in which case the boat travels in an arc, of which the rope forms the radius.

A method of making a boat travel against the stream by the power of the stream itself has been proposed, and it consists in a fixed cable lying in the bed of the river, which cable is acted on by a wheel or drum driven by a paddle wheel or screw impelled by the current. The cable may either have one end coiled up on board the boat, or have both ends anchored, as in rope traction before referred to.

The above gives but an incomplete sketch of the various means devised by the ingenuity of man to propel vessels through the water, as a description, be it ever so brief, of the different modifications of the various plans for propulsion would fill a good sized volume, there being probably upwards of eight hundred United States patents for propelling devices, to say nothing of the many foreign inventions for the same purpose.

MR. R. HITCHCOCK, of Watertown, N. Y., states he was the inventor of the clock propelled by a wind wheel, described in our issue of January 20 as the patent of C. B. Hoard. The patent was granted to Mr. Hitchcock after the decision of an interference suit.

AN excellent backing for fine harness can be made by dissolving five or six sticks of black sealing wax in a pint of alcohol.