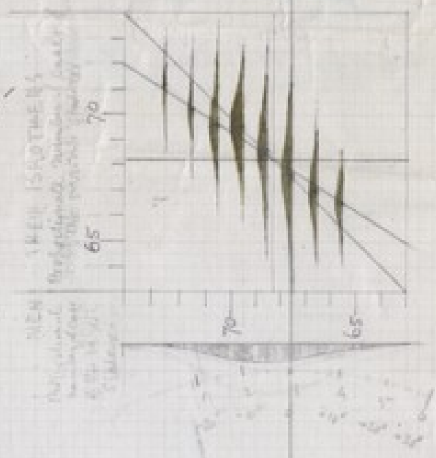
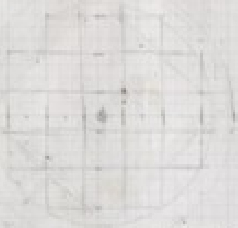
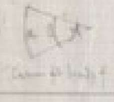
Resemblances





[illegible] squares whose sides are [illegible] the X–Y coordinates have their centres at positions mentioned below. These squares are divided into 25 [illegible] squares [illegible] are lettered as shown in the figure [illegible]



	Horizontal coordinal	Vertical coordinal
nose tip	−40	+44
nose root	0	+24
Chin tip	+25	−75

height of forehead = 60
Slope given to nearest 10° from −20° to +30

forehead slope
top of forehead
nose [illegible]
nose base
upper lip
[illegible] chin — 6 figures

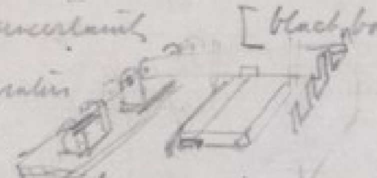
[illegible] nose tip
[illegible] nose root
Chin tip — 4 [illegible]

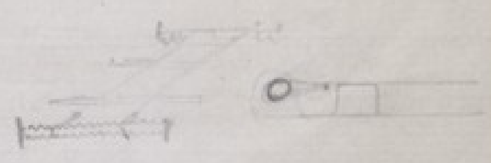
3 heads

Ressemblance

52r

1 Ova — chopped up
2 Eyes - [illegible]
3 [illegible] lying Bob. Herschel.
4 5 How to make digit marks [ink smoked paper chalk plastic casts wax sealing wax.] (these removed there)
6 Bertillon [Pictet]
7 Fringe of uncertainty [black board]
8 My apparatus
11 Mechanical searcher





12 13 Nature of resemblance — proportion of mistakes — faint light cause of it
14 Imagination helps — (im-perfect focussing)
15 (Gesture) / . Effect of angular size
16 Way the Eye travels over a face
17 Measure of resemblance [black board]
18 measure with reservations — Impossible to draw from verbal description
19 it gives negative evidence only — [Collection of portraits] not so very many are wanted really see p. 25
20 Profiles
21 Base & adjust — Types of face — circles of curvature
22 Slopes
24 Other measurements
25 Standard profiles (see p. 19)
from 5 Conclusion.

Identification Inclusion & exclusion.
Resemblance Inclusion & grades of Resemblance to indicating lines
Measure of Resemblance & [illegible]
uncertainties personal, angular size, focus, light — Average value in sharp focus fair light & of a given angular size

Every man carries in his person ~~numerous~~ independent & measurable evidences of his own personality. ~~by a They can be~~

~~The indications of personality are~~

~~Each~~ One person differs from any other in very many measurable particulars & ~~we identify~~ a person among ~~those identified by~~ is recognisable from amongst ~~if we possess the measures of many persons we are able by measurement to know~~ to ascertain whether or not ~~the measures of a given person correspond with those of any one of a group of persons whom we already possess~~ many others, by ~~his measures~~ measurement. The particular measures that ~~may be used are~~ most suitable ~~for the purpose~~ for identification and the ways of ~~selection~~ rapidly searching through a large collection to find the person to whom they correspond are the chief ~~subjects of the lecture~~.

The particulars ~~of~~ in which differences can be measured may be very minute, for example those that can be seen in the marks made by ~~a~~ slightly inked finger tips pressed upon paper. Sir W. Herschel used them for identification when acting as   at   in Bengal. He has kindly given me the ~~impressions of his own~~ the digit marks of the two first finger of his own right hand that were made in the years 1860 1874 1885 & 1888. respectively. Though 28 years have elapsed since the first & the last of them were made I can see no difference whatever between them. The ~~shape of~~ peculiar spiral form ~~in which the~~ taken by the little ridges studded with their pores is the same, ~~so~~ are the the places where fresh lines ~~began to show~~ appear themselves among ~~the rest~~ is the same both in distance & direction in all. ~~It is still~~ It is rather difficult to make perfectly clear digit marks but very easy to bring out the ~~furrows in relief~~ ridges on the living hand in relief by rubbing a ~~thick mixture of~~ little chalk and water mixed thickly into the furrows.

There are two ways of identifying a person. The direct way, by selecting the right one; the indirect way by rejecting the wrong ones. Direct recognition is instantaneous as soon as the eye falls upon the right person; the eye travels over his features with a rapid glance; they are recognised as familiar & the identification is concluded. In the indirect way we scrutinise all & ~~sort to one side~~ reject those that do not fulfill the requirements, which may be of any degree of stringency, and retain those that do. There is no certainty in identification by either method. Our fancied recognition may be wrong, and many persons may fulfil the specified requirements. The advantage of the second method is that it recognises boldly the fallibility of judgment & tells us precisely what value is to be put upon it. If it says for example that out of ten thousand men three ~~two~~ fulfill the requirements that is one of those precise facts on which the judgement confidently rests, but if the assertion is I am sure that the person I caught sight of was so & so, the assertion is of doubtful and unchecked value. ~~The bulk~~ of what I have to say mainly refers to indirect identification but I will preface it by a few words ~~about~~ that have some bearing upon the direct method.

Likeness & unlikeness exist as we well know in various degrees but I do not think any one has hitherto ~~yet~~ tried to ~~make a definite~~ measure their degrees. This I will now endeavour to do. Two objects resemble one another more or less according as we are liable on a hasty glance or under unfavourable conditions of any kind to mistake one for the other. If two portraits can never be distinguished, their resemblance is absolute; if they are never mistaken, their resemblance is nil, and there is room for any number of intermediate grades.

There is

F.G. 2a

There is no absolute standard of resemblance because one person may see a resemblance where another does not. He may have more familiarity with the portraits, or a better educated eye or superior natural keenness in estimating differences, and ~~Again his associations may be different and his attention thereby led to one part~~ There are other causes as well, into which I need not enter as they would lead me too far. On the other hand the mass of civilised mankind are sufficiently alike to enable us to speak of an average estimate ~~perception~~ of resemblance without ~~much~~ chance ~~of error~~. of much error.

In explaining a method of measuring resemblance or ~~its~~ conversely speaking ~~which is a more convenient method~~, of measuring dissimilarity, the simplest figures will suffice for illustration. & Take two superimposed ~~oval~~ rectangles of about the same area & call them A & B we will suppose their ~~to be~~ outlines to be perfectly distinguishable. Then draw a intermediate outline C. This we will suppose, is still distinguishable from A & B. Subdivide the space between C and either A or B, let us say, C & A ~~& C & B~~ again by an outline D, & repeat the process as often as necessary until the interpolated line is indistinguishable from A. ~~They~~ This may be considered to ~~be the~~ occur when both lines are contained within a belt of one 1/300 three hundredth part of an inch. This belt is itself an exceedingly fine line such as the ordinary eye cannot divide. ~~When this limit~~ It is reached in all cases after a moderate number of subdivisions

f. 5 3. a.

The first subdivision halves the original distance, the second quarters it, the third reduces it to one eighth, the fourth to one sixteenth, the fifth to 1/32nd, the ~~sixth~~ one 64th part and so on, in leaps, at the ninth it is ~~[illegible]~~ less than one four thousandth part. ~~& so on~~. These ~~[illegible]~~ form, what I call, successive ~~so many~~ grades of dissimilarity

~~B~~ 18

Next suppose one of the rectangles to have some peculiar addition or subtraction, say a deep notch cut out of it, then we may if we please estimate the resemblance exclusive of the notch, we should in this case say that one of the rectangles has a deep notch in such & such a part, but that in other respects there were only two grades, or whatever the number may be, of dissimilarity between them. So it is with profiles; ~~[illegible]~~ we may either treat them as a whole & specify the number of grades of dissimilarity, or we may make certain reservations & specify the number of grades in respect to the remainder of their outlines ~~with regard to their [illegible]~~.

It is absurd to ~~suppose~~ believe in the possibility of so describing a face by words or figures that a likeness could be drawn from the description. We know only too well that eminent painters & sculptors who are gifted by nature and professionally educated, make frequent failures in catching those subtle traits by which likenesses are chiefly perceived. ~~They moreover sometimes make drawings that are~~ ~~It is absurd to suppose that a face could be~~ On the other hand there would be no difficulty in specifying one ~~[illegible]~~ out ~~three~~ of a collection of portraits drawn with ~~[illegible]~~ lines, between which the features of the person whom we wish to describe, ~~[illegible] the outline~~ lie. ~~& if the collection is large enough two may be selected that differ but little.~~

Grades of [illegible]

f.6 4.a.

It ~~will~~ is worth considering the ~~best~~ conditions for such a series. We will start from the basis of an interval of $\frac{1}{300}$ of an inch being just non distinguishable by the unaided eye. 15 of these intervals ~~make at~~ which is the number of subdivisions in the fourth grade make about $\frac{1}{20}$th of an inch. Therefore if the contour of a profile portrait be drawn with double lines $\frac{1}{20}$th of an inch apart the extreme variation of the various portraits that may be interpolated between those lines cannot exceed 4 grades of resemblance nor can any one portrait differ from ~~the~~ a medium line drawn half way between the two boundaries by more than 3 grades. This is what I propose to adopt.

Next as to the scale of the portraits. When some years ago I made a large number of experiments on composite photography I came to the conclusion that the smallest sized portrait that well expressed the features was about twice the size of the effigy on a penny. More precisely the scale I used & which still seems to me the best I could use, was such that the vertical distance between the pupils of the eyes & the parting of the lips was 4 tenths of an inch. Taking these as fixed points no ~~human English profile~~ European profile that was not that of an idiot ~~or a~~ would differ from the medium profile by more than two tenths of an inch at any one point. That is by ~~about~~ $\frac{1}{300}$ ~~or~~ 60 subdivisions each of $\frac{1}{20}$th inch in width. 64 subdivisions is ~~arrived at~~ reached at the sixth grade. Therefore no portrait could differ more than six grades from the median portrait. As we are to be content with a resemblance to 3 grades, ~~it is clear that~~ we may be assured that ^no^ very large collection of standard portraits would ~~not~~ be required ~~there~~ for the purpose of a rough ~~statement~~ description of the ~~main~~ character of the face. A simple catalogue number ^not exceeding 3 figures^ would be all that was wanted to express this.

~~Every person bears a stamp of individuality in~~
Every one is stamped throughout with the marks of his own personality. ~~They exist as~~ We know inferentially that they exist in completeness in single cells for it is from single cells that every organised being is derived; ~~and~~ they are so small in the case of man, that if we take Dr. Allman's estimate of their ~~magnitude~~ size as given by him in his Presidential Address to the British Association in 18 . at Bath I find that ~~the weight of~~ 4 million of them, or more than those from which the entire population of the British Isles must have originally sprung ~~would go in an~~ might be transmitted by post for a penny, yet every one of them contains all the family likenesses & the ~~[illegible]~~ other natural peculiarities that ~~the~~ each individual is destined to show. ~~Again we see peculiarities in~~
Of the way in which they are packed in so small a space, it is almost needless to say that we ~~know~~ know nothing, they are ultra microscopic, undefinable by their effects on the comparatively coarse vibrations of which light consists. We can only acknowledge their existence and admire & pass on.

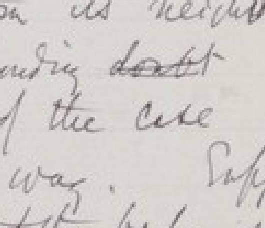
~~In the next stage~~ ~~another~~ a much larger stage, ~~there are the features of structure that~~ ~~most clearly distinguishable~~ ~~which we can see by an ordinary microscope or to examine the eye~~ the naked eye, or with the aid of a common lens, that are ~~patent~~ & ~~apparently persistent.~~

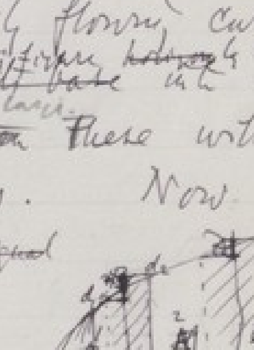
~~In~~ The structure of each individual, shed as ~~it can be~~ seen in sections under a microscope is different in details from ~~one another~~, ~~but the same~~, and it is reasonable to believe that those details would be ~~from what I shall have directly to say~~ are to a great extent persistent. They have never so far as I am aware been ~~[illegible]~~ regularly examined into so I will say no more about them except one ~~[illegible]~~ sentence to show how large is the number of such sections each of which, or ~~a few~~ at all events a few of which ~~would~~ might identify an individual. The little calculation is ~~on~~ based on the data that the ~~beautiful~~ little instrument called the microtome chops up ~~the~~ structure much as we cut a cucumber with a knife but on a beautifully methodical principle into little films of less than $\frac{1}{2000}$ of an inch thick & say $\frac{1}{8}$th of an inch square, each suitable for microscopic examination. Again that a man of a little more than . . stone ~~[illegible]~~ contains cubic inches of material, reckoning the weight of flesh as a little greater than that of water. ~~Consequently~~ It follows that the man would yield such slices, of which I will ~~not say~~ am far from saying that every slice ~~[illegible]~~ but that a small selection of them would suffice to identify him among many others

It will be most convenient to pass from the minute characteristics to those on the largest scale leaving what has to be said about the countenance till the end. Men differ measurably, [and largely,] in ~~the~~ the various proportions of their body so that the records made at an Anthropometric laboratory of different persons are rarely alike. An adult can be identified by his measurements with considerable accuracy; while and conversely, ~~it is possible in most cases to prove~~ the measurements suffice in most cases to afford conclusive & useful negative evidence by proving that a person is not the man whom [supposed] he may ~~incorrectly~~ have been suspected to be.
This fact has been turned to account in France in a very ingenious way, by M. Alphonse Bertillon for the identification of criminals & deserters. ~~There~~ An Office is established in Paris called . . . .

(Go on for some 10 minutes, then fiches)

Although I have no experience of my own of the rapidity with which M. Bertillon's system works and although both he & M. Topinard who is the first French authority on anthropometry ~~matters con~~ are both ~~perfectly~~ satisfied with ~~it concurrent~~ it does not seem to me as perfect as it might be. The three fold classification may be ~~very~~ convenient theoretically speaking but it is a barbarously rudely ~~off hand~~ way of dealing with the infinite variety of nature. ~~and Each~~ Also there must be also a fringe of uncertainty about the lines that separate the medium class from its neighbours on either side, ~~that would lead to~~ and a corresponding ~~doubt~~ uncertainty in ~~irregularity~~ of classification. The state of the case admits of precise statement in the following way. Suppose the measures taken of ~~the~~ any particular part of the body, say of the head length, to be ~~arranged at~~ represented by lines ~~of~~ and that these lines are arranged vertically side by side at equal distances apart between such limits as are convenient for a diagram. Then the lines will form a dense palisade as it were whose upper boundary is a smoothly flowing curve of the shape shown in the figure. Divide this figure ~~its base lengthwise~~ by vertical lines into three ~~equal~~ portions of equal breadths A B & C, small middle class ~~then~~ These will be ~~the ideals~~ of M. Bertillon's three classes. Now let the possible error that has to be provided against ~~allowed for be equal to ± x in every observation case~~ be equal to r ~~Then the fringe of uncert~~ Draw horizontal lines from AB+r & AB−r till they cut the curve at D_1, D_2 & thence drop verticals on to the base. The width of ~~& shade~~ the shaded space between them ~~bears~~ is the ~~same~~ fringe of uncertainty between classes I & II, and the number of the cases that fall within it, bear the same proportion to the whole number of cases, that its width bears to that of the entire figure.

