ware in the past few decades. When the war broke out, the stoneware works of this country were not able to deal with the demands, and tantiron vessels, which can be made in a few days, while good stoneware requires months, were largely adopted. Valentiner plants comprising, a still, condenser and coils, built up of pipes and return bends flanged together, all of tantiron, are now made. The denitrating tower is an interesting novelty. The spent acid of nitroglycerin works consists of diluted sulphuric acid, which has to be concentrated again, and some nitric acid, which is to be regained by distillation. There may also be small globules of oily nitroglycerin which might coalesce if the evaporation were carried on in pans. The tower, 15 ft. high, is built up of socket pipes, 14 in. diameter, and is packed with quartz fragments; the acid enters at the top and steam at the bottom, and the nitric acid and vapors condense in the cylinder by the side of the tower. Nitric-acid stills are also used for the distillation of acetic acid. The autoclaves for making ammonium nitrate from cyanamide at a temperature of 120 deg. C. and a pressure of about 2 atmospheres, resemble one style of nitric-acid retorts. The outer vesel is a jacket of cast iron, the inner vessel of tantiron forms the saturator; the height is 8½ ft., and the diameter 4½ ft.

Acid eggs, apparatus for forcing up corrosive liquids with the aid of compressed air, are made of two tantiron cups, joined by their top flanges so as to form a horizontal cylinder with spherical ends and one common flange; on the vertical middle plane they are provided with acid inlet and outlet valves and an air pipe, and are supplied in large sizes. The pumps of the works, reciprocating and centrifugal, do not differ much in appearance from ordinary pumps; the barrels and impellers and pipes are made of tantiron or lined with it. As these parts of hard tantiron cannot be machined or repaired, it is recommended to keep spare parts ready for cases of accident. Centrifugal pumps are supplied for lifting 6,000 gals. of acid or corrosive mine water, &c., per hour, against a head of 50 ft., running at 1,600 r.p.m. . Slime pumps, *e. g.*, for conveying the crushed quartz in gold mines are likewise made of tantiron, to obviate the heavy erosion of the pipes by the gritty quartz particles. For the same reason, tantiron-lined steel pipes are used in the Rand mines, South Africa, for the sand-filling plant. When the pillars left in the galleries below are to be removed, the galleris have to be refilled with the finely crushed quartz from the vast white waste mounds which form a conspicuous feature of the district. The spoil is flushed down the pipes with water. The first pipes used, steel pipes, were ruined by 6,000 tons of sand; porcelain-lined pipes were then tried, which could stand up to 50,000 tons; the tantiron pipes, introduced four years ago, are still doing duty, and their life capacity is estimated at 500,000 tons. The erosion is greater at the top, where the sand strikes the pipe than at the bottom, and is not the same in all sections, probably owing to peculiarities of their positions. Similarly-lined steel pipes and tantiron pipes, up to 2 ft. in diamare in use for ash ejectors, especially on board ship, where heavy erosion and corrosion by the caustic ashes and the sea water have to be guarded against.

In stop cocks and valves of tantiron corrosion by acid sodium bisulphate (the acid cake residue of the distillation of nitric acid from salt and sulphuric acid), erosion by grit, rusting and sticking are the chief sources of trouble to be met. Here, again, tantiron competes with lead and stoneware, and its advantages lie in greater strength and indifference to high temperatures and frost. A groove is made in the center of the cock and charged with a greasy preparation of ceresin, vaseline, black lead, and asbestos, which is pressed into the groove by means of a screw. A great variety of cocks, valves, T-pieces, straight and bent socketed pipes, provided with threads, are made in tantiron.

Of other specialties, we mention the corrosive-vapor drying and baking ovens, the flat doors and walls of which are lined with sheets of tantiron, which are screwed on. Tantiron can be rolled at about 700 deg. C., but is brittle then. Another specialty is the tantiron electrode for cyanide baths (silver and gold), and also copper baths, &c., replacing iron and other alloy electrodes, which are not insoluble, and very objectionable on this account, or more expensive than tantiron. For the same reason, steel-mixing mills for the manufacture of manganates, the balls and stirrers of other mills, and many aparatus used in the acid and dye and other chemical industries, are made of tantiron.

