Correspondence.

Electric Fire Pumps.

To the Editor of the SCIENTIFIC AMERICAN :

The general introduction of the electric motor into buildings of all classes suggests an application which might, under certain conditions, prove to be of great value. A fire pump designed to be driven by an electric motor would, it seems to the writer, have many decided advantages. In large manufactories and public buildings, where steam boilers are kept continually under pressure, there is no difficulty in maintaining fire pumps capable of supplying one or more streams with the necessary promptness. There is, however, a large class of buildings, in which may be included private residences, where steam power is not at hand, and where reliance must be placed entirely upon the local fire department, which may or may not be efficient, and which, at the best, must consume a certain amount of valuable time in getting to work. In such cases it is believed that an electrically driven pump would find its most useful application. Such a pump would be in constant readiness for action, and could be instantly started at any time by the simple pressure of a button, or could even be arranged to start automatically in connection with a system of electric fire alarms, or by releasing the air in the discharge pipes, as in the well-known sprinkler systems. It should be provided with relief valves set at the desired pressure, so that, after once being started, it would run at full speed, the amount of water delivered being regulated at will by the hoseman up to the full capacity of the pump. The apparatus should, if possible, be installed in a small detached building or shelter, where it would not be disabled by fire or by the cutting power of wires leading to a burning building. WILLARD P. GERRISH.

Harvard College Observatory, Cambridge, Mass., October 24, 1900.

[The suggestion of our correspondent is a good one. We believe that this method of equipment has already been installed and with success in some buildings in this city.—ED.]

The Relations between Experimental and Mathematical Physics.*

M. HENRI POINCARÉ BEFORE THE CONGRESS OF PHYSICS.

ROLE OF EXPERIMENT AND GENERALIZATION.—Experiment is the only source of truth, and by its means alone can we learn anything new or certain. What place remains then for mathematical physics? The latter has rendered undeniable services, because it is necessary not only to observe, but to generalize ; it is this which has been done from all time, only as the remembrance of past errors has made man more circumspect, he has come to observe more and generalize less. Should we not be content with experiment alone? That is impossible, and would be to ignore the true character of science, which is built of facts like an edifice, but is not a mere conglomeration of material. A good experiment teaches us something besides an isolated fact ; by its means we may predict and generalize. Thus each fact observed enables us to predict a great number of others, but we should not forget that the first alone is certain and all the rest are only probable. The role of mathematical physics is to guide the generalization so as to increase what may be called the efficiency of the science. It remains to be seen by what means this may be accomplished.

THE UNITY OF NATURE. — All generalization supposes in a certain degree the belief in the unity and simplicity of nature. For the first there can be no difficulty ; if the different parts of the universe were not like the organs of the same body, they would not act upon each other, and we have only to ask how nature is one. The second point is more difficult. It is not sure that nature is simple ; modern ideas have changed ; but those who do not as formerly admit the simplicity of the natural laws are often obliged to consider them from this standpoint, otherwise all generalization and all science would be impossible. It is clear that a given fact may be generalized in different ways. The choice is guided by considerations of simplicity ; this is illustrated by our method of drawing a curve between a series of points. To sum up, every law is supposed simple until the contrary proof is given. If we study the history of science, we find two phenomena of opposite character ; at times simplicity is concealed under complex appearances, and at others apparent simplicity conceals a series of complicated phenomena. The complicated movements of the planets and the law of Newton is an example of the first, and the kinetic theory of gases and Mariotte's law is an example of the second case. But Newton's law itself has perhaps only an apparent simplicity, and may be due to some unknown and complicated mechanism. No doubt if our means of investigation become more penetrant, we will discover the simple under the complex, then the complex under the simple.