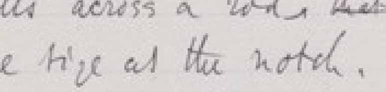




A similar construction shows the width of the fringes between Classes II & III. Owing to the approximate symmetry of the figure the two fringes are at least approximately equal in breadth.

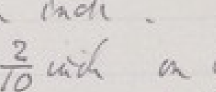
= It may be said that the accuracy of observation by skilled operators is so great and the changes in the person operated on are so small within any moderate number of years, that the fringe of uncertainty is too narrow to deserve much consideration. I can not agree with this view, but if it be true it shows that the delicacy of measurement is in large part unutilised by the rude process of classification. There is a dilemma; either the measurement of the same man by different operators after an interval of a few months or years can be relied on to agree within narrow limits, or they cannot. If they can be relied on then no adequate use is made of the delicate measurements by the rude system of classification into 3 groups. If they cannot be relied upon then the fringe of uncertainty is of perplexing width.

But is it necessary to make any classification at all? I will show that it is not & that we may identify a measures by means of a mechanical method which is quite independent of classification. [illegible] arm [illegible] pivotted at one end [illegible] & a notch in its lower edge falls across a rod whose section is of the same size as the notch. If the rod is adjusted properly the notch in the arm will fall astride the rod; otherwise the arm will rest on the rod. Or if we wish to make provision for some inaccuracy of adjustment we make the notch in the arm wider than before & it will still fall astride of it unless the limits provided for the uncertainty of adjustment are overpassed. In this rod the distance



of the notch from a particular mark on a perpendicular is the length of head of a particular person as measured at a specified time by a specified operator. He is measured on a second occasion by another operator. And the rod is set in the same way at a similar distance from the [illegible]. The arm is then let fall upon the rod & although the distances may not be exactly the same the play in the notch is sufficient to admit of its straddling across the rod. There is no question here of classes, it is merely a question whether or no the second measurement approximates to the first one within the limits that we choose to allow for inaccuracy. If it does, the arm subsides, if it does not the arm remains tilted up upon the rod.

✓ We will next deal with two elements at a time as Head length & Head width. We mark out two spaces on the arm to correspond to these two respectively and ~~divide~~ graduate them to suit. It appears from the measures made at the Anthropometric Laboratory I have now established at South Kensington in connection with the Collection of Scientific Instruments in the Western galleries, that graduations ranging from 7.1 inch to 8.0 inclusive in the one & from 63 to 73 in the other, will contain nearly all the cases. So by adding an extra ~~another~~ graduation at either end in each of them to take in the large ~~highly~~ exceptional instances that are too rare ~~to be worth~~ ~~we shall which it~~ ~~that they may be clubbed together~~ ~~is unnecessary to allow for in detail~~, we ~~find~~ obtain the requisite range. ~~In this card I allow an~~ I have graduated this strip of cardboard ~~with larger figures on a bold~~ scale to explain ~~clearly~~ the process.



Now the allowance for error that I will make is ± $\frac{1}{10}$th of an inch. Consequently the breadth of the notch would have to be $\frac{2}{10}$ inch on the supposition that the rod is a mere edge; as it is not, but is about half a tenth thick we must add that half tenth to the width of the notch making a total of 2½ tenths or ¼ of an inch. The cutting pliers that I hold, ~~are~~ such as ticket collectors use ~~on~~ railways. These ~~cut~~ snip out a notch ¼ inch wide & ½ inch deep. So in these graduations I have kept to the ~~real size~~ exact scale. For head length, they proceed at tenths of an inch interval from 70 to 81 and for head breadth from 62 to 74. There is moreover a space of half a quarter of an inch on ~~either~~ the outer sides of the first & last graduations that will be snipped away when the pliers are applied opposite to them. The whole space taken up by each of the two elements is 11 tenths + ~~2½ tenth~~ 2½ tenths or ~~13½ tenth~~ 1 inch & 3½ tenths which is a little more than 1¼ inch. An allowance of 1½ inch for each ~~element~~ is ample. The action of this apparatus is very simple

When both notches fall astride the rod the arm subsides. If only one does or if neither does the arm remain on the tilt.

Allowing 1/2 inch for each element, an arm of 12 inches long would deal with eighteen elements, and if instead of using cards, strips of zinc [like the blades of [illegible]] machine made to the same size & their wards were neatly slotted out in arcs of circles, I see no reason why strips of [illegible] that size should not suffice. I have put together in the roughest manner different designs, sufficient to show the action of a machine that would at each stroke deal with 1000 measures. In a proper instrument the rods would be replaced by piano forte wire stretched across a series of parallel bars about 1 inch apart on which the wire would rest & by which it would be supported at short intervals. The adjustment of the wire can be effected in at least two ways, perhaps the best is by winding it round horizontal screws. When these are turned the wire travels horizontally. In the very rude machine I show, the strips or tumblers lie in compartments each of which holds a few of them loosely. If many stand packed in the same compartment or if they do not lie loosely side pressure produces too much friction & they will not act independently. Four inches is ample space to hold 100 strips side by side, together with their intervening septa. Consequently, if the frame that holds the piano forte wires has an effective length of 40 inches, it will deal with 1000 strips simultaneously at once. In the machine I show, you will understand how the tumblers can be simultaneously lifted, the key frame inserted & then the tumblers allowed to drop upon it. Any tumbler that subsides is easily seen & can be lifted up for examination with a pair of forceps. The fingers are too clumsy for this purpose. I can well imagine that by a machine of this kind say 10000 measures could be searched with great ease & rapidity and that objects such as that of M. Bertillon might be easily achieved. ~~When it comes~~ For larger numbers as the hundred thousand or a million, measures it is a very different matter

I have dwelt on this mechanical searcher not with immediate reference to criminal identification, which is out of my line but ~~with~~ rather with regard to what I have still to say about identifying features.

In what I am about to say I shall confine myself to profiles. They are sharply defined, as any one can see who watches the shadow of a man cast by a bright light proceeding from a small aperture upon a white wall

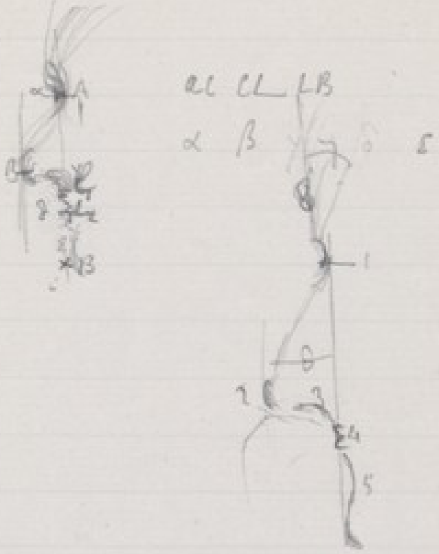
[Show on screen]

and they are full of character. It is much to be regretted that photographers do not take them more frequently than they do. The old fashioned silhouettes were very interesting & so are medallions & medals.

[: talk about my silhouettes]

It will be found on comparing portraits as I have done by the thousand in my experiments on composite photography that ~~the~~ as a rule they differ ~~distinctly~~ measurably but not much, ~~in many and in many~~ and that they differ in numerous independent particulars, but they do not differ much in any of them. ~~the measurement of the human body~~ There is no feature that I know of, which if measured ~~in~~ ~~from~~ on the portraits of many persons in the way I will shortly describe will not show ~~so much~~ sufficient variation to enable to us to assign ~~say~~ with certainty ~~that of~~ each individual portrait to ~~a~~ specified half of the entire series; it may be the ~~middle half~~ ~~or the~~ half the that has one third ~~one~~ or it may be that which has one quarter, or some ~~any~~ other specified fraction of the whole series of ~~the~~ portraits on one side and the residue on the other. But in any case we ~~shall~~ be able to sort out

not vary so much, that if we are given any one of the measurements ~~of any one them~~ we could not sort apart to one side at least a ~~full~~ half of the entire series and say with certainty that the portrait which is referred to was not included among them. If the instrument I described was adapted to be used with features, there would be many short sections in each ~~applied~~ to the group the notch would not have to comprise 1 the numbers & each section would be short ~~between to more than one half of the length of the section of the arm that was assigned to that measurement.~~ If there were 8 different measures made the instrument would distinguish between 2^8 or 256 portraits; if 10 were made it would distinguish between 1024. We will now go into details.



In what I am about to say I can only give the results of such trials as I have thus far made, and not a plan that commends itself as final. It is perfectly clear to me that the problem in view can be solved in many of the ways that I have tried in turn, but whether better plans than any of these cannot be suggested is quite another question. All that I aim at is to direct attention to the topic of identification especially by verbal description, in the belief that experience will gradually show the briefest & surest way of doing so among many alternative methods.

In measuring a profile we require a ~~scale and~~ a direction and a scale. I have tried many plans and find the best ~~to~~ direction is given by a line [that touches the concavity of the notch between the brow & the nose] and the convexity of the projection of the chin. Cases where doubt arises as to either of these points are rarer than in any others, unless it be that which touches the most projecting part of the forehead & the chin. I ~~began with the latter~~ have made most of my experiments with the latter but have now abandoned it in favor of the former. For scale I draw ~~the lines that~~ two lines parallel to this. The one that just touches the nose, the other that just touches the ~~most distant~~ free end of the little flap ~~of~~ that ~~[illegible]~~ more or less covers the orifice of the ear and is called the tragus, and take the distance between them for the unit of measurement calling it in each case 100. In a silhouette the ear is not given & then I take the ~~distance~~ between the inward border of the profile of the [illegible] [illegible] of the [illegible] [illegible]. In dealing with bearded faces the position of the chin must be guessed, a ~~slight~~ small error in the estimate is unimportant & will not sensibly affect the scale.

We can now proceed to measure as much as we like, having firm ground to go upon.

(1) In the first place however there is certain very distinct types of face. In one the brow & the nose form two nearly parallel steps ~~in~~ another the face is straight, in another the lower jaw falls ~~[illegible]~~ considerably behind the upper. When a face falls distinctly within any one of these or other recognised types it should be noted, otherwise nothing has to be said about it. In the ~~first~~ case a suitably disposed ~~notch~~ string in the key of the instrument will ~~deal with~~ select all the cases that are notched as ~~excluding all other that do not~~ belonging to that type. In the second case these string will be removed altogether from the key and there will be no selection at all in respect to type of face.

The ~~next~~ 2nd most characteristic part in a face which no fault of focussing can hide, is the depth & shape of the notch between the nose & lip. There are at least 5 different

(The ~~shape~~ length slope & shape of the lower part of the nose [illegible] involve 3 elements, the base of the upper lip & the radius of curvature of the junction between them, [illegible] 7)

peculiarities in this alone, every one of which admits of separate measurement and they are all independent of one another. ~~I am able to~~ ~~make directly, others indirectly.~~ Thus

one second measure (2) the average slope of the base of the nose, such as is seen in a silhouette, shadow, in which ~~is not~~ ~~regarding~~ the line of the nostril is not regarded. There is rarely any difficulty in roughly determining the angle of this slope ~~and sketches with of cases where the base is owing to an unusual curvature of~~ it is usually directed to the ~~tip~~ lower part of the lobe of the ear but its direction varies very much. The ~~corresponding~~ noted in the instrument ~~I should~~ need not cover ~~so~~ much as one third of the section assigned to this measurement. ~~It is hard to say~~ Artists appear to be very inexact in rendering this for I have noticed much greater uniformity in busts than in real life, and they are grossly wrong in some cases. I would especially mention the effigy of her majesty on the coins, which utterly disagrees in this respect with the photographs. In the coins ~~the~~ the line of ~~in~~ in question passed as much below the base of the lobe of the ear ~~at a distance about equal as far as I can judge to the entire vertical diameter of~~ as that base is below the tip of the ear whereas in the photographs. . . . A little inaccuracy is justifiable in artists, both for artistic effect & ~~to~~ emphasize characteristic features ~~points~~ but I see no excuse for such grossly unscientific rendering as this.

(3) The third measure is the curve in ~~between~~ ~~at the~~ ~~through~~ which the base of the nose ~~sweeps~~ passes ~~into downwards at the end~~ is joined to the upper lip. ~~It may be Success~~ Trials are to be made with different discs of known diameters and the one that best fits the curve is specified. If the portrait were of the natural size then in some cases a 5 shilling piece ~~half crown~~ or a still larger disc would fit it properly, in others a florin, in others a sixpence, in others a threepenny piece, ~~so~~ ~~it~~ in others a pencil held edgeways would suffice or even a knitting pin, in ~~some~~ others ~~there is no~~ the curve has no appreciable diameter at all but the base of the nose & the

upper lip when seen in profile, ~~meet in an~~ forms a sharp angle. The diameter of the circle ~~of curvature~~ which express the curvature should of course be specified in ~~scale~~ the units of the scale by which the portrait is measured, ~~that is~~ as in the scale I have described, when the horizontal distance between the nose tip & the distant spot the tragus of the ear counts as 100. The 4th & 5th measurements are the lengths of the base of the nose & of the upper lips respectively, which admit of being roughly determined

4. The horizontal distance between the standard vertical line and the parallel line that just touches the nose

5 ~~The vertical distance from the pupil of the eye or~~ ~~the~~ The horizontal distance between the ~~nose~~ brow notch & the front of the eye ball. I have notes kindly furnished ~~to~~ me by Messrs Pickard & Curry of their measurements for fitting spectacles [show my frame] In some persons the brow notch is so slight that the person ~~always~~ usually seems to present a profile ~~view~~ for even a 3/4 view of his face the projection of the root of the nose masks a perceptible portion of the ~~opposite~~ distant side of ~~the face~~ his features.

6 The horizontal distance of the upper lip at the point where the red begins & the standard vertical line.

7 The vertical distances from Pupil of eye or slit of eyelids to the point in the upper lips just mentioned

8 From that point to the corresponding point in the lower lip.

9 From the latter point to where the standard line touches the chin

10 ~~9~~. The general slope of the brow to the standard vertical

11 ~~10~~ That of the nose to the standard vertical.

