ese hugoys, a carp-like fish six to twelve inches long.

Other interesting novelties of this animal's paradise include a playground for children, where they can disport themselves in gymnastics or games of all kinds. To provide further amusement for young and old, Mr. Hagenbeck has arranged for a number of elephants, dromedaries, camels, small ponies, and zebras to be

available for rides. When the writer left the park, arrangements were being made for the erection of a group of native villages. They will be populated by races from all parts of the world.

As to the animals in this wonderful zoo, to give an idea of the number of beasts seen there, one has only to add that it is the largest collection ever got to-

gether. At the time of the writer's visit there were 53 lions in the park, 7 Bengal tigers, 4 snow leopards, 4 Indian rhinoceroses—an animal which has not been in the market for twenty-five years—3 African elephants, 9 baby elephants, and other wild beasts more or less in proportion. Indeed, the value of the animals alone is put down at \$250,000.

INDUSTRIAL USES OF CASEINE.

THE FUTURE OF A STRANGE SUBSTANCE.

BY D. SIDERSKY.

In the former system of butter making, based upon the process of hand skimming, a buttermilk having a considerable alimentary value was obtained and could

ine produced by the latter process is the most desired. Generally we treat the skimmed milk with sulphuric acid added in the proportion of 10 parts at 66 degrees

circulating by means of an air-fan. The drying takes place at a rather low temperature, about 50 deg. C., and it is completed at the end of 24 hours. The dried caseine is passed into a roller mill and the powder thus obtained is sifted or bolted according to what kind of final product is desired. To obtain a very pure caseine, some manufacturers first free the skimmed milk from the small quantity of fatty matter which it contains by rendering it alkaline by soda and passing it into the centrifugal machine.

Caseine is found in commerce in different degrees of purity, according to the industrial uses for which it is desired. Dr. Fascetti has analyzed a great number of commercial caseines, determining the water, nitrogenous matter, non-nitrogenous organic matter, and ash, decomposed into their respective elements, phosphoric and sulphuric acids and lime. He finds that the amount of water varies from 6.10 to 12.30 per cent, and the ash from 1.22 to 7.58 per cent. Similar variations occur for the other elements. Thus the albuminoid matters vary from 70.31 to 84.76 per cent and are always below the total quantity of organic matter. His analyses give the following average for industrial caseine: Water, 10.20; organic matter, 85.45; ash, 4.35 per 100 parts, counting albuminoid matter, 75.65; nitrogen, 12.12; phosphoric acid, 1.90, and lime, 1.88. A high proportion of ash is not always taken as a drawback and for certain uses such as the manufacture of lactite, a caseine rich in mineral matter is preferred. On the contrary, the presence of certain organic elements such as milk sugar favors the decomposition of caseine on account of fermentations which occur. As industrial caseine does not become soluble except after a certain preparation, that is, the hydration by means of alkaline or alkaline salt solutions, some of the German and Dutch establishments deliver soluble caseines of variable composition to commerce, which are richer in water and mineral matter than the usual kinds. The commercial value of a caseine depends upon its purity, that is, the proportion of albuminoid matter, determined by an analysis of the nitrogen.

Uses of Caseine.—The adhesive properties of caseine are utilized in a great number of industries of which we may mention several. In the paper industry, adhesive matter occupies a prominent place, for uniting sheets of paper in the desired thickness, for preparing a determined form from a mass of paper, or for coloring or varnishing objects in paper so as to protect them from dampness. For all these uses we employ caseine

THE POLAR BEARS' DEN, SHOWING ALSO THE POND FOR SEALS AND SEA LIONS.

be well used in the preparation of certain cheeses on account of the fact that a certain amount of fatty matter remained in the skimmed milk. The use of such buttermilk was made easier, seeing that butter was generally made on the farm and small quantities of milk were used. With the introduction of centrifugal apparatus for mechanical skimming and the development of the butter industry which concentrated the work in special factories and operated on large quantities of milk, the problem of utilizing skimmed milk became more complex. The skimmed milk of the centrifugal apparatus, which contains only two parts in one thousand of fatty matter, is no longer good for the manufacture of cheeses, and the large quantities now produced could not all be absorbed by feeding stock. For this reason, manufacturers had the idea of extracting albuminoid matters or caseine from the skimmed milk, whose proportion was almost as high as that of the fatty matter of fresh milk.

