The experiments which we have been considering compare favorably as to methods and care with previous experiments of the same sort; and it does not seem unwarranted to conclude that those, also, are subject to errors of somewhat the same magnitude. It appears plain that we can, with proper care, determine the digestibility of the total ration fed with a very satisfactory degree of accuracy; but it seems equally plain that we cannot compute from that result the digestibility of any single fodder composing the ration with the hope of obtaining any thing more than approximately correct figures. The data which we have for the digestibility of the concentrated fodders are of more or less value for practical purposes, since they are usually the average of several determinations; but for scientific purposes such determinations are of very doubtful value.

H. P. ARMSBY.

AN ANTHROPOMETRIC LABORATORY.

IN the February number of the Journal of the Anthropological institute of Great Britain and Ireland, Mr. Francis Galton describes the laboratory which he established at the International health exhibition to familiarize the public with simple methods of measuring and recording many of the physical characteristics of man. The instruments in action dealt with keenness of sight, color-sense, judgment of eye, hearing, highest audible note, breathing-power, strength of pull and squeeze, swiftness of blow, span of arms, height standing and sitting, and weight. Some other apparatus not in actual use, such as a balance to determine delicacy of touch, was exhibited.

All these instruments were so contrived as to economize the time of the attendant; so that, although each person measured was in the laboratory about twenty minutes, he consumed but seven minutes of the attendant's time. Thus it was possible to measure ninety persons daily, and cover the running expenses of the laboratory with a tax of threepence each. Of course, the reduction of expense to a minimum gives a much broader field for work, especially in introducing periodic systematic measurements into schools, which is one of the ultimate objects of this demonstration.

Keenness of sight, or power of accommodation of the eye, was measured by means of an original instrument of a flat, sickle-shape, upon which were set upright, at regular intervals, small blocks of wood, covered below with printing in diamond type, and having printed at the top in large type the distance in inches from the eye-piece. The number of inches at which the diamond-type is legible is an expression of the accommodating power. This test showed, that, of 850 persons, forty per cent had both eyes equally effective, while sixty per cent had a notable difference in the power of the two eyes. The average difference between the two eyes was two inches; but the average strength of the right and left eye was almost exactly the same. The color-test was Holmgren's light-green test, nicely arranged to economize time. Judgment of the eye in dividing a line into halves, and in setting a movable arm square upon a board, were tested in ingenious ways, which doubtless among children would express the native quality, but oftentimes among adults would be only a measure of facility acquired by occupation. The highest audible note was measured by five whistles, set to emit 10,000, 20,000, 30,000, 40,000, and 50,000 vibrations per second respectively. Of 317 males between forty and fifty years of age, a hundred per cent heard the first whistle, to four per cent who heard the last. In this, as in every other particular, the males excel the females.

The spirometer used consists of a counterpoised vessel suspended in water, which rises as air is breathed into it, and shows the number of cubic inches of displacement by a scale at its side. The breathing-capacity increases rapidly in early youth, becomes stationary between twenty and thirty, or a little later, and thenceforward steadily declines. Up to the age of twenty, the breathing-capacity has been the same for both sexes; but at that age that of the males becomes half as great again, — a ratio which is maintained throughout after-life. Unexpectedly, it appears that there is no close relation between the breathing-capacity and the strength of pull or of squeeze. The latter, which were estimated by means of Salter's instruments for the purpose, show that the left hand is about six per cent weaker than the right, and that women are weaker than men. Of the 1,657 adult women measured at the laboratory, the strongest could exert a strength of squeeze of but eighty-six pounds, or about that of an average man.

For the first time, swiftness of blow was measured, either of a blow delivered with the fist straight at a pad upon one end of a flat bar running freely between guides, or of a pull, by holding a stirrup attached by a string to a similar bar, and striking out into space. The swiftness is registered by means of a spring with pencil attached, which is set free, and vibrates transversely as soon as the bar begins to move. The results of this measurement are not discussed.

A curious fact, which came to light on comparing the height sitting with the height standing, is, that in women an increase in stature is accompanied by a disproportionate increase in the length of the legs, while in men, for all statures up to six feet, the ratio between height sitting and height standing is the same, 54 : 100.

During the continuance of the laboratory, 9,337 persons were measured, of whom 4,726 were adult males, and 1,657 were adult females. The results of all these measurements are not fully discussed, nor has Mr. Galton perfected his ideal of a laboratory. Among other measurements which will be added to the list, are those of the head, its maximum length and breadth with graduated calipers, and its maximum height above the plane which passes through the upper edges of the orbits and the orifices of the ears. Mr. Galton adds, that while writing his account, instruments for head measurements were being solidly constructed for him, which will be in use in Cambridge, Eng., in 1885.