¶ I fully acknowledge that these measures ~~are~~ do not give enough ~~to~~ materials to draw an outline but they would serve to distinguish any face from the rest in a somewhat large collection. ~~and~~ The question that I have not solved as yet is to ~~find~~ select as small a group of measures as possible that shall serve both purposes. ~~The one of identification the other of defining limiting [illegible] specifying~~ to arrange ~~one of~~ a well selected series of profiles severally drawn on the ~~small scale say of a medal~~ ~~(with a thick outline)~~ ~~and~~

The view I have for fulfilling the latter is to collect a series of well selected, standard profiles, each drawn with a ~~thick~~ double outline ~~and to determine that which so as to~~ & to be able to ~~specify, the one say~~ then by knowledge that the outline of the given portrait lies between the double lines of ~~any~~ a p

The view I have for fulfilling the latter is to gradually collect a series of standard profiles, each drawn with a double outline & having a register number. Then by saying that a given portrait would fall between the double lines of the standard, No. so & so, we obtain a first approximation to what we want to know. I have much reason to believe that a set of much less than 1000 standard portraits would ~~fulfill what is wanted~~ enable a likeness to be specified within ~~the~~ two degrees of resemblance that is to say, the double lines would be so near together, that it would not be possible to divide the interspace into four parts distinguishable to the naked eye at the ordinary distance of reading, the portraits being of the small size I spoke of namely $\frac{4}{10}$th of an inch from the eye to the mouth.

? end ~~[illegible]~~ with extract from page 5 f 20 12

~~The conditions under which~~ The varying conditions under which the same person ~~is liable~~ greatly to loses his ordinary ~~vary in the~~ accuracy ~~of his~~ in estimating of visual resemblance when the light becomes faint. It is an habitual act with growing when we want to ~~examine~~ read or examine anything, to take it to the window in a good light. As the ~~evening~~ night begins to closes in, the features of persons whose forms we still see plainly, become indistinguishable. The railings to the ~~street~~ area steps along the sides of an ~~stree~~ unlighted street merge into a uniform grey mass & it is curious ~~to watch them~~ on approaching them to note the suddenness with which they disentangle themselves. Again the same neighbouring railings that seem a grey mass to the naked eye by night, though they would be clearly ~~defined~~ distinguished by day, become again distinguishable by using an opera glass. The fact of their being magnified is an

f. 21

"advantage" more than equivalent to the loss of light due to ~~looking through~~ the use of ~~the~~ opera-glass ~~the glass instrument~~ whose glasses however clear they may be necessary obstruct or reflect back ~~in one way or another~~ ~~some of the direct passage to the eye of~~ some of the light that ~~fall would otherwise~~ falls upon them. The cause of this very curious phenomenon of indistinctness of vision at night has been ascribed by Lord Rayleigh partly to the ~~st~~ inaccuracy with which the eye is focussed in the dark, but I am sure there is a physiological cause in play as well. ~~For~~ In the first place, if ~~we~~ those ~~compare the views of~~ do not use the naked eye at all but look at the ~~railings~~ two sets of railings one rather near & the other further off we can focus the opera glass as we please & still the fact remains that railings which are distinguishable by a fair light cease to be so in the dark unless the intervals between them subtend a wide angle ~~in short unless they are~~. In the second place it is a fact common to all sensation that we have difficulty in clearly localising an only just perceptible (or its difference of stimuli) ~~sense stimulus~~. If we rest the point of a smallish pin ~~is allowed to rest lightly~~ upon the skin of a friend & he shuts his eyes ~~are shut~~, the sensation he will describe ~~is undefined~~ is blurred and undefined but if we give a poke with ~~the~~ point of the pin he will localise the ~~point~~ puncture with much precision. Or if we ~~paint~~ stain a portion of a surface with a slight excess of tint we recognise the fact that there is a stain but cannot easily trace its outline. When the ~~is little~~ difference of light is faint the contrast of tints diminishes rapidly, — the black still remains black but the white is decreased many thousand fold. ~~A very Even in air or the diffe~~

Thus a photographic plate which would take an image of a black profile on a white sheet of paper in a quarter of a second in the light of a clear day in the open air, would probably require ~~in~~ some ~~many~~ minutes ~~perhaps~~ or probably hours to be equally affected in a room so dark that the objects are barely distinguishable, & one hour contains 60x240 or 14.400 quarters of a second

Where the sense indication is so faint the power of the visual imagination grows in relative importance ~~makes itself largely~~ felt & our perception is compounded in part very unequal parts of fact & imagination largely of ~~but unconsciously of the latter~~. ~~One~~ I have endeavoured to measure the relative powers of the aural imagination & that of the sense stimulus, by finding the two distances ~~bound~~ at which a reader can be followed, the one ~~when~~ by the ear alone & the other by the ear aided by a book. The latter distance is when measured about 2 to 3 ~~at least double~~ that of the former. At a double distance the ~~ear~~ hearing ~~is only one quarter as distinct~~ × reduced according to the law of the inverse square which makes the loudness of the sound with these equal as 9 to 4. That is to say only half the loudness is necessary when I have the book before me as when I have it not. Therefore the aural imagination supplied about ~~3 times~~ as much as the aural stimulus. I cannot in the least ~~trace~~ distinguish in this case between the two, they are intimately blended. Most people must occasionally have observed something of the kind when they have a bad place in church and are listening to ~~hearing~~ the reading of the psalms ~~read~~ or the singing of the hymns, or if at a meeting when ~~sung at church~~, ~~or~~ a report is read ~~at a meeting~~. So long as ~~when~~ the book or printed sheet is before their eyes, they follow every word perfectly apparently by the simple act of hearing, but without the book they hardly distinguish a single word ~~nothing~~. The aural imagination has been excited ~~through~~ the sight & it unconsciously supplements the ~~ineffectual~~ hearing ~~power & makes a clear perception~~. Either by itself would be insufficient but the two ~~together~~ produce a distinctly audible ~~clear~~ perception. In tracing resemblances especially in faint light the imagination thus leads us frequently into mistake.

Another cause of resemblance being overlooked is from the eye not being sharply focussed on the person as when looking vaguely at the faces in a crowd. With outlines it is different. I have made ~~several~~ experiments with several profiles by photographing them when the camera is focussed to various degrees of inaccuracy but it is difficult to destroy their likeness. ~~In a full face view it is different because~~ the adjacent shadows blend together & the likeness usually is soon lost.

The last cause of failure in perceiving resemblance is due to the ~~object~~ person or portrait being seen so far off that it subtends but a small angle.

the features of the face are ~~the~~ with us the common f. 23 of 15
recognition. It is not so with savages & unclad persons who are ~~known more~~ recognized by their general shape of the whole body, which being a larger object* is more various with characteristic curves than the features of the face.

~~When a person approaches,~~ Let us suppose ourselves sitting on a chair in ~~Kensington~~ the park & watching the promenaders ~~and~~ to see the stages through which the lineaments of a person become distinct as he approaches us. I find that when he is 40 yards off I only see the shape of his face & the two blurs ~~which~~ that comprise respectively his eyes & eyebrows, and his mouth & the shade beneath his nose. At 25 yards or a little more the features rapidly disengage themselves and the ~~general~~ face is fairly well seen. ~~Few of us realise the smallness of~~ Now at that distance the face subtends an angle of half a degree which is that speaking roughly which is subtended either by the sun or by the full moon. In other words if a man were to stand on a hillock 25 yards off in such a position that either the moon ~~at moonrise or moonset~~, or the sun ~~at sunrise or sunset~~ was seen close to his shoulder, then it and his face would seem to be of about the same size. Or more roughly still, if we hold our little finger bent back at arms length ~~as~~ as far from the eye as possible, we find that it is large enough wholly to mask the sun or the moon & that its nail is of about the same apparent size. In other words a portrait painted on the finger nail viewed at arms length or one that we may imagine to be painted on the face of a somewhat dim moon is of the same apparent size as the face of a person at 25 yards off, at which distance his features begin to be clearly visible. If the face be painted on a very small scale as in an illuminated missal to be read at a distance of 12 inches then if it must be included in a space of one quarter the breadth of the little finger nail, or of about the size of a capital O in such type as novels are usually printed in in order to correspond with the magnitudes of which we have been speaking. The outlines of a face cut sharply out from a bright back ground would be clearly visible if on a still smaller scale. thus we may conceive 4 distinct silhouettes each thrown by some optical device on the face of the moon, as by reflecting them from the face of a piece of glass through which the moon is viewed.

As soon as the features become distinguishable the face ceases to be viewed in a vague way as a single object: the eye becomes sharply focussed upon some one point and the glance travels rapidly in a curiously irregular manner along the chief traits. This action of the eye becomes of course increased in amplitude & more marked as the person approaches & his face grows in angular diameter. I have often but with imperfect success endeavoured to recall of the path followed by my own glance, when I am not thinking about it & am simply trying to make out whether or no the face is known to me, I am conscious it is always the same, but it is travelled over with too much rapidity to [illegible] that the path in question leave a distinct trace on the recollection. My impression is that my scrutiny is fixed from the left eye of the person I am [illegible] horizontally to his right eye then back again to the half way point between them & down the nose to the mouth, then a quick short right & left movement & finally sweeps round the right half of his face. After this there is no regularity.

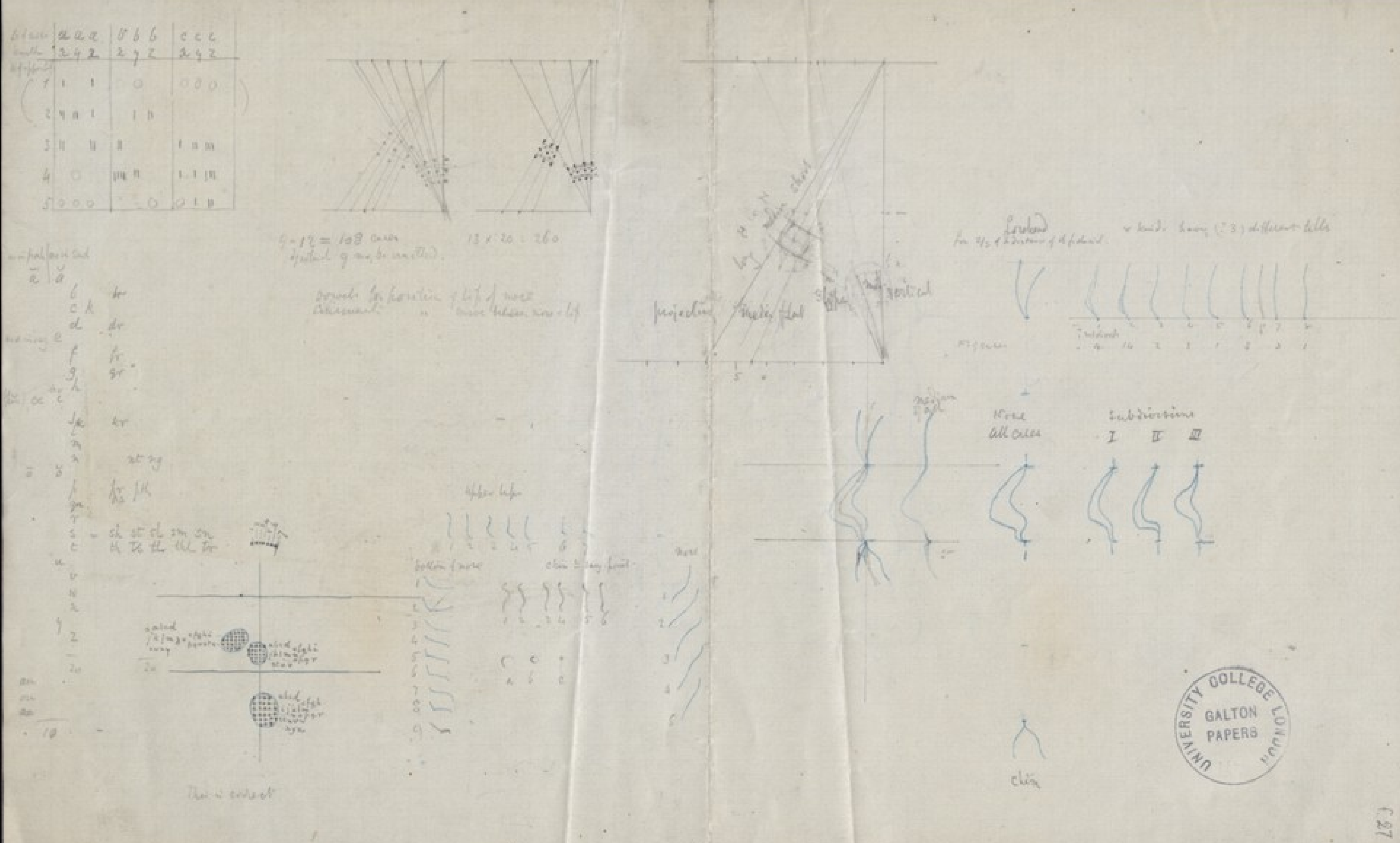
[illegible] in supposing that I always begin to look at [illegible] the same way & that others do the same [illegible] way, these minute movements of the eye [illegible] characteristic as hand writing

f. 25

We are, moreover, so practised in recognising objects seen in various degrees of perspective that we do so, almost without cognizance ~~unconsciously almost~~ of the ~~altered~~ deformation thereby occasioned. Thus, We ~~see~~ perceive at once that a table is not square from whatever point of view we see it although its image on our ~~the~~ retina is very far from being a square. We allow ~~unconsciously~~ for the deformation. Hence in comparing ~~one~~ a portrait with a face ~~much deformati~~ we may be satisfied with a resemblance although the vertical & horizontal proportions are on somewhat different scales

Some persons the prolonged line cuts the ear tip or even above it, in others it cuts the ear hole, in others the ear lobe in others a point below the ear lobe that may be estimated in terms of the length of the ear. The observation is rapidly made, & ~~perhaps~~ best when the person observed is at some little distance ~~because when and there are~~ in which case the actual base of the septum of the nose & the inner part of the nostrils merge into a ~~single~~ ~~line~~ bold line such as a person who was ~~making a~~ rapidly sketching a caricature portrait would represent by a single stroke. The ear may be divided by eye into 4 parts, namely the tip, half way between the tip & the ear hole, the ear hole & the lobe. Calling all above the ear tip by the figure 1, the other points ~~are~~ will be 2, 3, 4 & 5. & proceeding downwards on the same scale we ~~read~~ have the lower positions of 6, 7, 8 and 9. It is only necessary to mention one of these numbers in order to define with adequate precision the slope of the base of the nose.

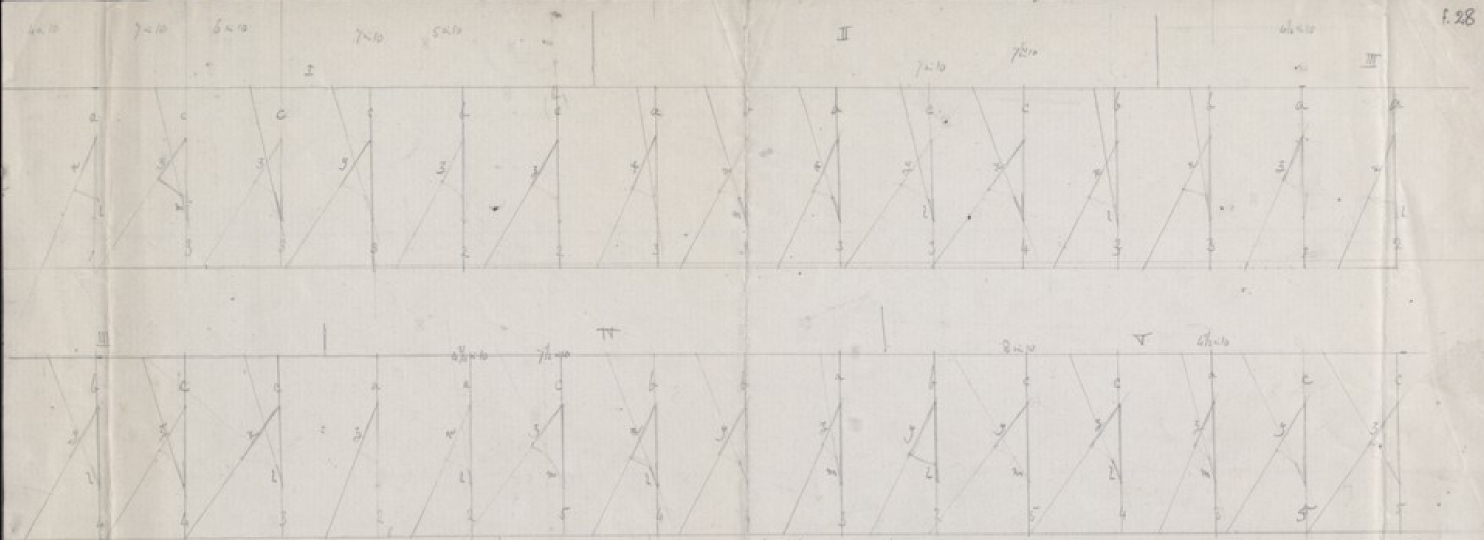
My object in ~~making~~ these remarks on personal identification & description is not ~~so much~~ to make any definite proposals but rather to turn the attention of anthropologists to a branch of their wide science which has been little investigated but which deserves & seems likely to repay investigation.