The caseine industry commenced in the United States about fifteen years ago. Owing to the success of the trials made for substituting caseine for gelatine in the preparation of sized paper, the new industry developed rapidly, on account of the low price of milk in the great cattle raising centers. Soon the American manufacturers began to introduce a part of their production upon European markets, where the home production was just commencing, and thus put a drawback upon the new industry by lowering the prices. In France, the production of caseine commenced about 1897 and developed quickly. But soon the price of caseine fell from 120 francs the 100 kilogrammes (\$0.53 per lb.) to 70 or 80 francs (\$0.30 to \$0.35 per lb.) on account of American competition. Statistics show in fact that the imports of this product increased considerably from 1898 to 1902. Considering that this was a drawback to the butter industry, the legislators in France established a duty of 20 francs minimum and 30 francs maximum per 100 kilos of caseine (\$0.08 to \$0.12 per lb.), and this duty was applied since June 24, 1905. On this account the industry developed under better conditions in France, and it is even exported at present.

Extraction of Caseine.—The different processes of extraction of caseine from milk are based upon the precipitation by acids, and it is but seldom that the method of pressing is used. According to the quality of product which is desired, we make use of sulphuric or hydrochloric acid, or the lactic acid which is formed spontaneously in the milk by fermentation. The case-

strength diluted in 50 parts of water, for 5,000 parts of skimmed milk, previously heated to 47 or 48 deg. C. The coagulation takes place at once, and by means of a thorough stirring, the caseine precipitates in rather large flakes. After a short settling we siphon off the whey as well as possible and then wash the curds in cold water to take off all traces of acid. When the water is removed, the caseine is placed in cloths which are folded over, and it is put under hydraulic pressure. This further purifies the material, which appears as a soft white mass resembling lightly-wet cotton well packed down. The mass is then ground up and spread upon metallic gauze frames which are superposed in a wood drying chamber having a current of hot air

PORTION OF THE PUBLIC DINING ROOM AT HAGENBECK'S ZOOLOGICAL PARK. ANIMALS' HEADS ARE USED AS DECORATIONS.

THE COMPLETION OF CARL HAGENBECK'S NOVEL ZOOLOGICAL PARK.

which has been previously made soluble in slightly alkaline water. By adding a small amount of formic aldehyde to the caseine solution and varnishing objects with such solution, they are made impermeable by a simple exposition to the air. In this way are prepared waterproof boxes, and washable paper collars, etc. With paper pulp soaked with a caseine solution we obtain vessels of different forms and sizes, trays for photography, etc., which are made waterproof by means of formol. For stereotype use such paper is employed; and it is light and durable. Thus it will be seen that there is here a wide field of usefulness for this product.

The wood-working industry also uses caseine, either as an adhesive matter or for conglomerate matter. For gluing boards, using a high pressure and heat, a liquid adhesive compound is prepared with caseine, slaked lime, and silicate of soda. The same liquid serves as an agglomerate for the masses which are prepared with sawdust to which different kinds of matter is added, and this is compressed in molds to obtain artistic reliefs. Messrs. Rauppach and Vogel prepare a special glue for wood by mixing wet caseine with ammonia so as to give a gelatinous consistence. The surfaces to be joined are spread with this glue and are allowed to dry for a few minutes, then they are moistened with milk of lime, when the surfaces are joined and are given the proper pressure. After a few minutes the desired effect is obtained and the wood block thus formed can be worked.

Glues made with caseine mixed with lime, plaster, etc., give a series of varnishes which are very resistant to heat and moisture. They can be used to cover walls, for filling holes in vessels and giving tight joints for boats.

Caseine is used to advantage for painting, and the processes employed vary with the requirements. For instance a mixture of equal parts of powdered caseine, slaked lime, and resin is made, adding a solution of zinc sulphate or aluminium and 5 or 6 per cent of Meudon whiting. This gives a very durable paint which can be colored as desired by the addition of mineral colors.

In the textile industries, caseine is used as a mor-

dant for tissues, and it replaces gelatine to advantage in treating tissues. In lace manufacture and tissues of high value, caseine is substituted for white of egg. The same is true for the preparation of glazed paper, where the use of caseine makes the polishing of the surface easier and gives better impressions. For enameling of positive photographic papers, hydrated caseine is used to advantage, and 33 parts of it are mixed with 4 parts tribasic phosphate of soda and 100 parts water. To obtain a photographic emulsion, caseine is dissolved in water containing a little citric acid, with glycerine added.

