is simply by sliding the rings to which they are attached at either end, along the rod which passes through them. It is easy to arrange a more delicate method of effecting this if desired. Hitherto I have snipped out the notches in the cards with a cutter made on the same principle as that used by railway guards in marking the tickets of travellers. The width of the notch is greater than the width of the wire by an amount proportionate to the allowance intended to be made for error of measurement, and also for that due to mechanical misfit. There is room for 500 cards or metal strips to be arranged in sufficiently loose order within the width of 30 inches, and a key of that effective length would test all these by a single movement. It could also be applied in quick succession to any number of other collections of 500 in each.

Measurement of Profiles.—The sharp outline of a photograph in profile admits of more easy and precise measurement than the yielding outline of the face itself. The measurable differences between the profiles of different persons are small, but they are much more numerous than might have been expected, and they are more independent of one another than those of the limbs. I suspect that measures of the profile may be nearly as trustworthy as those of the limbs for approximate identification—that is, for excluding a very large proportion of persons from the possibility of being mistaken for the one whose measurements are given. The measurement of a profile enables us to use a mechanical selector for finding those in a large standard collection to which they nearly correspond. From the selection thus made the eye could easily make a further selection of those that suited best in other respects. A mechanical selector also enables us to quickly build up a standard collection step by step, by telling us whether or no each fresh set of measures falls within the limits of any of those already collected. If it does, we know that it is already provided for; if not, a new card must be added to the collection. There will be no fear of duplications, as every freshly-added standard will differ from all its predecessors by more than the specified range of permitted differences. After numerous trials of different methods for comparing portraits successively by the eye, I have found none so handy and generally efficient as a double-image prism, which I largely used in my earlier attempts in making composite portraits. As regards the most convenient measurements to be applied to a profile for use with the selector, I am unable as yet to speak decidedly. If we are dealing merely with a black silhouette, such as the shadow cast on a wall by a small or brilliant light, the best line from which to measure seems to be B C in Fig. 8; namely, that which touches both the concavity of the notch between the brow and nose, and the convexity of the chin. I have taken a considerable number of measures from the line that touches the brow and chin, but am now inclined to prefer the former line. A sharp unit of measurement is given by the distance between the above line and another drawn parallel to it just touching the nose, as at N in the figure. A small uncertainty in the direction of B C has but a very trifling effect on this distance. By dividing the interval between these parallel lines into four parts, and drawing a line through the third of the divisions, parallel to B C, we obtain the two important points of reference, M and R. M is a particularly well-defined point, from which O is determined by dropping a perpendicular from M upon B C. O seems the best of all points from which to measure. It is excellently placed for defining the shape and position of the notch between the nose and the upper lip, which is perhaps the most distinctive feature in the profile. O L can be determined with some precision; O B and O C are but coarse measurements. In addition to these and other obvious measures, such as one or more to define the projection of the lips, it would be well to measure the radius of the circle of curvature of the depression at B, also of that between the nose and the lip, for they are both very variable and very distinctive. So is the general slope of the base of the nose. The difficulty lies not in selecting a few measures that will go far towards negatively identifying a face, but in selecting the best—namely, those that can be most precisely determined, are most independent of each other, most variable, and most expressive of the general form of the profile. I have tried many different sets, and found all to be more or less efficient, but have not yet decided to my own satisfaction which to adopt.

A closer definition of a profile or other curve, can be based upon the standard to which it is referred. Short cross-lines may be drawn at critical positions between the two outlines of the standard, and be each divided into eight equal parts. The intersection of the cross-lines with the outer border would always count as 0, that with the inner border as 8, and the intermediate divisions would count from 1 to 7. As the cross-lines are very short, a single numeral would thus define the position of a point in any one of them, with perhaps as much precision as the naked eye could utilize. By employing as

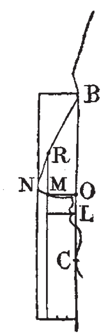

FIG. 8.

many figures as there are cross-lines in the standard, each successive figure for each successive cross-line, a corresponding number of points in the profile would be accurately fixed. Suppose a total of nine figures to be given, together with a standard collection of under a thousand doubly outlined portraits, each with six cross-lines. The first three figures would specify the catalogue number of the portrait to be referred to, and the remaining six figures would determine with much accuracy, six points in the outline of the portrait that it is desired to describe.