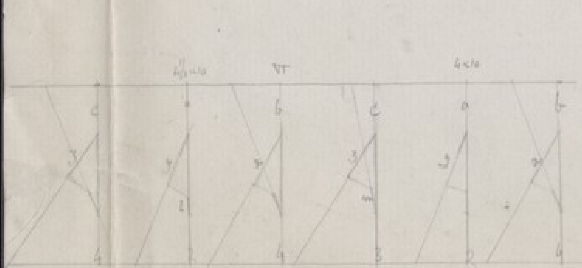


9 × 12 = 108 cases
13 × 20 = 260
projecting
median flat
vertical
Forehead
Nose
all cases
Subdivisions
I
II
III
Upper lips
Chin

127

f. 28



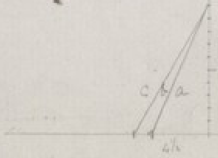


Length of nose		
[63]	40 & under	z
	more than 40 & less than 45?	y
[71]	45 & above	x

Length of upper lip		
[24] short lip	15 & below	l
medium	more than 15 & less than 20	m
[32] long	20 & above	n

Angle of nose projection

in 10 –	4½ and below	a	= 11
	more than 4½ & less than 6	b	= 11
	6 and above	c	= 14
			36



of the somewhat confused little triangle that occupies a position somewhat like that of the eddy which lies between the stream lines of two currents flowing from different directions. On first examining ~~the~~ finger marks I found my eye to wander not knowing where to fix itself, but after familiarising myself with the appearance of these furrow-heads I soon found myself able to find them with ease & assurance, in any impression, ~~it being understood that~~ if the impression is fairly clear & a suitable magnifying power is used. Their places can be pricked with a needle, & those who have no other convenient multiplying arrangement at hand, might interpose the pricked paper between the direct sunshine and a drawing board set parallel to it & make dots with a pencil at the places where the points of light fall. The relative positions of these dots are highly characteristic. In Fig 2 I have also given the shape of the whorls at their origin. These ~~have~~ may be of very different characters. Purkenje classifies them under 7 heads. These begin as single or as ~~double~~ multiple ~~spirals~~ loops, they ~~are~~ run in long loops ~~elliptical~~ or in ~~circular~~ regular ~~ovals~~ spirals and so on.

Go on = p 4

f. 30 1

here? : Words would describe

(Ryder Haggard or) Stevenson - can't describe. Description wanted for .... identification. &

Limitations of language — list of words — Police words

We recognise by individual characteristics what a man has different to all others & are very indifferent to [inserted above: both to size and] correct proportion - we see faces in many attitudes - we have acquired the art of instinctively accounting for the changes produced by perspective — shadows of a square & circle — could tell if a table were not true square or circle - Caricature.
Every man bears his signature — Cell from anywhere might (theoretically) produce the whole as a Begonia leaf

reflection in a spoon

Bearded walking in front. The very hat becomes part of the person - curve of brim alters with shape of head

2 to 1 against a Royal Academy picture being a fair likeness & totally 3 to 1 against a bust - The characteristic traits are very delicate usually, & very numerous. I don't attempt to deal with these; but as follows.

2 × 3 >

Meeting a person in a street when he is (120) feet off ~~in an~~ in an average murky London atmosphere

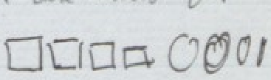
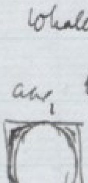
$1 \text{ foot} \times 60 = 1^\circ$ we see [only] the contours of his face and the blurs that indicate his eyes eyebrows mouth & shade below the nose

$\text{9 in} \times 60^{ft} = 1^\circ$

$8 \text{ in} \times 80^{ft} = \frac{1}{2}^\circ$ ~~this~~ at 80 feet - the face subtends ½° about, the same as that of the face of the full moon & this is

$\frac{1}{20} \times 60 = 3 \text{ in} = 1^\circ$, $6 \text{ in} = 1\frac{1}{2}$ the apparent size of the small letter O in ~~such print~~ at the ordinary reading distance of

$\frac{1}{15} \times 60 = 4$ such [type] ~~print~~ as novels are commonly printed in. If the outlines of his face & the markings in it were ~~sharp and~~ drawn in sharp black lines we should see them clearly enough even on so small a scale. Such lines drawn on the moon would be perfectly visible. But in a man's face they blend & are not distinct

I saw recently, I forget where, an assertion by some considerable authority that resemblance did not admit of numerical measurement, but I think I can show you that it does. Begin as it best with simplest case, a square (rectangle) & a circle (ellipse) 
Perfect resemblance is where one is as likely to be mistaken for the other as not. Probably no one can appreciate the difference between an index of $\frac{20}{19}$ & $\frac{20}{20}$. Whatever may be the limit, it is ~~quickly~~ soon reached by successive intermediate subdivision between any two notably distinct ellipses or rectangles, or even between ellipses & rectangles  & the number of these is a convenient measure of resemblance. A figure may have a marked characteristic e.g. a projection as in fig . The ~~easy~~ best way of dealing with this, is to describe it separately as a characteristic & then to deal with the rest of the figure as though it had been shaved away.

Another measure of resemblance when the objects ~~are nearly alike~~ differ only in petty irregularities is to find how much they require to be thrown out of focus & blurred so as to be indistinguishable. Each dot becomes a disc with ill defined margin, & partly owing to this want of definition & partly to the smoothing down of small roughnesses by the process the desired effect is produced. Thus a page of type becomes a uniform shade. But its range is small — no blurring can make 2 very unlike pictures alike

f. 32 3

A third means is by viewing the objects in a ~~obscure~~ faint light. It is very remarkable how ill defined the ~~margin~~ outlines become at night. Large objects can be seen clearly enough but small ones are blurred confusedly. Standing at night by the side of railings, the near ones are perfectly ~~well~~ seen but at a little distance they become confused. Then opera glass & the point of confusion is shifted to much further off — Ld Rayleigh - error of focussing (try with my Hi power glass) I think it has a more physiological cause & is analogous to the difficulty of defining the place of a very gentle touch. If the round ~~head~~ of a pin is gently laid ... then reverse it & press the point into the skin with emphasis & the subject will ~~unmistakeable~~ make no mistake

Imagination fills in — psalms sung & followed

Writing & gesture generally, smile - shine of face. presence. "Magnetic influence" manner (animals attracted)

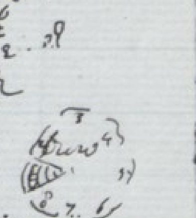
Hand impress

Smell Romance - a vast field of research untouched for want of osometers

Nigrescence - polarity

Voice & manner of speech & laugh

Profiles most distinctive. bother with men's beards & women's
top knots & bangs. Rough out a face & identify by that - not by delicate
shades. ~~Many~~ Range of possible variation in $\frac{1}{n}$th of British ~~mankind~~ say $\frac{19}{20}$ths
Like arms of a semaphore, many but each with small movement, and each
with a somewhat different shape. cut out ab. bc. &c each in sets or french curves round a card
with double lines within which the feature must lie
Shapes from sides & diminishing in sizes towards centre. ? 4 shapes × 4 sizes = 24 = letters each.
Also inclination to feature above.
Try for { their much which is visible in both bearded men & women. Also for {
A single feature when all else is masked, hardly suffices to ~~define~~ identify a well known friend.
? use my moth pentagraph. Pinhole camera for enlarging to uniform size.
Photographers getting a portrait of somebody like the ~~person~~ celebrity & selling it ~~for~~ as his likeness.
My lock & key arrangement applicable to faces, if they are translated into numerals. (?)



words that comprehend much. lanky. shindy

1 345

//

Hered : Identification

It is one thing to so describe a person that you shall recognise him at a glance, and another so as to be able by comparing himself study to know whether he is the same person as one already described. It is of the latter that I am going to speak. – only incidentally of the former

Each cell is characteristic of the individual, Begonia leaves, buds,
Each ~~square~~ minute plot of ~~section~~ the body each square inch of section

277 cub inch in 10 lbs water, 2770 in 100 lbs. suppose section of $\frac{1}{250}$ in

$250 \times 2770 = 25 \times 27700 = 100 \times \frac{1}{4} 27700 = 692500$ sq inch
27700

$x = \frac{1000,000}{692500}$

6.0000
5.8404

1/5 a man of 142.4 lbs weight (i.e. a little more than 10 stone) would cut ~~into 1.52 million~~ 1424 ~~sections~~, each of 1 square inch in area & $\frac{1}{250}$ inch thick

But we cannot cut up a man. Have only face & hands in a man exposed of - - square inches altogether & a good deal of that is covered with hair. In women much more of the person is exposed in ~~evening~~ full dress costume for evening parties than man. The word full dress is a misnomer it expresses the opposite – Strange fancies of what is decorum. Fancy a lady coming down in the morning with her dress cut to expose as much neck bust & arms as in evening, or imagine a man with a similar ~~costume~~ undress. What an outcry there would be. The fantasy of what is thought decorum or not is not easy to be accounted for

Even limiting ourselves to a study of the surface of the face & hands, ~~the~~ are differ-ences marked kind. I shall not dwell upon colour on the distribution of the veins visible under the skin nor on that of the hairs or down by which it is covered further than to draw attention for a moment to Eschricht's paper which deals of the extraordinary distribution of hairs over the body of a child some months before birth

[Hairs on fetus]

I should much like to make a photographic study of the markings of the iris – 1000s of eyes & can never match – difficult to photograph ?

[photograph of living eye]

Markings of the hand

[Whole hand with the large wrinkles]

[Whole hand with the rugae · Fig 29 Kollman]

Characteristic marks of the rugae – history of Purkenje on identification by – Sir W Herschel. Californian mem for persistence of in same man

[Sir W. Herschell, fingers]

[Californian mem &

Lying Bob]

Purkenje's divisions

[from Kollman [⌒ A &c]]

Shew how to make ink (copper ink) smoked paper wax plaster of Paris

F. 34v

Recognition by the gesture Birdwood

Recognition of a face at 40 paces

size ... medals fancy on moon

a sixpence at 7 feet is size L^r of D

Face is 7.5 or .8 inches in diameter
subtends ½ degree at 70 feet

Eyes shades of nose & mouth become confused

Shapes of color for [illegible] — colored bars of will annual

if eye not focussed sufficiently as

Start into definition rather suddenly.

?- Path of eye in scrutinising a face

? mirror or artificial eye. a 'signature'

of travelling speck on walls.

Different ways of different persons in looking for things

86 = 1.9345
sin 30' 7.9408
1/.075 = 9.8752

a 6^d = .75 inch about

x × .0087 = .75

x = 7500 / 87 3.8751
86.22 1.9395
1.9356

30 1 in at 30 ft
[illegible] 7.5 feet

log tan 31' =

natural tan 31' = .0090
diam sixpence = 0.75

x = .75 / .009 = 750 / 9 = 83.33 inches = 7 feet (84 = 7)

diam face = [illegible] 7.5 inches — [illegible] 86.3

Sixpence & Human face

natural $\left\{ \begin{matrix} \sin \\ \tan \end{matrix} \right\}$ $31' = .0090$

diam of sixpence = 0.75 inch

$x = \frac{0.75}{.009} = \frac{750}{9} = 83.33$ inches

= say 7 feet (7×12 = 84)

diam of human face in breadth and in length both = about 7.5 inches
∴ subtends 31' at 70 feet!

The 1/10 of a diameter of a sixpence = .075 inch of [illegible]

(A) Singularities. Characters

(B) Proportions & L^a

(A) — {a bust / b cut out faces

Transformation [throwing a profile on screen at O subtends 31' at 8.3 inches & take quickly the photo. and [illegible] at O at 12 inches or 1 foot

Full face & profile — silhouettes only — how to make them [? make one]

B. (Notch below nose) Depth & angle with vertical of face. [to see]
a ? nostril line of.)

		No. [illegible]	letters
25	Sets of bands each with ear hole marked	25	1
25	Sets of 5 lines (ear OC) radiating from ear hole ? 1, [illegible]	25	1
	A B shade 19 }	26	1
	b C d 16		
	d e 16 ?	26	1
	E F 10		

7 letters

4 groups each of 6 radiating lines [illegible] one

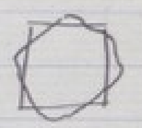
It is strange that we should not ~~yet~~ have acquired more power of describing Form, and of explaining in words what a person is like, so that we might be pretty sure that other persons should not be mistaken for him. For my own part, I have frequently chafed under the difficulty of defining hereditary resemblances and types of features, and in dealing with various outlines of an altogether ~~a~~ different character. At last I thought I would try to do what I could, to relieve myself from this embarrassment, and have taken very considerable trouble and made many experiments. The net result is that I feel satisfied there are many ways of doing approximately what I want but it is exceedingly difficult as yet to select the best & then with ~~sufficient~~ ~~[illegible]~~ assurance to ~~justify~~ ~~[illegible]~~ plan a plunge into ~~[illegible]~~ what would be a rather large undertaking. In this case according to the French proverb the better has proved to be the enemy of the passably good. So I shall give few details to night but dwell ~~principally~~ chiefly on general principles. I galmost hope you may be just a little and temporarily sated with the completeness with which ~~[illegible]~~ subjects are usually set before you in this place and may welcome for a change, a topic that is still imperfectly worked out but which has in this stage several novel points.

would be capable of telling by a single movement, whether the measures of a particular person were or were not contained in any one of many hundreds of cards: It made any desired allowance for inaccuracy of measuring. It bore some resemblance to the levers & their wards in ~~some~~ certain locks. Each card was a strip of some 10 inches in length and has notches to serve as wards along its lower edge. ~~all the cards were simultaneously~~ ~~It was dropped~~ It was allowed to fall across stretched wires that acted as a key. The ~~position of the~~ each wires in the key were adjusted to the ~~corresponding~~ measures of the suspected person. If the wards in any card ~~corresponded~~ fitted to the wires of the key that card fell lower than the ~~rest & was~~ others ~~others which were other~~ whose fall was checked by the wires. About 500 cards or their metal equivalents, could be easily contained within the width of 30 inches and the simultaneously raised & dropped ~~lowered~~ by ~~the same~~ a frame that turned on the same axis ~~upon which~~ as the cards ~~were moved~~

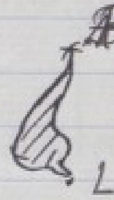
Measures made on a photographed profile ~~portrait can be used for identification~~, and those ~~very~~ very ~~precise owing to the the sharpness of the~~ its ~~edge of the photograph~~.