Plastic Matter.—Caseine dissolved in alkaline solutions serves for agglomerating the residues of different industries, such as powdered cork, with which varied objects are made. In such objects there is, however, but little caseine, but even here the consumption of the product is appreciable owing to the great development of these industries. Other kinds of plastic matter are prepared directly with caseine mixed with various chemical products, and serve to imitate marble, ivory, onyx, etc. These materials are designated under the names lactile, galalith, etc. They are almost unchangeable, inodorous, and incombustible. By working them in the lathe a variety of objects are made, such as billiard balls, buttons, umbrella handles, combs, napkin rings, etc. To prepare the lactile, hydrated caseine with a little water added is mixed with one or more of the following substances: acetate of lead dissolved in acetic acid, alum, borax, copper sulphate, soap, gelatine, talc, tannin, starch, coloring matter, etc. The whole is mixed for three-quarters of an hour in a special apparatus so as to give a homogeneous mixture, heating slightly at the same time and drawing off the liquid which separates. When the mass comes to a pasty consistency, it is put in a centrifugal dryer, then finally dried and sometimes treated with formic aldehyde. Lastly, the mass is compressed in a hydraulic press so as to form it into slabs. Sometimes the product is run into molds so as to form small objects or ornaments.

To make transparent objects, it is necessary to first prepare a clear solution of caseine. According to M. Spittler, this is secured by dissolving the caseine in

water containing a little caustic soda and adding successively in small quantities a 5 per cent soda lye, which gives a bulky precipitate. This deposits rapidly and is separated by filtering. From the filtered liquid the caseine is thrown down by a little acid, and it is washed in cold water until it is neutral. Caseine thus treated gives clear solutions, and it serves as the starting point in the manufacture of galalith.

Use of Caseine for Clarification of Wines.—Albuminoid matters are added to inferior wines in order to clarify them by forming a tannic precipitate which draws down all the mechanical and bacterial impurities. The substitution of caseine for white of egg has been the subject of exhaustive researches made by the eminent French chemist M. Münz. Among the different varieties of commercial caseine, he prefers the kind which is prepared by the Hatmacker process, which is very white. It is dissolved in tepid water in the proportion of 5 or 6 per cent. The amount used is 5 or 6 grammes per hectoliter of red wine (75 to 90 grains per 26 gallons) or 4 grammes for white wine (60 grains). The clarification is excellent and the decoloration is but slight. As to the cost, it does not exceed \$0.01 per hectoliter of wine.

While the use of white of egg is five or six times as much, Dr. Fascetti, who has specially examined this question, recommends the use of a weaker solution of caseine, not exceeding 3 per cent, and prepares it as follows: Powdered caseine is sprinkled with water heated to 40 or 50 deg. C., and the caseine becomes hydrated and swells up, then it dissolves entirely, forming a white opalescent liquid. After cooling, it is added to the wine and the whole is let stand for one day. A fine precipitate is formed, which deposits rapidly, giving a good clarification, and the color of the wine becomes brilliant. Dr. Fascetti found by experiment that for an initial acidity of the wine representing 5.47 parts in 1,000 (expressed in tartaric acid), the clarification by caseine gave a diminution of 0.74 part, on account of the precipitation of a certain quantity of tannin. With more concentrated solutions, the clarification does not succeed as well and the color is changed.—A paper read at the second Congress of Milk Industries, Paris, France.

THE AEROPLANE. THE LAWS UNDERLYING ITS PHENOMENA.

TEN or fifteen years ago authorities writing on the subject stated that if only it were possible to make engines so light as to weigh but 10 pounds per horsepower, there would be no difficulty in constructing a flying machine. A few years after, petrol engines were made of such a weight. To-day they are made, and on the market, weighing no more than 2½ pounds per horse-power!

Skeptics used to say that it would be impossible to raise a large apparatus off the ground by engines and propellers. To-day this has been accomplished, not once, but on many different occasions. They also urged that, once in the air, it would be impossible to balance the machine in steady flight. Now, although this has proved somewhat of a stumbling block, we hear of men maintaining themselves for half an hour at a time in mid-air while being propelled along at a great speed. Many have declared the landing would be a difficulty, but, even without considering these recent flights, we know that thousands of glides have been made with man-carrying gliding machines that have almost always ended satisfactorily.

It is necessary for those who would design an airship—and many minds are now being concentrated on that objective—to make some study of the principles of aerodynamics. The science of aerodynamics, that is to say, the study of the reaction of the air on bodies moving through it, has only recently been seriously taken up. It is now pretty well decided that the pressure (in pounds per square foot) exerted on a surface moving against the air is somewhere about 0.003 times the square of the velocity in miles per hour. It has been proved that the size and shape of the body may make some difference in the relative pressure per square foot, as may the velocity when considering very high speeds. What we are now considering is the pressure developed on a plane surface moving at right angles. But when this surface is inclined, other complicated calculations come in.