I have not succeeded in contriving an instrument that shall directly compare a given profile with those in a standard collection, and which shall at the same time act with anything like the simplicity of the above, and with the same quick decision in acceptance or rejection. Still, I recognize some waste of opportunity in not utilizing the power of varying the depths of the notches in the cards, independently of their longitudinal position.

I shall have next to speak of other data that may serve for personal identification, and especially on the marks left by blackened finger-tips upon paper.

(*To be continued.*)

SOAP-BUBBLES.

SOAP-BUBBLES fill the same happy position as do those charming books in which Lewis Carroll describes the adventures of Alice, in that they serve equally to delight the young and to attract the old. Clerk-Maxwell has mentioned the fact that on an Etruscan vase in the Louvre are seen the figures of children amusing themselves with bubbles, while to-day the same subject is being forced on the attention of the world by a strange development of modern enterprise. On the other hand, the bubble has occupied the minds of scientific men of all times. Sir Isaac Newton, Sir David Brewster, and Faraday, not to mention many others, devoted themselves to the soap-bubble as a means for investigating the subtleties of light. Plateau a few years ago delighted men of science with that wonderful book in which he, a blind man, expounded, in the clearest and most elegant manner, the result of years of labour on this one subject. Lately, Profs. Reinold and Rücker have employed the soap-film in investigations which tend to throw more light on the molecular constitution of bodies. These experiments will be remembered by all who saw them as being no less beautiful than instructive. The latest experiments with bubbles, which were shown by Mr. C. V. Boys to the Physical Society and at the Royal Society *conversazione*, and of which a full account is to be found in the May number of the *Philosophical Magazine*, depend upon no property which is not well known, and, unlike those referred to above, are not intended to increase our scientific knowledge; and yet no one would have ventured to predict that bubbles would submit to the treatment described in the paper, or would have expected such simple means to produce such beautiful results.

The first property of the soap-film turned to account is that strange reluctance of two bubbles to touch one another. Just as a bubble may be danced on the sleeve of a serge coat, or even embraced, without wetting the sleeve or being broken, so can two bubbles be pressed together until they are materially deformed without really touching one another at all. One bubble may be blown inside another, and if the heavy drops which accumulate at the bottom are removed, the inner one may be detached and rolled about within the outer one; or the outer one, held by two moistened rings of wire (Fig. 1),

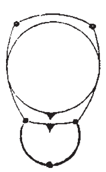

Fig. 1.

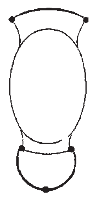

Fig. 2.

may be pulled out so as to squeeze the inner one into an oval form (Fig. 2), or may even be swung round and round, and yet the inner one remains free and independent, and when the outer is broken it floats gently away. If the inner one is coloured with the fluorescent material uranine, it shines with a green light, while the outer one remains clear as at first, showing that there is no mixture and no contact.

When the inner bubble is blown with coal gas, it rests against the upper side of the outer one (Fig. 3), pulling it

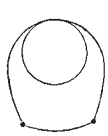

Fig. 3.

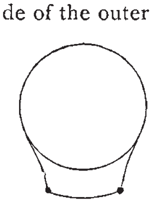

Fig. 4.

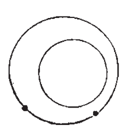

Fig. 5.

more and more out of shape as its size increases (Fig. 4). It can even be made to tear the outer one off the ring to which it was attached, after which the two bubbles rise in the air one inside the other. The outer bubble may be held by a light ring of thin wire to which thread and paper are attached, and then when an inner bubble of coal gas is blown, it will carry up the outer bubble, ring, paper, and all; and yet, in spite of this weight pressing them together, the inner bubble refuses to touch the outer one. If a little gas is let into the outer of two bubbles, the inner one will remain suspended like Mahomet's coffin (Fig. 5).