It seemed from experiments thus far, that the measurements of the photographed profile ~~afforded as~~ were very suitable ~~measures~~ for identification. The characteristic outline was perfectly sharp and a lines ~~existed the~~ can be found in it from which to an increase different degrees – but (Sully)

Resemblance – measure unlikeness
 Least discernible difference
 Easily applied to profiles & other sharp lines
 $\frac{1}{100}$ inch. = 1 grade of unlikeness
 Notch in one figure – reservation of it



Shape within which all human profiles fall
All of Lavater in this.
It later is only brow to lip. better to simplify



Vast number of possible outlines with just discer: diffce
Not many when diffce = 10 grades of unlikeness = $\frac{1}{10}$ inch

Draw such portraits broad outline middle line of no one [illegible] [illegible]. reduce all to a small & common scale. Standard collection
Length of contour ~~from~~ between B & L varies between assigned limits Take line BL = 3 inches or 30 tenths, contour from 34 to 44 tenths
Bend wires or peg cord
Catalogue numbers ~~written~~ not more than 3 figures: 5 grades of unlikeness to [illegible] be [illegible]
~~[illegible]~~ Value of this for excluding unsuitable mass.
~~Further a~~ Recognition of the right picture is one thing
  Exclusion of the wrong ones another
We must follow last plan of lying between specified limits – is our only way.
Too much tendency to dwell on characteristic points & neglect rest
Must train eye to take in many particulars
Absurd to suppose from verbal description paint portrait
But Painters blunders.

Possibility of further approximations

Trouble of finding the proper portrait in collection got over by my apparatus described further on.

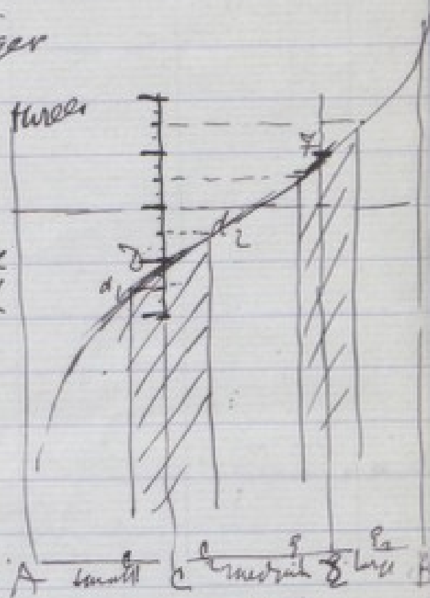
F. 39 3

Every one stamped throughout with marks of his own personality
his own signature is found all over him | [illegible] How many
Gesture little bit. — handwriting on which so much depends — Experts
— We want measurable differences. or at least such as we can define
— minute differences
eyes — dealer with 1000.
Why not photograph Entire hand creases
skin. blue veins, [illegible] — so little shown in one [illegible]. ~~[illegible]~~ — . . ~~Kollman~~
Digit marks much literature, occurred to many Bread & Butter Purkenje first Eng. in Latin in 1822
~~[illegible]~~
How to make digit marks. ink is difficult [illegible] smoked paper, on glass, do it plaster casts
wax dentists, sealing wax. — printers ink Chalk & water — photograph
Purkenje's divisions Explain interpolation — distance & direction of where they begin — also pores difficult to print are landmarks.
Lying Bob Gilbert Thompson US Geolog Survey — Arizona & New Mexico
Tabor for Chinese — not used in China Wade . this is [illegible]
Nature 1880 { Sir W. Herschel — agree in interpolation be as above
Faulds

Berlillon Bureau des Signalements Office (established at Paris Lyon & Marseilles
Head length breadth foot finger

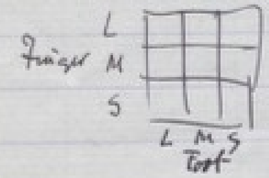
Hard & fast lines of division, always by threes
Values near limits between 2 classes
Stature 2.3 inches (say 2) between top & bottom stature
of middle third . 3.4 between ... middle half
Error at least ± ½ inch Explain scheme
Different measurers – growth – accident.
mem Head prisoners & at Cambridge

Fringe of uncertainty



There is a dilemma Either the delicacy of the measurement test
is not turned to full account in classification or the fringe is
dangerously wide. — Want to know whether a man with large foot has a relatively large or medium or small foot not absolutely
Satisfied great glut of some compartments } delicacy is wanted here

My anthrop Laboratory



Mechanical Selecter.
Can by one movement select out of 500 cards
It is not my business to look after prisoners, but Bertillon
& useful for other things – curves generally even meteorology:

Shew single tumbler explain this *fully*
Tumbler & key 1 key.
Notch wide enough for string + play. Even notch very width ×
Describe Selector Tumblers even here $\frac{1}{10}$th thick 300 in 30 inches
Frame. – tumblers act independently each by own weight.
Dont press too much – divisions at intervals – action sweet.

Key – 30 inches effective length. wires supported by bridges.
No delicate adjustment here – would be by windlass
on wire (with a spring interposed) & set by wire standing
over graduation.

Action very quick & to many boxes of tumblers in succession.
Contrast with Bertillon. He is a hard & fast clasp – & within
given limits of error of a given measure.
Shew working size.
My own trials have been on humble scale
Cutting pliers
dropping cards as cards in in pack within a card case.

f. 42

6

Measurement of profiles.   make a standard pose

Excellence of these – sharp lines & most characteristic

Pentagraph – (good too for digit marks)

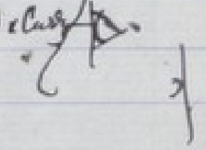
My proposal for photographers. – ? use sensitised paper ready blacked on one side.

Have taken much trouble – Lavater cards

Profiles differ in ~~many~~ small but many . ... independent ... limbs

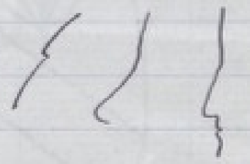
Base in regular profile } for direction same
in silhouette }

Units of scale

Pickard & Curry 

points to measure.

Slope of base of nose (outside nostril)

Types of face ~~Beddoe~~ 

Determination by selector of type in which a profile falls.

Fill up with {
conditions of varying resemblance
distortion
focus
dark & smallness.
imagination

Beddoe

Use for hereditary antecedents

payment by order on a camp suttler and having also to take special precaution against forgery, used his thumb mark for the same purpose as the delicate ~~scroll~~ patterns in bankers cheques, namely to write the value of the cheque in figures across it, ~~with the~~ assurance that no erasures could be made without detection. I have a copy of one of ~~his cheque~~ orders by me. The person who of all others has used finger marks on a large scale for purposes of identification is Sir William Herschel when in the Bengal Civil Service & who found it most successful in preventing personation and in putting the ~~authenticity~~ genuineness of deeds entirely beyond dispute. He described his method fully in Nature in 1880 vol 23 p. 76. "The question immediately arises, are these marks persistent? Through the help of Sir William Herschel who kindly permits the use of his name as a guarantee of authenticity, I am able to give for the first time very important evidence in the affirmative, namely copies of his own finger marks (the two first fingers of the right hand) made at dates separated by an interval of no less than 28 years and which are exactly alike. The first was made in 1860 when he was serving in India, the last was made for me a few weeks ago. I have also impressions made by him in 1874 & 1880. They are all alike. It is not of the general aspect that I alone speak but of extremely minute details

There are minute peculiarities of structure in every part of the body which would suffice to distinguish one person from another and they abound even in those few square inches of surface that are customarily exposed to ~~the~~ view. The course of the blue superficial veins seen through the skin the convolutions of the ear, the markings of the iris which have never yet been adequately studied except by the makers of artificial eyes, are among these. The most striking of all of them is perhaps the spiral arrangement of the ~~ridges~~ delicate ridges ~~of the~~ on the skin that is found on the lower surface of the finger tips & elsewhere in the palms of the hands. I do not speak of those large wrinkles ~~in~~ that ~~which~~ professors of palmistry study ~~take so much interest & which~~ though they would ~~are undoubtedly very characteristic~~ give sufficient ~~aid to identification &~~ and which correspond in their origin to the creases in a well worn dress or to the folds in the hide of a rhinoceros, but to the delicate striation in such impressions as those often left by the buttered fingers of children on the margins of picture books. These were first enquired into by Purkenje in 1822 and subsequently by many writers as Alix, most recently by Kollman (Tast-apparat der Hand, Leipzic 1883) It has occurred to many persons independently to suggest finger marks as means of identification, that Bewick's thumb mark in one at least of his vignettes, is known to many. Quite recently I have heard of two cases in America, one was Mr Tabor a San Francisco ~~Photogr~~ photographer who urged its use strongly as a means of identifying Chinese, another was the ingenious device of Mr Gilbert Thomson in charge of a geological survey party in Arizona, where being obliged to make his

Proof to F. Galton
42 Rutland Gate. S.W.

f.45r 1

Personal ~~Descrip~~ Identification & Description
continued from . . . . .
by Francis Galton FRS.

Personal characteristics ~~that admit of being verbally described~~ exist in much more minute particulars than in the ~~form~~ general proportions of the limbs & body ~~descri~~ spoken of in the last article; they exist in gesture and ~~writing~~ handwriting. The ~~[illegible]~~ bifurcations and interlacements of the superficial veins, the markings of the iris, (which have never been carefully studied except by the makers of artificial ~~[illegible]~~ eyes, who recognise many thousands of varieties, ~~and~~ which deserve to be carefully photographed from life on an enlarged scale), and the convolutions of the outer ear, all admit of being classified as helps towards identification.) ~~They all admit of being referred to~~ (As in the sets measures already spoken of, each individual specimen of these admits of approximate description by ~~being~~ reference to the catalogued number of some example in a standard collection, that shall not differ from it by more than some specified number of units ~~degrees~~ of unlikeness, the unit being in each case the value of the least discernable difference. All this ~~has~~ was ~~been already~~ fully explained in the last article.

1 gallon = 277 cub: inch of distilled water
& weighs 10 lbs
a man who weighs 10 stone or 140 pounds contains about
14 × 277 cub inches =

$$
\begin{array}{r}
277 \\
14 \\
\hline
1108 \\
277 \\
\hline
3878
\end{array}
$$

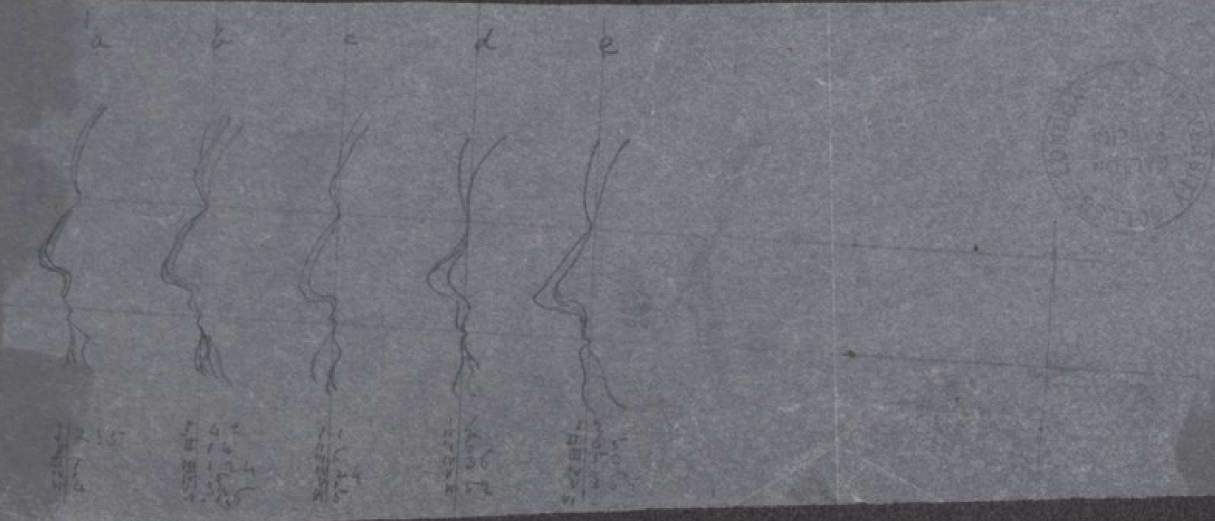
call it 4000 for a man about 10 stone

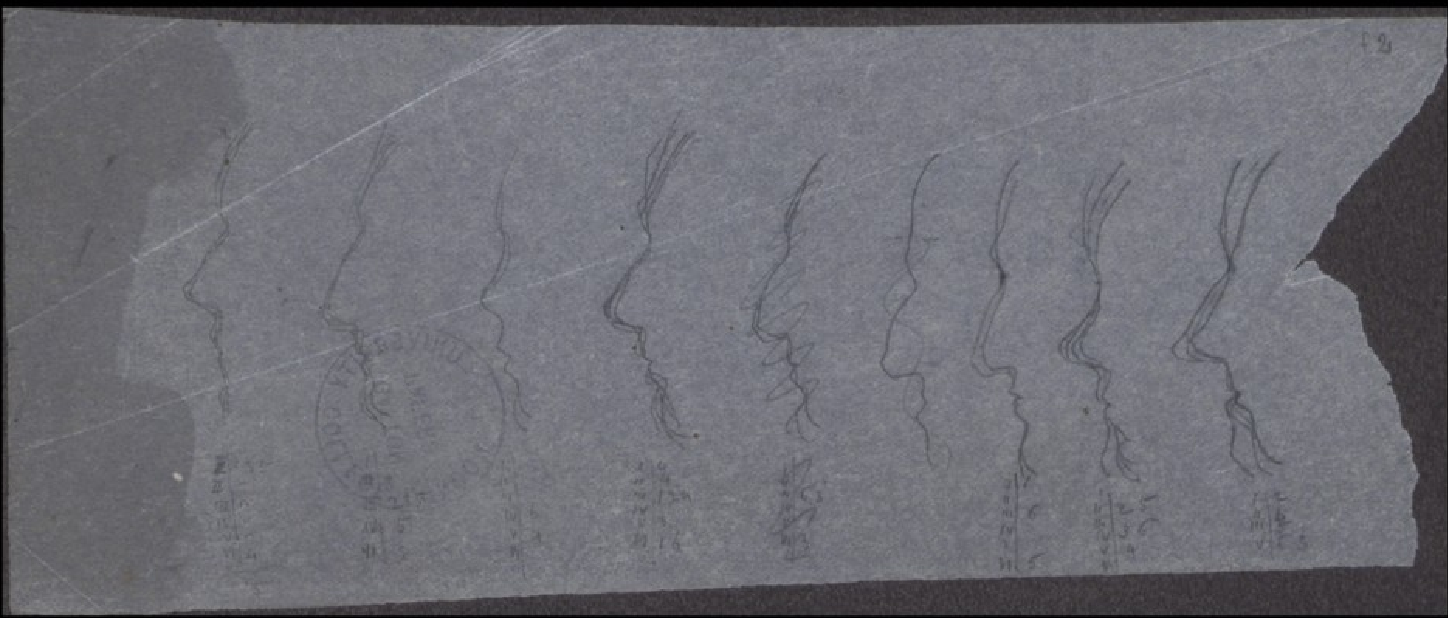
$4000 \times 10^2 \times 2000 \quad = 8.000.000.00$

F. 46

We may either consider the black ridges or the white furrows, shown in the impressions ~~the courses of the hills or those of the valleys~~. I prefer the latter because it is much easier to make visible marks on white paper than on black, and will speak of them in what follows.