THE STATUS OF AERONAUTICS IN 1884.

DUROY DE BRUIGNAC, member of the French Société des ingénieurs civils, has recently presented to that association a very complete yet concise *exposé* of the present state of the art of aeronautics, especially as related to the general system of 'dirigeable' aerostats. The first indications of success are assumed to have been given by the experiments of Giffard (1852–55), Dupuy de Lôme (1871), and Tissandier and Renard and Krebs (recently). The first condition is considered to be stability, retaining the relative position of parts seen in the earlier balloons.

Giffard, in his earliest attempts, attained a speed of three, and later of four, metres per second. Dupuy de Lôme, and Renard and Krebs, have used better forms of balloon, and have secured more rigidity of structure; but none have obtained high speed.

Extreme lightness of motor is a vitally essential feature; and the best that has yet been done is illustrated by the steam-engines of Thorneycroft, weighing about 33 kilograms (73 pounds) per horse-power, and which, by sacrificing economy of fuel, it is thought possible may be reduced to 20 kilos (44 pounds), and the various storage and other batteries yielding electricity, which, according to Tissandier, may be reduced to a weight not exceeding 25 kilos (55 pounds) per horse-power. Messrs. Renard and Krebs claim a weight as low as 17 or 19 kilos. The experiment of Tissandier in 1883, in the application of electricity to this work, is thus expected to lead to useful results.

The propelling instrument is always the screw. Its position is a matter of importance. As usually arranged, it has a tendency to cause vertical deviations of the machine, which are objectionable. It is hoped that it may prove possible to place the screw-shaft in line with the axis of symmetry of the balloon, in order to avoid this difficulty. This may be done by setting it between a pair of spindle-shaped supporting balloons. It is uncertain whether it will be found best to place it ahead or astern of the balloon; but it is presumed best at the stern. The screw is objectionable on the score of its low efficiency, — about 0.30 (?); but nothing better has yet been devised.

Bruignac proposes a formula by means of which to calculate the resistance of the aerostat, and by its application determines the relative resistances of the machines of the several aeronauts whose work has been mentioned, as follows: Giffard, 1852, 0.076; Giffard, 1855, 0.035; Dupuy de Lôme, 0.18; Tissandier, 0.12; Renard and Krebs (1), 0.12; Renard and Krebs (2), 0.02. In the last two cases, the large and the small ends of the vessel are calculated separately.

The speeds actually obtained by them were 5.5 metres per second by the last named, and from 3 to 4 metres by their predecessors. Had the former driven their machines with the small end ahead, instead of the larger end, as actually practised, the critic calculates that they might have obtained a speed of nearly ten metres. A symmetrically formed cylindrical spindle is advised as the probably best form for the body of the air-ship, inserting a straight middle body when constructing very large vessels. The larger the machine, the lighter, comparatively, will be the driving machinery. The substitution of supporting hoods, sheets, or tissues, for cords, may assist in the endeavor to reduce resistances. The loss of gas by leakage can be reduced by choice of proper material for the balloon. The waste of gas in ascending and descending must be avoided, and may, perhaps, be obviated altogether. This becomes an easier matter in ascents of the kind here contemplated, in which no greater height will be sought than is sufficient to clear obstacles safely: probably a hundred metres will prove ample. For such work, the alternate compression and expansion of the adjusting volume of gas will probably suffice.

The conclusion is reached that the art of aerostation is much nearer a practically applicable state than scientific men generally suppose. The objects now sought are the attainment of better and more stable forms, the more effective arrangement of parts, the invention of lighter motors, invariable in weight, and convenient of operation, and the securing of higher efficiency of propelling instrument. Even now, with the experience of the past, it is possible to build a machine of this class capable of making at least ten metres per second through the surrounding medium.

These conclusions of Bruignac are especially interesting when compared with those of Pole as presented to the British institution of civil engineers, in which he finds that the supporting-power of the balloons adopted by the aeronauts above mentioned, and the driving-power and weights of the torpedo-boat engines of British makers, are such as should permit the construction of an air-ship four hundred feet long, to travel at the rate of thirty miles an hour.

R. H. THURSTON.

FINDING A BORE-HOLE.

Two novel and ingenious methods of locating the position of a bore-hole have recently been described in the London *Engineering*. In the first case, at Edinburgh, it was desired to connect the lower end of a bore-hole, two hundred feet deep, with a well some eighteen feet distant. A drift run in the supposed direction failed to strike the hole, although much rock was cut away, and it was evident that the drill had deviated considerably from the vertical. After an unsuccessful attempt to locate its direction