Diffusion of gas through a soap-film is shown by lowering a bell-jar of coal-gas over a bubble in which a second one is floating (Fig. 6). By degrees the gas penetrates the outer bubble, until the inner one, insufficiently buoyed up, gently sinks down.

The heavy and inflammable vapour of ether is made use of to show the rapidity with which the vapour of a liquid which will mix with the soap solution will penetrate through the walls of a bubble. A large

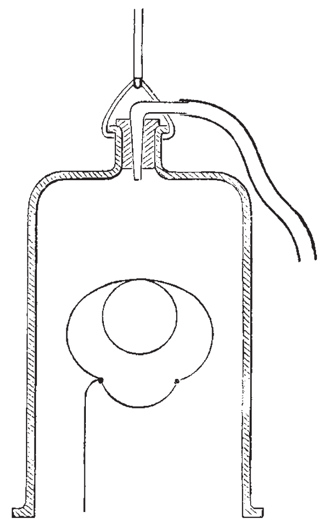

Fig. 6.

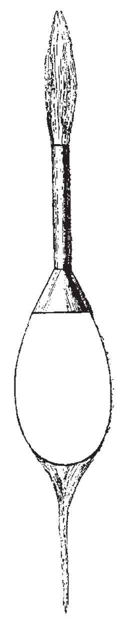

Fig. 7.

inverted bell-jar has some ether poured into it, after which bubbles blown with air in the usual way may be dropped into the jar, when they will float upon the vapour. They are then taken out and carried to a flame, when a blaze of light shows that the inflammable vapour has penetrated through the film. A bubble blown at the end of a wide tube and lowered into the vapour hangs like a heavy drop when removed; and if held in the beam of an electric light the vapour is seen oozing through the film and falling away in a heavy stream, while a light applied to the

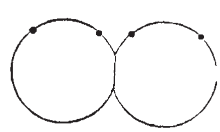

Fig. 8.

mouth of the tube fires the issuing inflammable vapour, and a large flame like that of a bunsen burner is the result (Fig. 7).

A variety of experiments are described in which bubbles are rolled along troughs made of soap-film—either straight, circular, or spiral—the prominent feature being that bubbles will roll upon or within one another as if they were made of india-rubber; they will even, where apparently in contact, take up the vibrations of a tuning-fork, and this will not force them to touch. There is one influence, however, which they cannot resist, and that is electrification. When two bubbles which are resting against one another (Fig. 8), provided that one is not within the other, are exposed to the influence of an even feebly electrified body, they instantly coalesce and become one (Fig. 9), and so act as a delicate electroscope. When one bubble is within the other, the outer one may be pulled out of shape by electrical action, and yet the inner one is perfectly screened from the electrical influence, thus showing in a striking manner that there is no electrical force within a conductor not even as near the surface as one side of a soap-film is near the other; for though the force outside is so great that the bubble is deformed, yet the fact that the inner one remains separate shows that the force within is too small to be detected. One of the experiments described shows at the same time the difference between the behaviour of two bubbles, one blown inside a third, and the other brought to rest against the third from the outside. Under these conditions, if electricity is produced

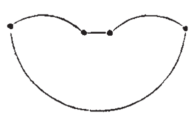

FIG. 9.

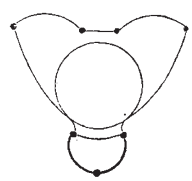

FIG. 10.

in the neighbourhood, the two outer bubbles become one, and the inner one, unharmed, rolls down and rests at the bottom of the now enlarged outer bubble (Fig. 10).

One experiment is described in which a cylindrical bubble is blown with oxygen gas between the poles of an electro-magnet. If the length is properly adjusted, the bubble breaks into two directly the exciting current is turned on, though the force due to the magnetic nature of oxygen is so feeble that not the slightest change of shape can be detected in a spherical bubble under the same conditions.

For other experiments and for details, readers are referred to the original paper in the *Philosophical Magazine*, the editor of which has kindly allowed us to reproduce the illustrations used in this article.

THE PARIS OBSERVATORY.