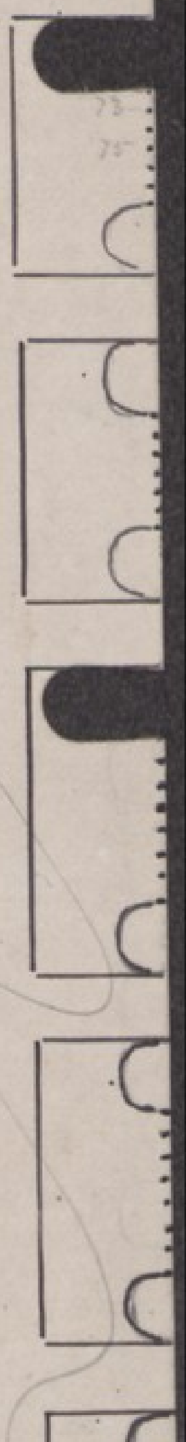
The furrows are seen to diverge in whorls, new furrows appearing at various places between the old ones. It is to the position of these that Fig 2 principally applies. The new furrows may arise in two ways, either (1) a new furrow may appear by itself ~~singly~~ in the interval between 2 others, or (2) a single furrow may bifurcate & forming a Y. The distinction between these is not to be greatly relied upon because a disintegration in one of the ridges or even a failure in the impression at the point of their junction to form the Y may ~~turn~~ ~~an impure~~ case 2 into case 1, and conversely case 1 may be turned into case 2. A careful study of the two wood cuts will show instances of this. Fig 2 distinguishes ~~shows~~ the forms given by Fig 1; Fig 3 shows some few instances of cases (1) or (2) being uncertain. But there is no doubt as to the ~~places~~ where a new furrow arises. Except in the middle


a
b
c
d
e



F3

f.4



Head length

Head breadth

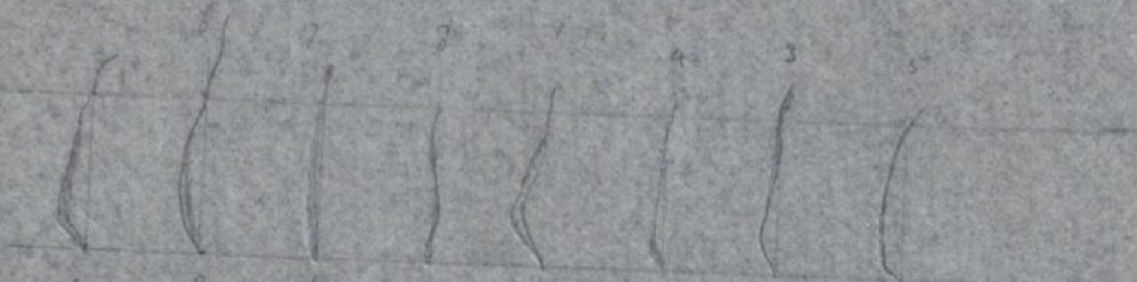
Height standing

Span

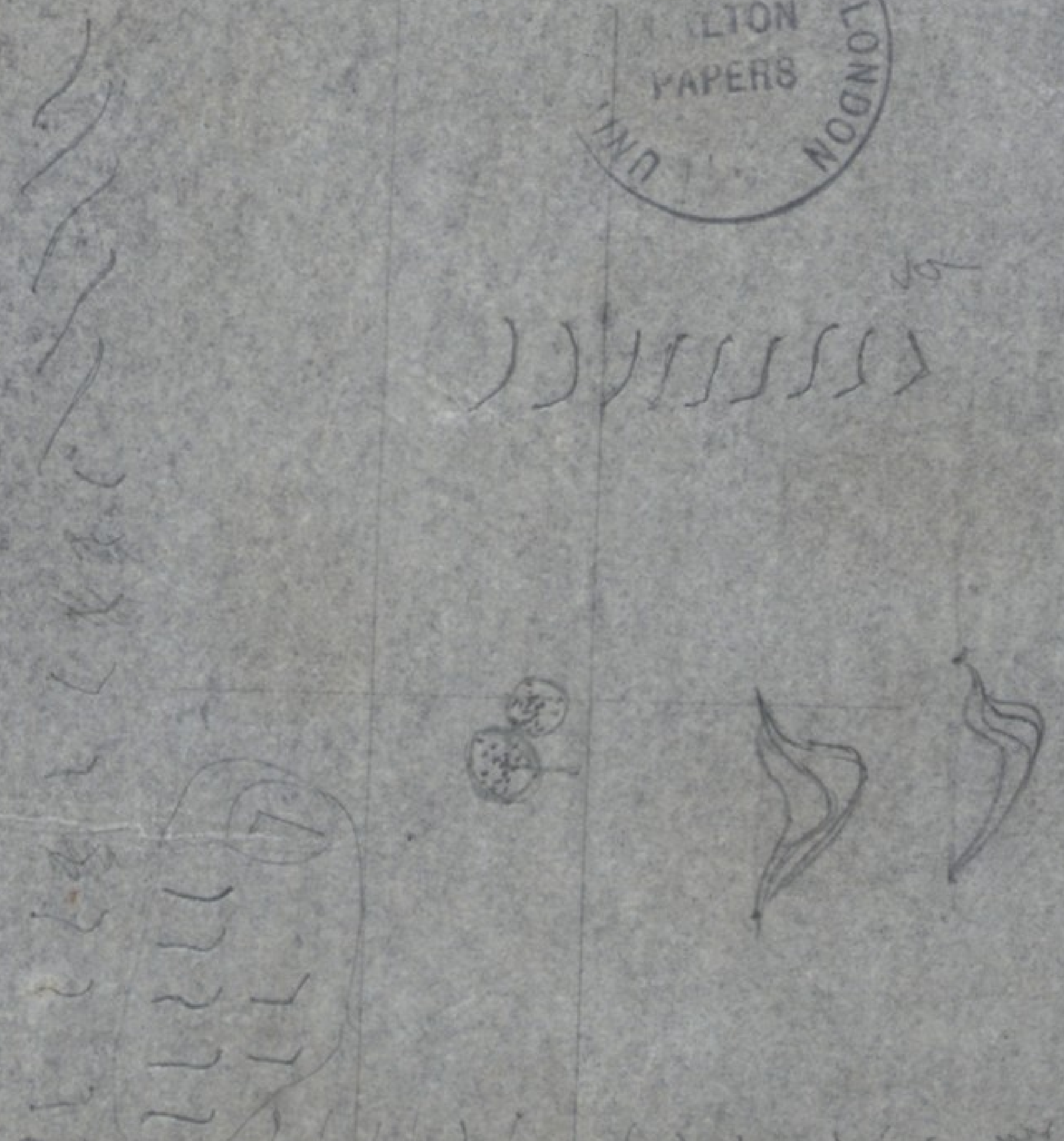
Height sitting

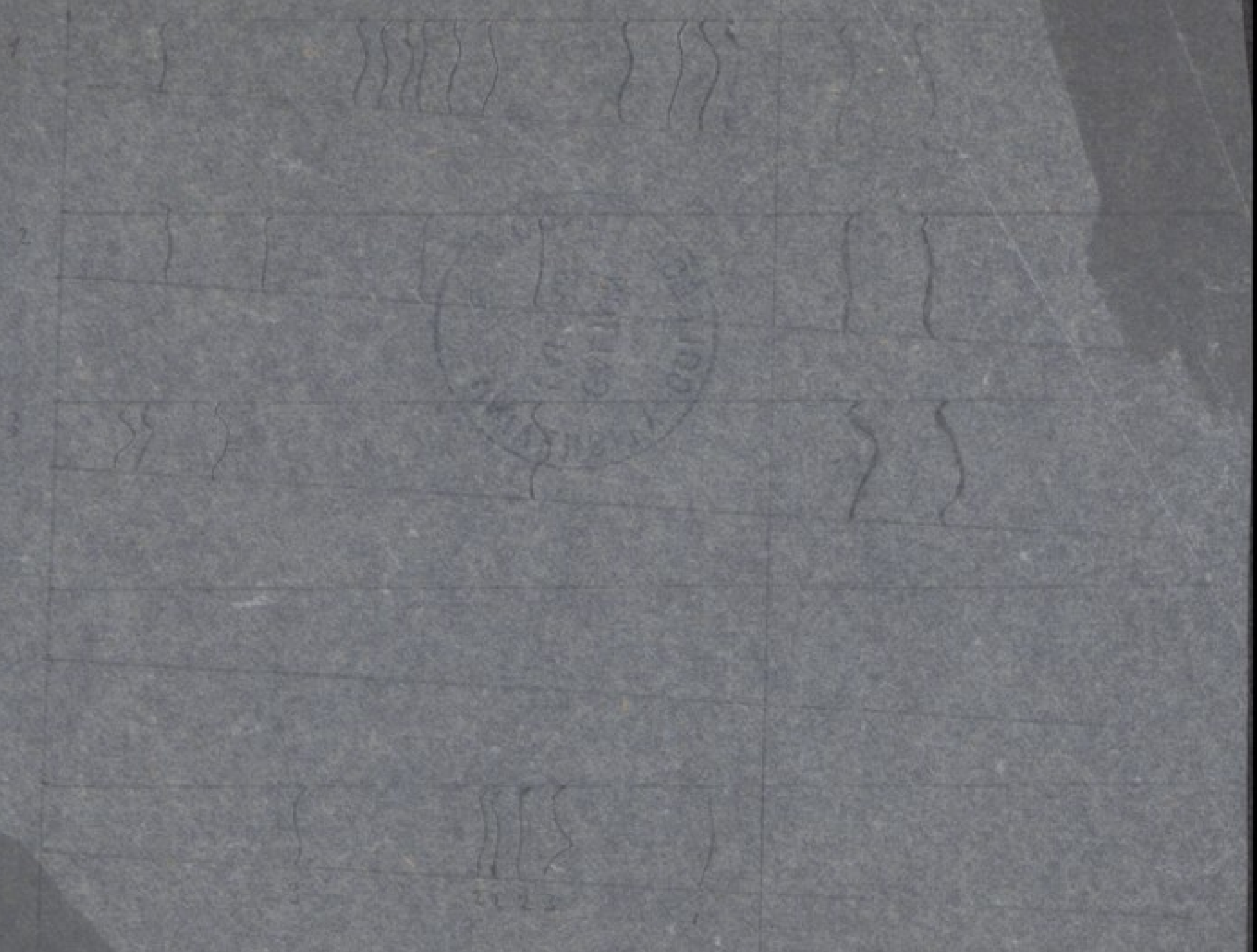
Height of knee

Foreheads for 2/3 of distance = that from forehead



I	1 3 4 5	2	6					
II	1 3 4 5	2						
III	1 2 3 6					5		
IV	5	3			1 4	2 6		
V		5 6	2				1 3	4
VI	5	1 4 6	3		2			
Total	14	8	3	1	4	3	2	1





F.8

F 10

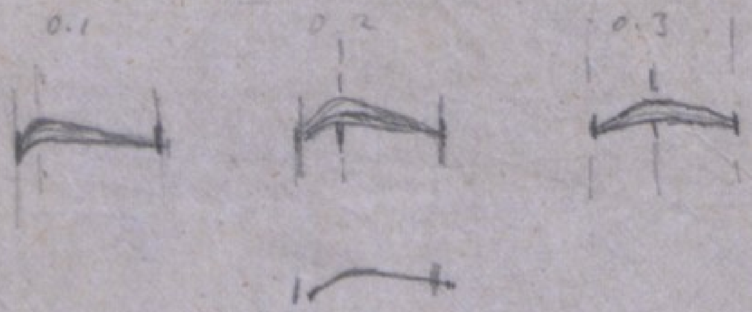
III. 3 – 2 a 3 b 7/2 6/9 5

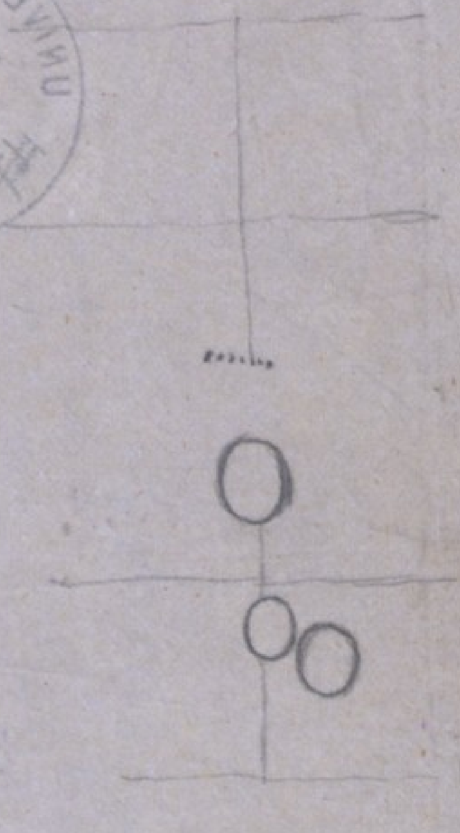
III. 6 – 3 b c x 1 9 4

I. 2

Drawn from data (first ever done)