ROLE OF THE HYPOTHESIS.—Every generalization is a hypothesis, and the hypothesis therefore has a necessary role which has never been disputed. It should, however, be verified as often as possible, and if not sustained, should be abandoned, and even in this case renders great service by the new outlook given. Then, under what condition is the use of the hypothesis dangerous? Those which are made unconsciously we are powerless to abandon ; a service may be rendered here by mathematical physics obliging us to formulate all hypotheses. We should distinguish different kinds of hypotheses, those which are natural, and a second category which may be called indifferent, as the results of calculations are not changed thereby; for instance, the continuous or the atomic constitution of matter. These are never dangerous if their character is not lost sight of, and they may be useful in calculation or to give a concrete idea. Hypotheses of a third category are veritable generalizations, and should be sustained or condemned by experiment.

ORIGIN OF MATHEMATICAL PHYSICS.—The efforts of scientists have always tended toward resolving the complicated experimental phenomena into a great number of elementary phenomena, and this in different ways. As to time, each phenomenon depending upon that the preceding instant. In space, in an analogous manner, each molecule acting upon its neighbor.

The knowledge of an elementary fact permits us to put the problem into an equation, and integration becomes possible. The reason that generalization takes usually a mathematical form in the physical sciences is that not only are numerical laws to be expressed, but the observed phenomenon is due to a great number of elementary phenomena, similar among themselves, introducing naturally the differential equations.

SIGNIFICANCE OF PHYSICAL THEORIES.—It may be said that scientific theories are of an ephemeral character, but the role of such theories must be taken into account. The theory of Fresnel has given place to that of Maxwell, but the former has none the less its value in the prediction of optical phenomena. If the relations expressed by the equations are known, it makes little difference whether the image we give to the phenomena change or not. The kinetic theory of gases has given place to many objections, but it has, nevertheless, produced valuable results, no matter whether its absolute verity is affirmed or not.

PHYSICS AND MECHANISM.—Most theorists have a predilection for explanations borrowed from mechanics or dynamics. Some of them wish to explain all phenomena by the movement of molecules attracting each other mutually according to certain laws; others wish to suppress attractions at a distance, and the molecules would thus follow straight paths and be deviated only by shocks; still others, as Hertz, suppress also the forces, but suppose the molecules are bound in a system analogous to our articulated systems, thus reducing dynamics to a kind of kinematics. Phenomena may be explained by all these systems. As to the conception of the ether, some regard it as the only primitive, or even the only real matter, and what we call matter as constituted of vortex motions of the ether according to Lord Kelvin, or according to Riemann of points where the ether is constantly destroyed; or with more recent authors, Wiechert or Larmor, of points where the ether has undergone a special kind of torsion. The old fluids, caloric, electricity, etc., have disappeared, not only when it was found that heat was not indestructible, but the unity of nature forbids the creation of such independent fluids.

ACTUAL STATE OF THE SCIENCE.—Two diverse tendencies are observed in the development of physics, that of co-ordination, in which science advances toward unity and simplicity ; and that of variation, where, by the discovery of new phenomena, science appears to advance toward variety and complication. If the first of these is to prevail, science becomes possible ; but if on account of the multitude of phenomena we are obliged to abandon our classification, it will be reduced to a mere registration of facts ; as to this, we cannot reply, but we may compare the present state of science with the preceding, and draw some conclusions. Half a century ago, the greatest hopes were entertained. The discovery of the conservation of energy and of its transformations had just revealed the unity of force ; heat was explained by molecular movements ; their nature was not known, but the solution of the problem seemed near ; for light, the question seemed solved. Electricity. just annexed to magnetism, was farther behind, but no one doubted that it would take its place in the general unity, and for the molecular properties of solids, the reduction seemed easier. In a word, great hopes were entertained. What do we observe to-day? First, an immense progress ; the domains of electricity, light and magnetism now form but one. The optical phenomena enter as particular cases of electrical phenomena. While they remained isolated, it was easy to explain them, but now an explanation to be acceptable must enter into the domain of electricity ; this is not without some difficulties. The theory of Lorentz is the most satisfactory ; Larmor goes still farther and seems to add to the former ideas of MacCullagh upon the direction of ether movements. However, we have not as yet a satisfactory theory. We should limit our ambition and not seek to formulate a mechanical explanation, but show that we could at least find one ; we have succeeded in this, owing to the principle of the conservation of energy and that of least action, both constantly verified. The irreversible phenomena are more intractable, but are brought into order by Carnot's principle. The role of thermodynamics has greatly increased, and we owe to it the theory of the pile and of thermo-electric phenomena. To sum up, the old phenomena become better classified, but new ones are constantly coming in, and we must now place the cathodic and X-rays, those of uranium and radium, etc. No one can predict the place they are to occupy, but no doubt they will fit into the general unity. On one hand, the new radiations seem allied to the phenomena of luminescence ; above all, it is thought that in these phenomena are found the veritable ions, these being endowed with a great velocity.