THE Annual Report of the Paris Observatory, which has recently appeared, draws special attention to the two events which have rendered the past year memorable, not merely in the history of the Observatory, but in that of astronomical science as a whole. The first of these was, of course, the meeting at Paris of the International Congress for the execution of the photographic chart of the heavens, and Admiral Mouchez gives the names of the members of the Congress, and the resolutions adopted by them. Of the Permanent Committee appointed by the Congress, Admiral Mouchez is himself the President, and he has already issued the first number of the *Bulletin de la Carte du Ciel*, future numbers of which will be brought out by the Committee as occasion may require. Twelve Observatories, including that of Paris, had definitely pledged themselves to join in the scheme, and five or six more expected to be able to do so shortly, so that there should be no difficulty in completing the chart within three or four years. The International Exhibition to be held at Paris next year would furnish a good opportunity for the reassembling of the Permanent Committee in order that the final decisions relating to the carrying out of this great scheme might be formed.

The other great event was the publication of the first two volumes of the great Paris Catalogue, the revision of the Catalogue of Lalande. This last work, which has already been referred to in NATURE (vol. xxxvii. p. 569), was commenced in 1855, but owing to many unfavourable circumstances has only been pushed forward vigorously during the last ten years, and now is all but completed. As the stars which still require observation have become fewer and more scattered, it has been found no longer necessary to devote more than one instrument to the work; the great meridian instrument has therefore been set apart for this work, and for the observation of minor planets and comparison stars, whilst the other meridian instruments have been left free for the careful study of the places of fundamental stars and for special researches. The "garden" circle has accordingly been used for the observation of circumpolars after M. Lœwy's plan, and the Gambey mural circle by M. Perigaud for the redetermination of the latitude of the Observatory. The value found for this latter by a series of *consecutive* observations of Polaris at upper and lower transit is 48° 50′ 12″·0, but Admiral Mouchez considers that despite the care and skill of M. Perigaud this determination falls short of the desired accuracy on account of the uncertainty of the corrections for refraction. This is partly due to the observations having all been made during midsummer, but chiefly to the bad position of the Observatory at the extreme south of Paris, the observations of Polaris therefore being made with the telescope pointed over the entire breadth of the city. It is hoped that the great Eiffel tower may render assistance to the study of refraction by affording much information as to inversions of the usual law of the variation of temperature with the height. The above value for the latitude still remains to be corrected for flexure of the instrument, and M. Perigaud is now undertaking the study of this error. The total number of meridian observations obtained during the year was 16,318, the highest monthly number having been secured in February, a most unusual circumstance. The observations of sun, moon, and planets amounted to 545.

The observations with the equatorials have been of the usual kind. M. Bigourdan has made 400 measures of nebulæ with that of the West Tower; and M. Obrecht, with the equatorial *coudé*, has made 720 measures of lunar craters referred to different points of the limb, in order to secure a better determination of the form of our satellite. But a yet more important work with this latter instrument has been the thorough examination of its theory by MM. Lœwy and Puiseux. In view of the success of the Paris telescope, of the number of similar instruments now under construction, and of the still wider popularity which the same form will probably have in the future, this was a work much to be desired.

The results, however, achieved in the field of astronomical photography are those in which, in view of the proposed chart, the greatest interest will be felt just now, and here the MM. Henry have further evidences of progress to present. Saturn and the moon have been photographed with a direct enlargement of 20 diameters. The phases of the lunar eclipse of August 3 have been recorded by the same means. With the smaller photographic instrument, aperture 4·3 inches, negatives have been obtained, one of which showed more than 30,000 stars on the single plate. Several curious new nebulæ have been discovered, one 1° in length near ζ Orionis; but the most remarkable have been those in the Pleiades. Two plates of this group, each with an exposure of four hours, have not only added much to our knowledge of the nebulæ round Electra, Merope, Maia, and Alcyone, these no longer appearing as mere faint clouds, but as well-marked nebulosities of intricate and complicated forms, but two new nebulæ are shown, both very narrow and straight, the longer one being some 40′ in length and but 2″ or 3″ in breadth, and threading together as it were no fewer than seven stars. The plate representing this photograph of the Pleiades, which is attached to the Report, shows 2326 stars, and comprises stars of the 18th magnitude, instead of the 1421 stars contained in the earlier photograph. MM. Henry have