Like every other manufactured article, tantiron is constantly being improved, and does not claim to have reached final perfection. Acid-resisting materials must possess various properties which are not easily combined, and possibly not capable of combination. A compromise has to be accepted.

The Influence of Aviation Upon Mathematical Physics

A DIRECTION in which much work is now being done is in the dynamics of and through media. This is an immediate effect of the development of the art of flying. In order to achieve success in aeronautics two problems referring to our subject need investigation—motion through a resisting medium and meteorology. The war has reacted profoundly upon this phase of research. Whereas only a few years ago orthodox mathematicians stood more or less aloof from aeronautical mathematics, the case is quite different now. The successful vindication of the researches of Lanchester and Bryan as leading to criteria of stability and controllability of an aeroplane based on exact mathematical formulation, and the imperative necessity to apply the best brains of the country to the solution of the urgent problems of aircraft attack and anti-aircraft defence, have swept away the the remains of old prejudice. It is obvious, of course, that much of the work that has been and is being done during the war must remain unpublished, and there can be no doubt that the cessation of hostilities will be followed by the release of an amount of accumulated knowledge and results that will color the teaching and development of dynamics for many years. Nevertheless, a considerable amount of important work, that has no immediate bearing upon practical military problems, is being published. Among the recent researches that have come to the notice of the writer are the following:

P. Appell (*Comptes Rendus*, 165, 694-5, 1917; 166, 22-3, 1918) discusses the results of experiments made by Z. Carrière (*Jour. de Phys.* 175-86, 1916) on the two-dimensional motion of a light sphere moving in air under gravity, having a rotation about a horizontal axis perpendicular to the plane of motion. Carrière found that after an initial part dependent on the initial conditions, the motion becomes practically uniform in a straight line inclined to the downward vertical in the same sense as the rotation, the inclination increasing with the ratio of the rotation to the translational motion. Appell suggests that the motion can be explained if the air resistance is taken to act in a line through the centre of the sphere, making an angle with the backward direction of motion dependent on the angular velocity, and states that he intends to publish the mathematical analysis for the assumption that the air-resistance varies as the velocity. In a paper read at the Royal Society but not yet published (*Nature*, 483, 1917), the writer of these notes shows that the centre of a plane lamina moving in two dimensions in air, the law of resistance being the square of the velocity, moves in a manner similar to that found by Carrière for a light sphere. One may even suggest that probably any rigid body moving in air under gravity will after a time approximate to a type of "terminal" motion along a wavy line inclined to the vertical in a sense and to an extent dependent on the relation between the rotational and the translational velocities. It is well known that a particle tends towards a terminal motion in a vertical straight line.

H. Larose (*Comptes Rendus*, 545-8, 1917) investigates the steady motion of a uniform flexible and inextensible string in air under gravity, finding the equations of the various forms of a string moving with a constant velocity along itself and an additional velocity in a horizontal direction.

Another problem in resisted motion is worked out by J. Prescott in a paper entitled "On the Motion of a Spinning Projectile" (*Phil. Mag.* (6), 332-80, 1917). The author takes the air resistance to be proportional to the square of the velocity, the constant of proportionality being one or another according as the velocity is less than or greater than 1,060 ft. per sec., thus introducing an important modification into the method of Bashforth, who made the resistance vary as the cube of the velocity, the constant of proportionality varying as the velocity underwent any considerable change. Assuming first that the resistance is always exactly opposite to the direction of flight, and then introducing the effect of the shape of the projectile by supposing the resistance to act in the plane of the axis of symmetry and of the direction of motion, at an angle with the former some constant times the inclination of the latter, Prescott calculates the trajectory as well as the drift and the angular defection of the axis of the projectile.

P. Frank (*Phys. Zeitschr.*, 2-4, 1918) shows that the problem of steering an airship in a variable wind so as to go from one point to another in minimum time leads to an equation of the same type as occurs in the propagation of light in a moving medium.