We not only discover new phenomena, but the old ones appear under an unlooked-for aspect. Nevertheless, the relations which we recognized between the supposedly simple objects hold good when we learn their complexity, and this is the essential point. Our equations become more complex, but their form remains. Lastly, the physical efforts have invaded the domain of chemistry, whence the new science of physico-chemistry, which, though recent, enables us to associate phenomena such as electrolysis, osmose and movements of the ions. From this rapid exposé, what are we to conclude? Everything considered, we have approached a unification ; though the progress has been less rapid than was hoped for fifty years ago, and the path laid out has not always been taken, we have, in fact, gained considerable ground.

* Abstract by Paris Correspondent of the SCIENTIFIC AMERICAN.

THE AEROSTATIC EXHIBITS AT PARIS.

The aerostatic section of the Champ de Mars contains a centennial collection of great interest ; the objects have been loaned by a number of persons who have private collections. The upper illustration shows part of a famous collection which has been loaned by M. Albert Tissandier. These objects, many of which date from the last century, all bear a representation of a balloon, either of the primitive hot air balloon of Montgolfier or the later form inflated with gas. Most of the porcelain and earthenware plaques and other pieces date from the last century, and are decorated with balloons or carry scenes of balloon ascensions more or less artistically drawn. One of these plaques bears the date 1785, and another is dated 1820. A large collection of fans will also be noticed ; they all carry scenes of balloon ascensions painted in miniature ; and some of these have a considerable artistic value. Two of the fans represent ascensions which were made in the last century at the Tuilleries or at Versailles. In the foreground is a collection of miniatures in round or square metal frames, representing balloon ascensions, and several books with a balloon stamped in gold on the cover. Near it is a collection of miniature boxes in colors or of carved ivory, gold, or enamel, upon all of which a balloon is represented. Most of these boxes date from the end of the last century, and some of them are finely executed. In this collection is a miniature, inclosed in a square leather case, representing "the ascension of Pilatre de Rozier and De Romain at Boulogne, with a balloon filled with inflammable air, on the 12th of June, 1785." Another miniature commemorates an ascension made on the 2d of March, 1784. At one end of the case is a collection of watches, medallions, rings, and like objects, as well as a number of miniatures. Among these is a button of the uniform worn by the military aerostatic corps of 1794 ; it bears the inscription, "Aerostatier, 1r. Brigade." An interesting relic is a watch with an engraved copper case bearing the representation of a balloon, which was presented to Captain Coutelle in 1794. Another watch of the same period is of steel incrusted with gold, and bears a design of a balloon ascension.