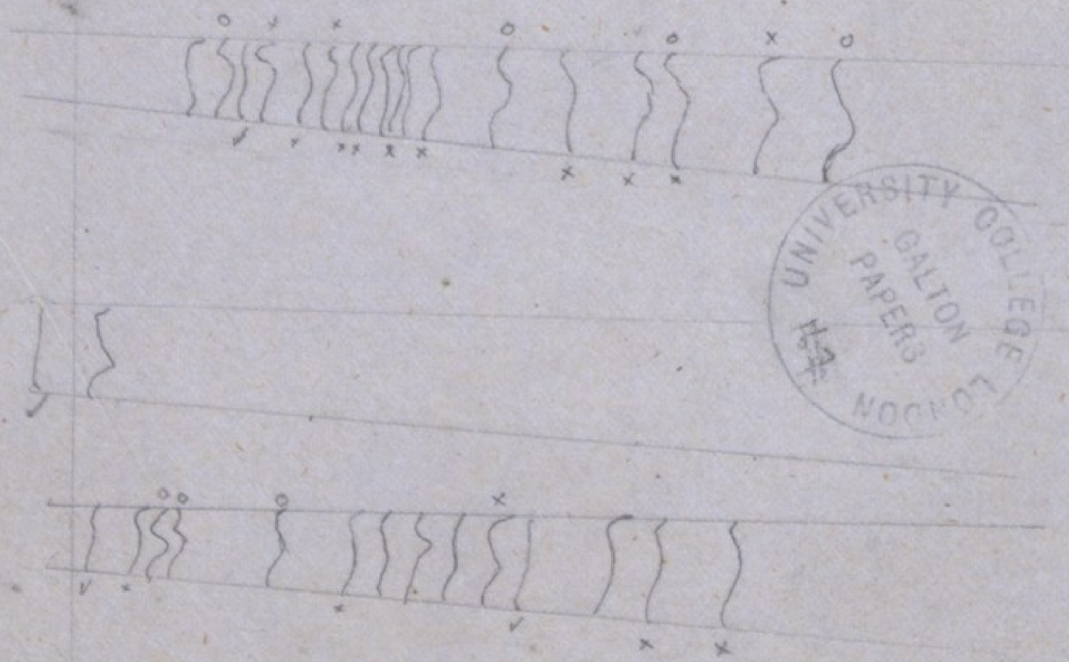
f.12v



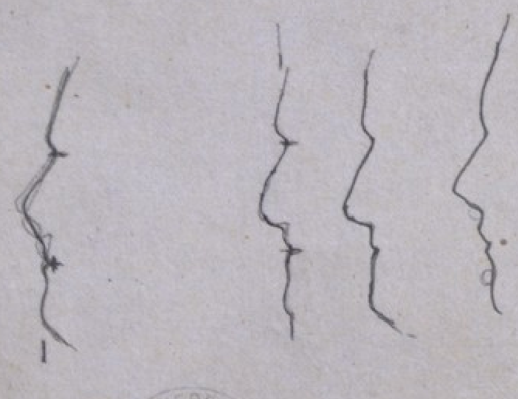


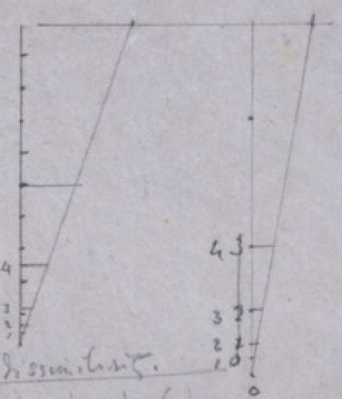
Lower lip & chin

f. 13



f 44





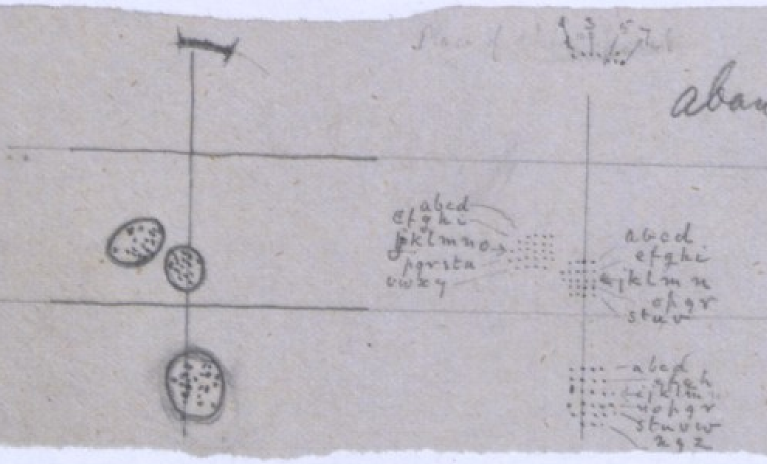
orders of dissimilarity.

Cent 1 | 2 | 3 | 4 | 5 | 6 | 7
1 2 | 4 8 16 32 64 128. | 256 | 1024

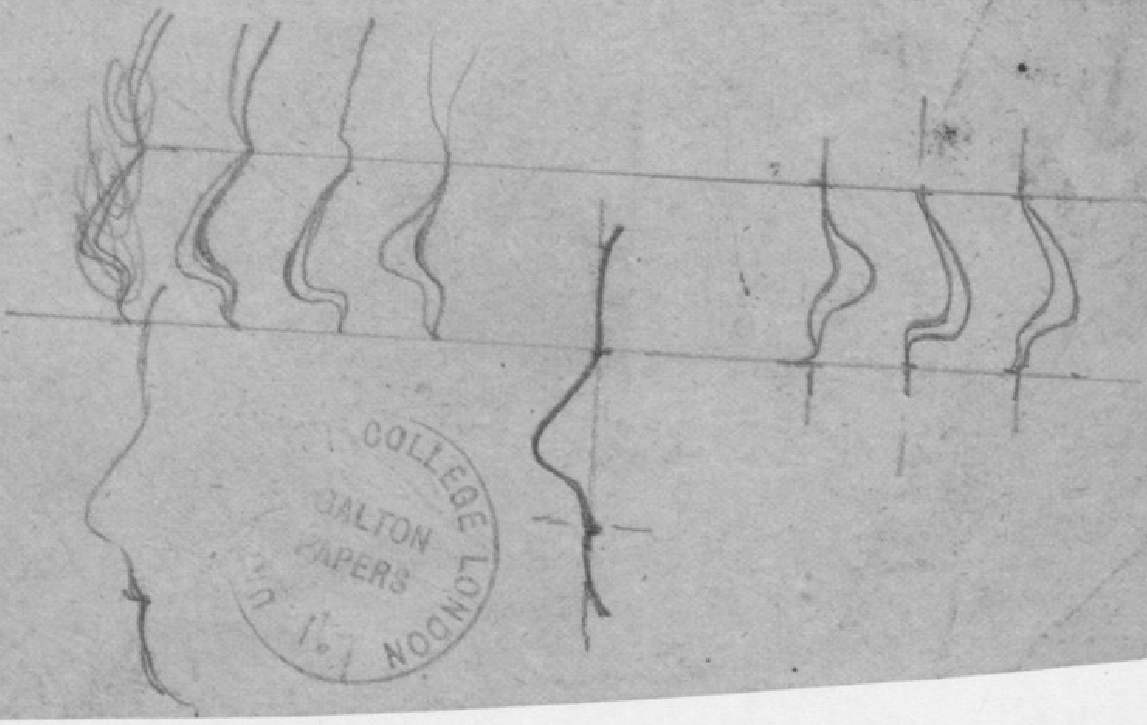
64/70 [illegible]

f. 15

abandoned



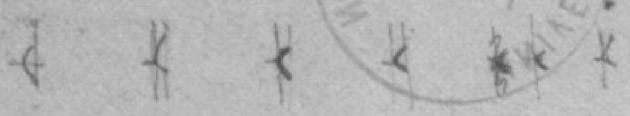
F 16

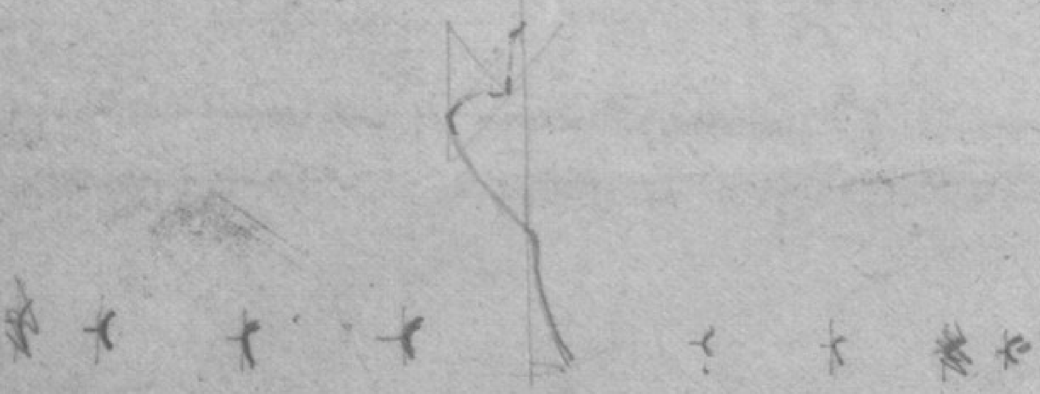


nose tips

a b c d e f g

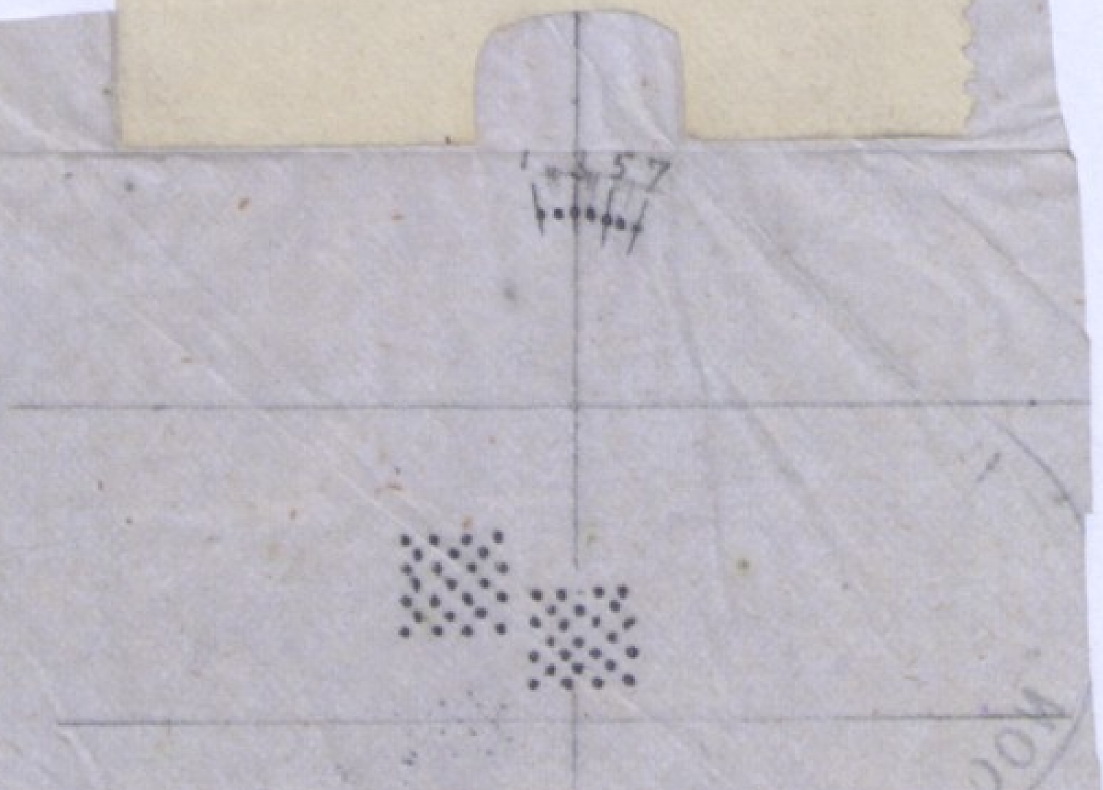
a)	I. 1, 4, 6	II. 5	III. 1. 2. 5 6	IV. 2 3, 4, 6	V. 4 6	VI 5. 6	Total 16





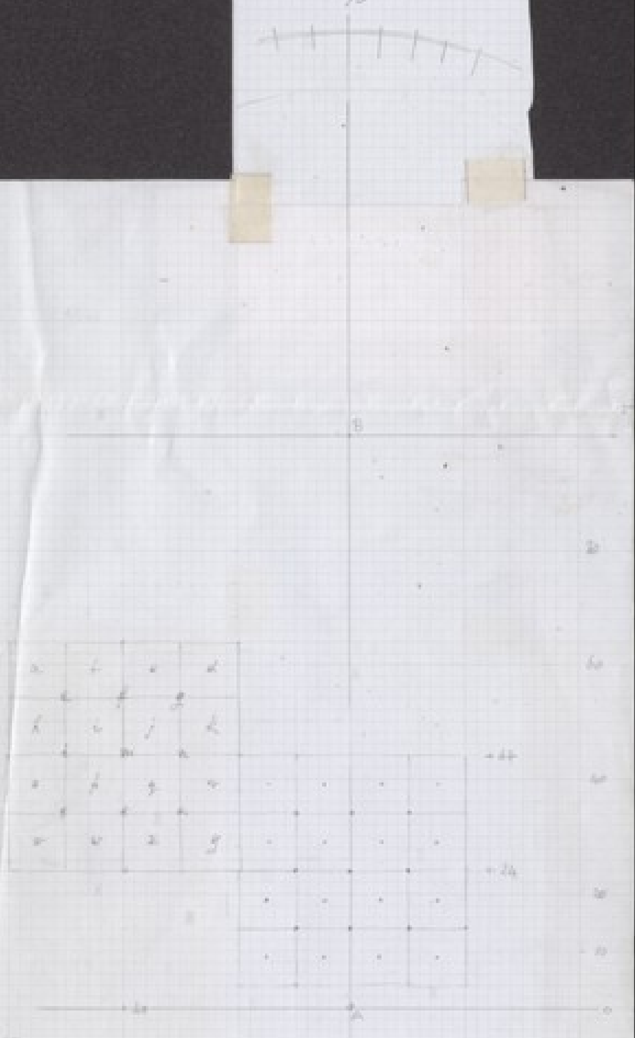
Top

F. 18



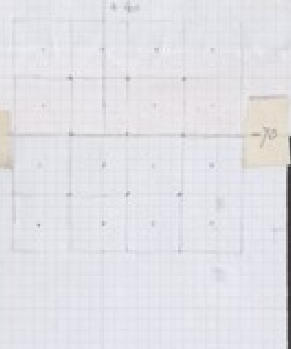
a b c d
e f g k
h i j
l m n
o p q r
s t u
v w x y

f. 19



AB = 100
Side of each square 40
" of each subsquare 20
Centres of the squares measured from A
vertical horiz.
Mouth left +44 −20
Mouth right +24 0
Chin left −70 +4

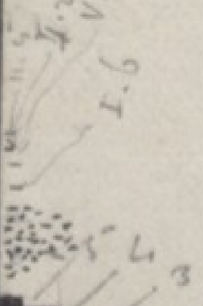
Length of forehead = 70
Steps in grades of 5th each



f. 20r

Vol II. 3
4
B. 2.45

1. 6
2. 5
2.6



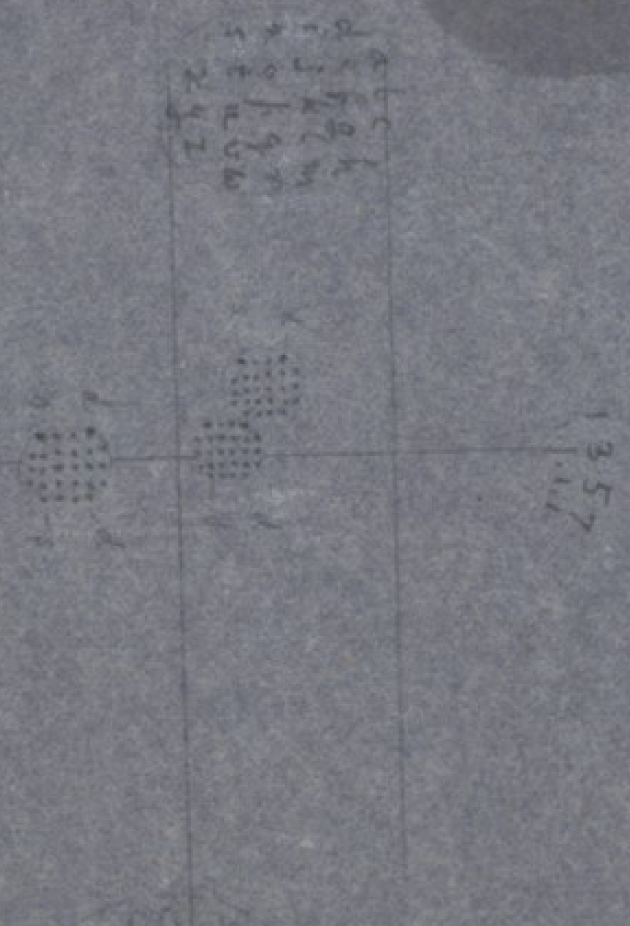
	nose notch 9	chin tip 1	face line slope 4
	a		
	nose base 3	upper lip 3	chin 3 forehead 2