Chanute, summarizing the conclusions of many experimenters, has shown that the formula of DuChemin, $P = 2P' \sin \alpha \div (1 + \sin^2 \alpha)$, is probably about correct, as the proportion between P , the pressure on an inclined surface, and P' that on the surface if placed perpendicular, α being the angle of inclination of the surface.

But, even with such formula before us, it is by no means easy to calculate what speed must be given to an aeroplane in order to support a given weight. Theoretically this can be done straight off, but in practice it is different.

Let us start by taking a flat piece of paper. If this be held horizontally and dropped, it ought, according to theory, to fall directly downward at a given rate. Now see what happens. It is evident that, drop it as carefully as we like, it will always start swaying about and moving from side to side till it falls over. In looking for a cause for this, we find a fact, which has been investigated by Langley and others, that with an inclined surface the center of pressure is not in the center of the surface, but toward its front edge, and that the more the surface is inclined, the further, up to a certain point, does this center advance. This is known as Joëssel's law, his formula being $C = (0.2 + 0.3 \sin \alpha) L$, when C equals center of pressure, L the length from front to rear, and α the angle of inclination.

This being the case, it is easy to see that directly our sheet of paper while falling moves toward one side or other (and as its edge offers so little resistance it is very liable to do so), then instead of meeting the air at right angles, as in falling perpendicularly, it meets it at an angle.

But by Joëssel's law the pressure will then advance toward the front, instead of being in the center of the surface, and this must cause the advancing edge of the paper to turn upward. When the paper is thus tilted the center of pressure moves back, and the paper will tend to resume its former position. So we obtain a swinging pendulum action which increases more and more.

If we take an oblong piece of paper, narrow in proportion to its length, this action becomes so intense that the paper when dropped will spin rapidly about its longer axis. On trying different shaped pieces of paper, we soon find several facts. The narrower the paper in proportion to its length, the faster it spins. We also notice that such an arrangement falls comparatively slowly to the ground. But we also may note that it always falls at a fixed angle. The narrower the paper the steeper the angle of fall—about 45 deg.

Now, if we want the paper to fall steadily it will be found that, unless we suspend a heavy weight below it, it is necessary to let it fall sideways—by arranging the center of gravity toward the leading edge. Then the paper will fall in an inclined direction as before, but if the weight be on the center of pressure as shifted it will fall steadily at the given inclination. However, this shifting of the center of pressure is, as we have seen, dependent on the angle of inclination. Taken as a general rule, we find experimentally that if the center of gravity be at a

point just about one-third (but more correctly 0.3) of the width of the paper, the latter will glide down fairly stably. Working this out by Joëssel's law, α should equal nearly 30 deg. Here is a piece of paper to which a string is attached exactly one-third across from the edge. It is so weighted that when suspended by this string it hangs just horizontally; on starting this with a slight push forward it will glide nicely through the air.

But this gliding is not well explained. One might have expected this paper to fall down at an angle of 30 deg., whereas what it does is, after falling a certain distance and getting up a certain speed, it goes horizontally and even rises in the air. This, again, is due to the pressure coming gradually more to the front as the speed increases. And I have here another model which may seem at first to show some inexplicable effects. It is usual to consider an aeroplane as a plane surface driven against the air at a certain definite inclination, which results in a certain pressure on the under surface. In fact, it is considered to be precisely the same action as that of the wind on a kite. But now in this case you may observe that there are three planes one behind others, each of which is set at a small negative angle—that is to say, each plane points slightly downward. Yet, on pushing this forward, it will be seen to travel horizontally and even to rise. This would seem to imply that it is not necessary for the air to impinge upon the under surface, but that some action is caused on the top of the plane.

Another point, which we find by experiment, is that narrower planes are more efficient than wide ones.

Another important fact in aerodynamics, unknown till Langley demonstrated it some fifteen years ago, is that a plane surface propelled horizontally through the air will fall more slowly than one falling vertically without progressing. This fact may sound peculiar, but it is easily explained. With the falling plane, the air is pressed away from the under surface and has to find its way round to fill the vacuum which would otherwise be formed above. This takes time, but before the requisite time has elapsed, the plane has moved forward and has a fresh lot of air to deal with. Langley only experimented on speeds up to about 45 miles an hour, and it would be very instructive to know what the results would be at higher speeds. This is a very important law as affecting aerial machines—for it implies that by traveling very quickly we can obtain great lifting power. The discovery of this law is one of Langley's great achievements.