One of the miniatures shows a gas balloon, and bears the date of December 1, 1783, and an engraving in a metal frame, representing an ascension made by Messrs. Robert and Hutin at the Tuilleries on the 19th of September, 1784. In the front of the case is a series of medals which commemorate the different ascensions made during the siege of Paris, 1870 to 1871. In the center is a large medallion in bronze, bearing a figure of the Republic, with a balloon in the background. Surrounding it are a number of small medals which relate to different ascensions. At that time most of the large railroad stations of Paris were turned into balloon headquarters, from which the ascensions were made. The medals bear inscriptions similar to the following, surrounding a balloon in the center : "Depart from the Northern Station—the Torricelli—conducted by the marine Bely—the 24th of January, 1871." The other side of the case contains a large collection of engravings and documents relating to aerostatics. Some of the oldest of these show different forms of Montgolfier balloons, most of which were of a highly ornamental character ; among the books and pamphlets is one dated 1784, relating to the experiments of Montgolfier and a copy of the proceedings of the Académie des Sciences of 1828 containing a eulogy of

Aeronaut Charles, one of the pioneers of the last century. Another copy of the proceedings of a much later date is that containing an account of an ascension made by the late M. Gaston Tissandier in the balloon "Zenith," in which he made the remarkable altitude of 24,000 feet. Another part of the collection shows a number of miniature photographic dispatches made upon films, which were used for the post established by carrier pigeons in 1870 to 1871 between Bordeaux and Tours. Each of these films, which measures one by two inches, represents a reduction of sixteen folio pages, and contains more than three thousand dispatches; one hundred thousand dispatches of this character weigh only fifteen grains. The films were rolled in a goose-quill tube and attached to the tail of the pigeon.

Another interesting collection is that of M. Louis Bereau, a part of which may be seen in the second illustration. At the top are a number of very curious engravings relating to balloon ascensions or to different projects for flying machines. One of the latter, designed by E. Petin, contained four balloons with a complicated rigging; under it is a design of flying machine presented to the Académie des Sciences in 1851, by Emile Gire; the balloon was filled with superheated steam and carried a series of immense wings. Another of these machines, with a cigar-shaped balloon carrying the propelling and steering mechanism, made an ascension from the Champ de Mars in 1834. The most interesting of these engravings, the third of the top series, is that representing one of the first public ascensions of Montgolfier, and the text merits a reproduction in full, as showing the state of the art at that period: "Aeronautic experiment made at Versailles on the 19th of September, 1783, in presence of their majesties the royal family and more than 130,000 persons, by Messrs. de Montgolfier, with a balloon 57 feet high and 41 feet in diameter. This splendid machine, with a blue background carrying the king's coat of arms and divers ornaments in gold color, displaces 37,500 cubic feet of atmospheric air, weighing 3,192 pounds, but the vapor which fills it weighing one-half less than the common air, there results a rupture of equilibrium of 1,596 pounds, owing to which the machine and its cage, containing a sheep, a cock, and a duck, will rise, and could yet lift 696 pounds. At one o'clock a cannon stroke announced that the balloon was to be filled; eleven minutes after a second announced that it was full, and at the third stroke it started. It then rose majestically to a great height, to the surprise of the spectators amid the acclamations of the public. It remained some time in equilibrium, and descended slowly eight minutes after in the wood of Vaucresson. The animals were not at all inconvenienced."

In the center of the collection is a curious tavern-sign dating from 1678, representing a man flying by means of paddle-shaped wings attached to rods and supported over the shoulder. The lower case contains a great number of photographs and documents relating to the subject. A large marble tablet contains a dedicatory inscription to the Montgolfier brothers by the citizens of Dannonay, and bears the date 1783 and a design of a balloon. Another tablet relates to an ascension made by Prof. Charles Guy from the Champ de Mars in 1783. At the top is the royal coat of arms, and below is a balloon. The collection includes a number of books; one of these, dating from 1784, bears the title, "The Art of Voyaging in the Air, or the Balloons; containing the means of making aerostatic globes according to the method of Messrs. de Montgolfier and the processes of Messrs. Charles and Robert." The frontispiece contains an engraving of a balloon. Another work of the period is entitled, "Essay on Aerial Navigation," containing the art of directing aerostatic balloons at will; read before the Académie des Sciences, January 14, 1784.