J. G. Leathem (*Phil. Mag.* (6), 119-30, 1918) continues his work on curve factors in the conformal representation of hydrodynamical problems in two dimensions (see also *Phil. Trans.*, A, 439-87, 1915, and *Proc. Roy. Irish Acad.*, A, 35-57, 1916). The fact that the lifting power of an aeroplane is greatly improved if the wing is not flat but "cambered," so as to be slightly concave on the lower surface and considerably convex on the upper surface, has long been made use of in practical aeronautics. On the other hand the investigation of the discontinuous stream-line motion past such a wing has long defied analysis. Thus Greenhill in his report on the subject to the Advisory Committee on Aeronautics (Report 19), published as recently as 1910, limits himself explicitly to plane barriers, or combinations of plane barriers. H. *Levy* (*Proc. Roy. Soc.*, A, 285-304, 1916) showed how to extend the classical work of Kirchhof and Rayleigh to curved boundaries. Leathem's method consists in discovering conformal transformations applicable to curves by extension of and analogy with known cases.

The practical problem of finding the resistance to motion through a medium is, however, best solved experimentally, and the work of Eifel, Dines, Bairstow and others has been mainly instrumental in supplying the information upon which the successful conquest of the air has been based. The hydrodynamical calculations are bound to lose in practical value because of the abstract nature of the problem when simplified into something that can be attacked by present mathematical analysis, since viscosity has to be omitted in general. We must wait till we learn more concerning the nature of the viscous forces in simple types of motion in a gas or liquid. We note that Guillet (*Comptes Rendus*, 33-5, 1918) has investigated experimentally the viscosity couple in the case of a lamina endowed with oscillatory rotation in its own plane.—*Science Progress.*

The Sizes of Cells

W. BROTHERTON and H. H. Bartlett have studied the variation of the size of the epidermal cells from the stems of Phaseolus (*American Journal of Botany*, April, 1918) in light and darkness. They emphasize the importance of comparing those cells which occupy corresponding positions on the curves of variation. The work of G. Kraus and MacDougal has shown that in etiolated plants the increased length of the internodes is mainly a result of an increase in the length of the cell units, though in part an outcome of their larger number. The present authors find that under constant conditions variation in length of the internodes appears to be associated mainly with an increase in the number of cells. The effect of light is regarded as directly or indirectly to retard cell division. There is apparently a physiological limit to the size which a primary cell can attain without undergoing division. In each internode there was an increase in the size of the cells from the base upwards till a maximum was reached followed by a diminution, at the top of the internode, which however was not so great as at the base.—*Science Progress.*

Artificial Gravel

IN one of the Southern concrete shipbuilding yards all conditions were favorable except that there was no rock or gravel at hand, and concrete is not to be made without it. Sand was there in abundance and so was clay, but mud ships have not yet been accepted as reliable carriers on the deep seas.

Clay is curious stuff. Chemically speaking it is a mixture of hydrated aluminum silicates with impurities in great variety. Its geologic history, however, is often more important than its exact chemical composition, for the conditions under which it has existed for the preceding hundred thousand years or so have a great bearing upon the size and structure of its particles; and in practice the physical nature of the particles of a substance has a great deal to do with its chemical behavior. The children of Israel needed straw to make brick, not that the straw fibre should serve as a binder, but because of a colloidal substance contained in straw which caused the particles of defective clay to bake into first quality product. It was a mean trick of the Egyptians to withhold straw and it was bad manufacturing practice, too.

Research with the Southern clay showed that if it is fixed at the proper rate and temperature very hard and porous lumps of the desired size result. Concrete made with them has practically the same crushing strength as that made with crushed rock. So proper apparatus was installed and the product used as aggregate. Owing to its porous nature it is very light, but the completed ships stood up to all the tests and proved to have a carrying capacity compared to dead weight clear above that of wooden or other concrete ships and nearly equal to those built of steel. A standardized contractor without the aid of a good chemist would have moved the yards or imported gravel.—*Little Journal.*