The rear of the case contains a collection representing the Aeronautical Society which was formed during the siege of Paris. One of the interesting objects is a stuffed carrier pigeon, which inaugurated the Aerial Post during the siege; this pigeon made four trips from Paris to Bordeaux, each time carrying a number of dispatches; it was killed while on its fourth trip. With it are shown the reduced copies of the dispatches, made upon films. A piece of the balloon "Washington" is shown near it; this being one of the balloons which figured at the siege; also a basket in which the carrier-pigeons were kept during the ascensions. The collection contains a number of photographs and engravings of ascensions made during this period.

AEROSTATIC SECTION OF THE PARIS EXHIBITION—COLLECTION OF M. ALBERT TISSANDIER.

AEROSTATIC SECTION OF THE PARIS EXHIBITION—COLLECTION OF M. LOUIS BEREAU.

Turf as Fuel.

Consul Hughes, of Coburg, September 6, 1900, says: At the present price of coal, says the Oesterreichische Zeitschrift fuer Berg und Huettenwesen, the use of turf commands our special attention. Hitherto, all attempts to use turf as fuel and for the production of gas on a large scale have failed, for the reason that no means existed to dry it cheaply and quickly, nor could it be pressed into a small volume. Turf contains about 75 per cent of water, of which it loses very little in ordinary "drying." It is now proposed to reduce the turf to pulp and destroy the fiber, after which the mass is easily dried, getting quite hard and furnishing an excellent charcoal. There is no reason why this turf coal should not be used for electric stoves and in the manufacture of carbide of calcium. In distilling the turf coal, paraffin, ammoniac, and a strong illuminating gas are found. In using it as a fuel for locomotives, a heat equal to that of 93·25 per cent of best coal has been attained, while it shows only 2·62 per cent of ashes, thus being equal in purity to high-grade Derbyshire coal. The cost of converting turf into coal has been calculated at 61 cents per ton.

Memorial to John Ruskin.

A simple and beautiful memorial, which has been subscribed for by friends and admirers of the late Mr. Ruskin, was recently unveiled at Friars' Crag, Keswick. The monument consists of a simple monolithic block of Borrowdale stone, rough and unhewn, as it came from the quarry. It is of the type of the standing stones of Galloway, which are the earliest Christian monuments of the Celtic people now extant. Upon one side is incised a simple Chi-Rho inclosed in a circle after the fashion of these earliest crosses, with the following inscription beneath from "Deucalion," Lecture xii., par. 40: "The Spirit of God is around you in the air you breathe—His glory in the light you see, and in the fruitfulness of the earth and the joy of His creatures—He has written for you day by day His revelation, as He has granted you day by day your daily bread." On the other side of the monolith, facing the lake and the scene which Ruskin once described "as one of three most beautiful scenes in Europe," is a medallion in bronze, the work of Signor Lucchesi, representing Ruskin as he was in his prime, in the early seventies. Above the portrait is the name "John Ruskin;" beneath are the dates MDCCCXIX. to MDCCCC. Beneath these again is incised the inscription, "The first thing that I remember as an event in life was being taken by my nurse to the brow of Friars' Crag, Derwentwater."

The Current Supplement.

The current SUPPLEMENT, No. 1296, contains many articles of unusual interest. "The Ferry-Bridge at Bizerta" describes a very curious suspended bridge. "The Paris Exposition Awards" are analyzed. "Electrical Machines at the Exposition of 1900" is a most elaborately illustrated article, giving illustrations of all of the large generators. "Chemical and Technical Education in the United States," by Prof. C. F. Chandler, is continued. This is one of the most important papers ever published in the SUPPLEMENT. "The Twin-Screw Steam Yacht 'Arrow'" is illustrated by a number of engravings. "The Age of the Earth," by Prof. W. J. Sollas, is concluded in this issue.

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(Illustrated articles are marked with an asterisk.)