forehead 4

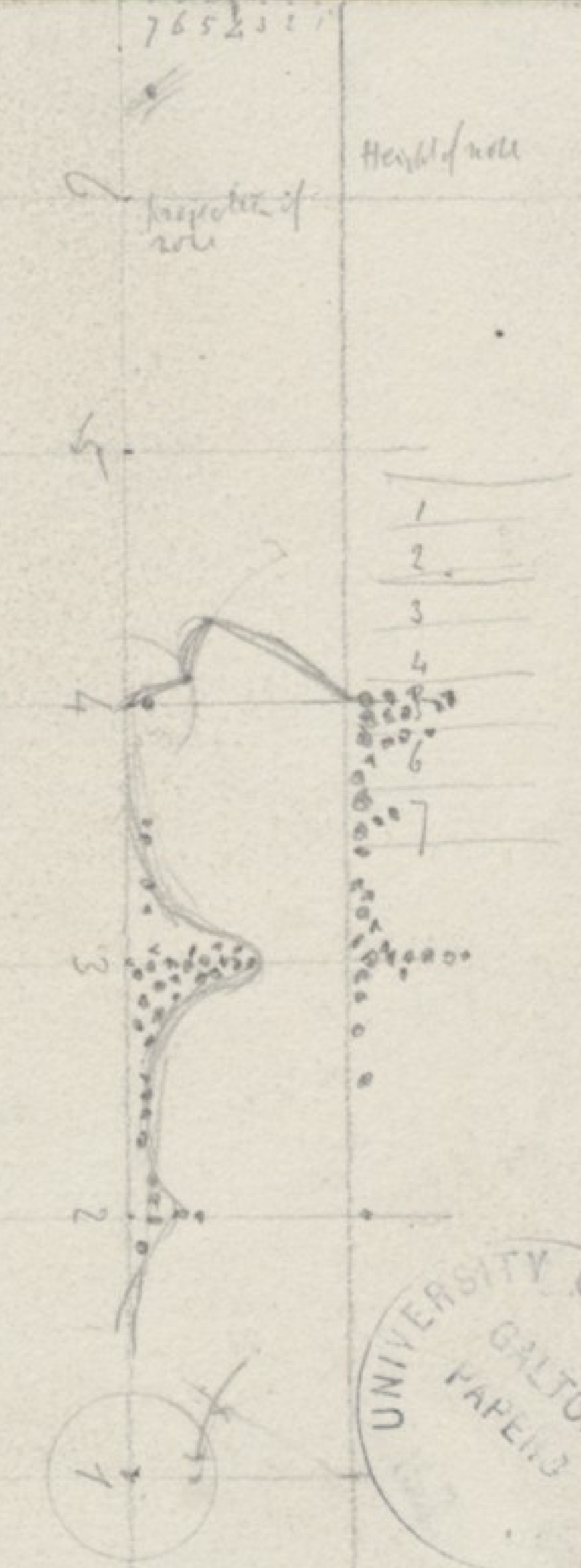
nose notch

lip parting

nose tip


1357

f. 22r

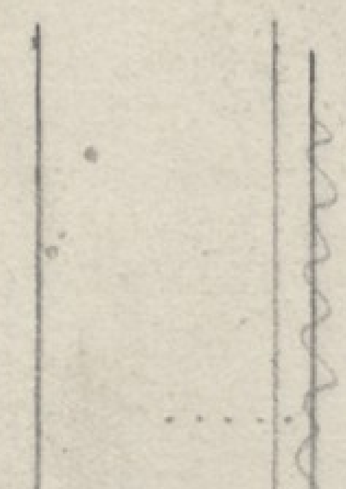


180
81
180
1440
15500

20
400
8000

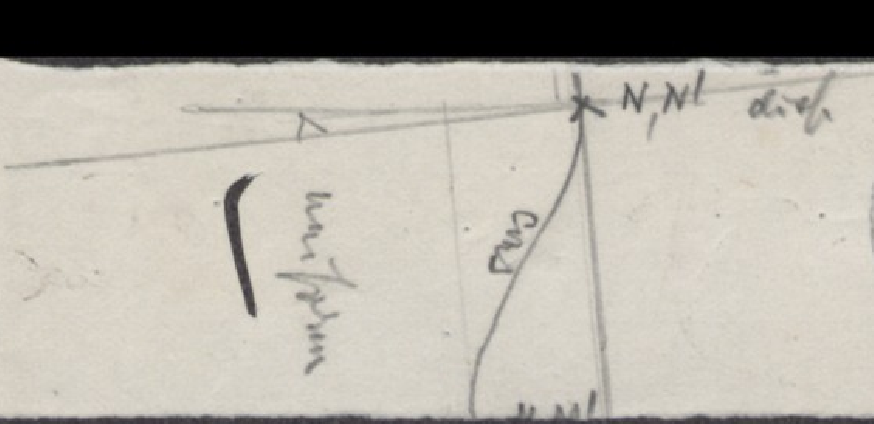
	No of [illegible]
length of nose	3
upper lip	2
slope of nose	2
upper lip	2

4×9 = 24
Combin.



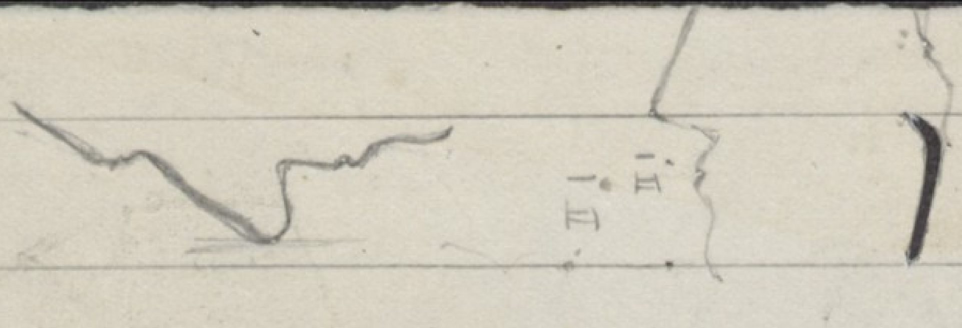
f. 23

Resemblance (2)
size & illumination, imagination
distortion.

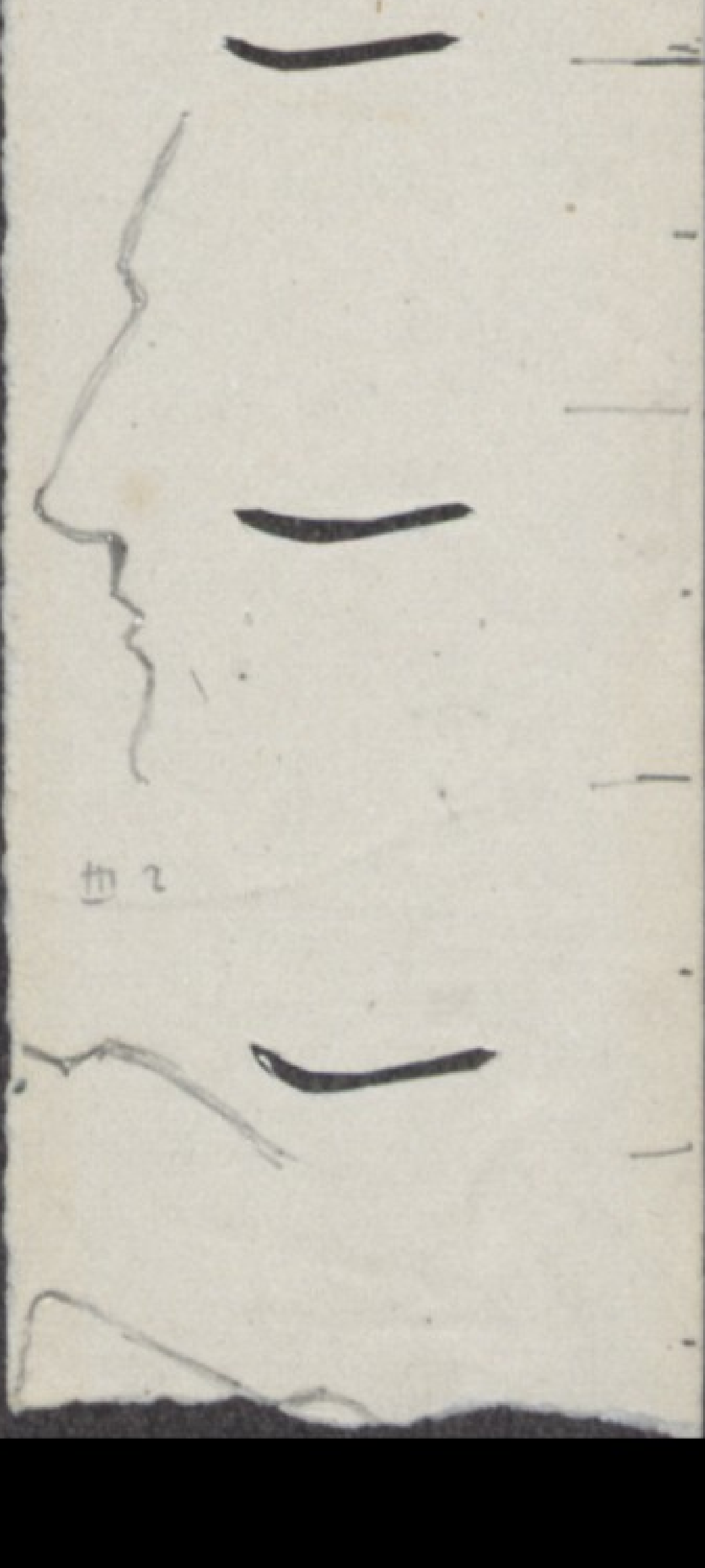


f. 24r

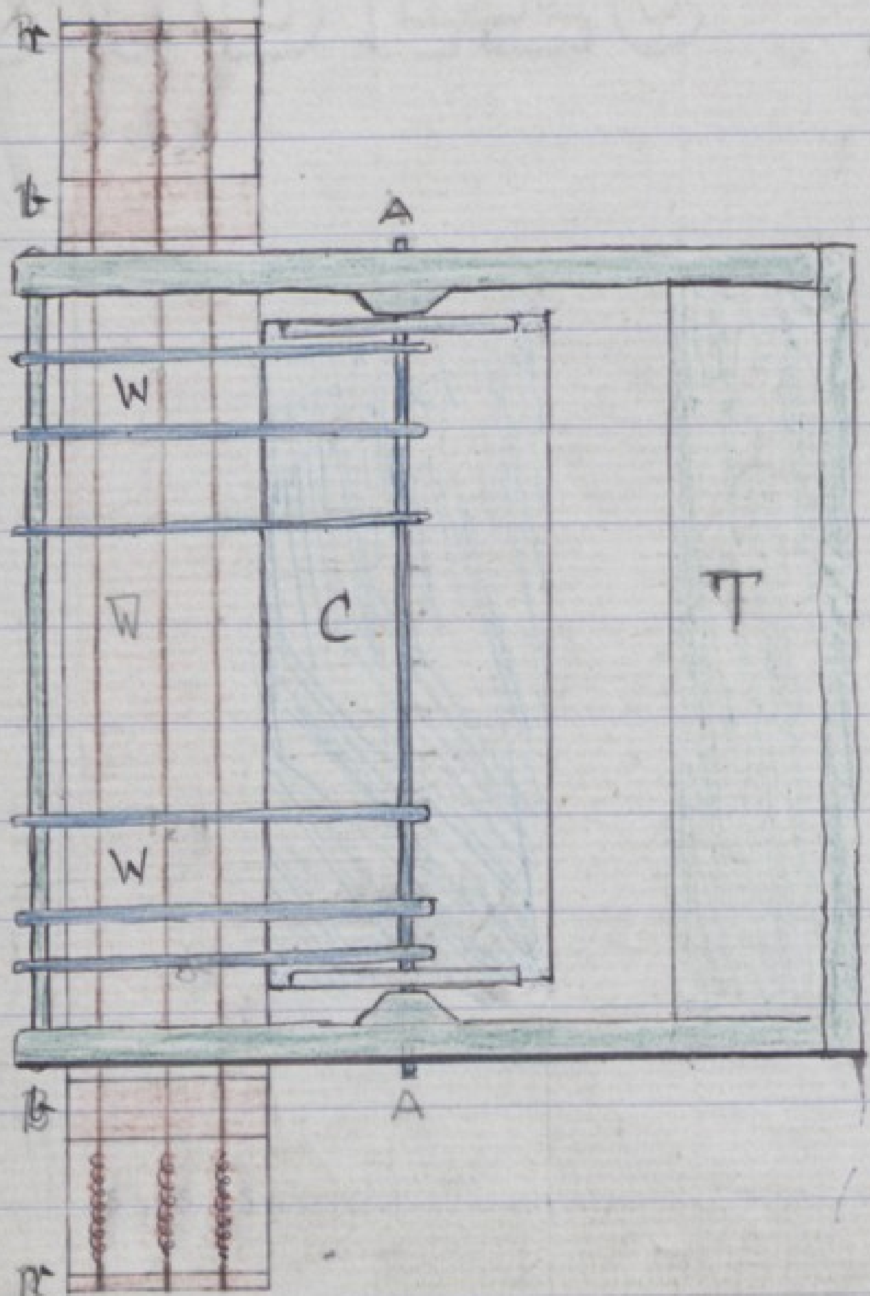
f. 24v

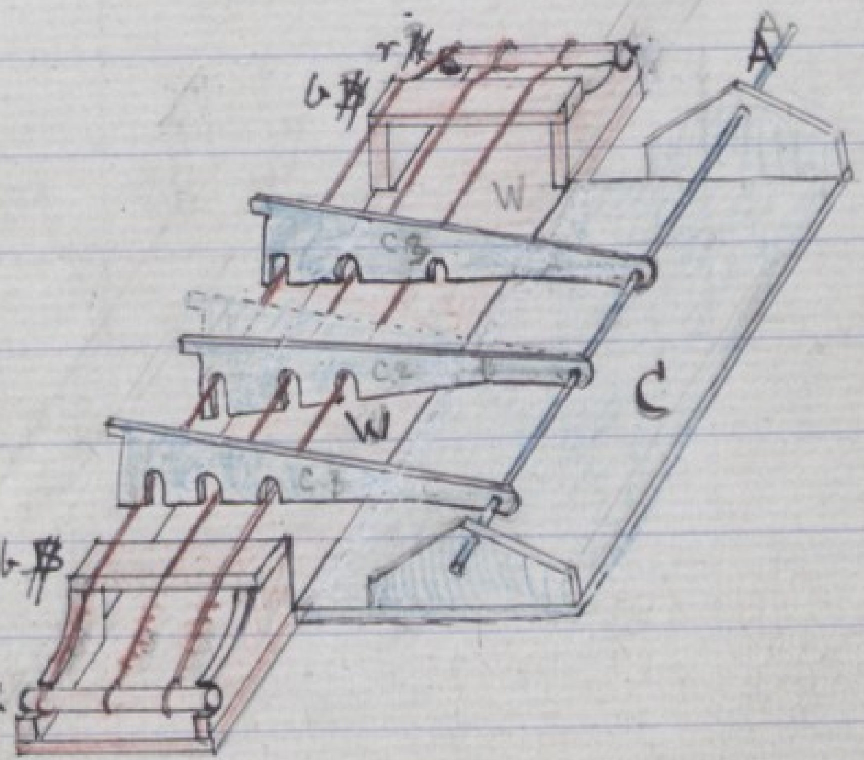


f. 25c

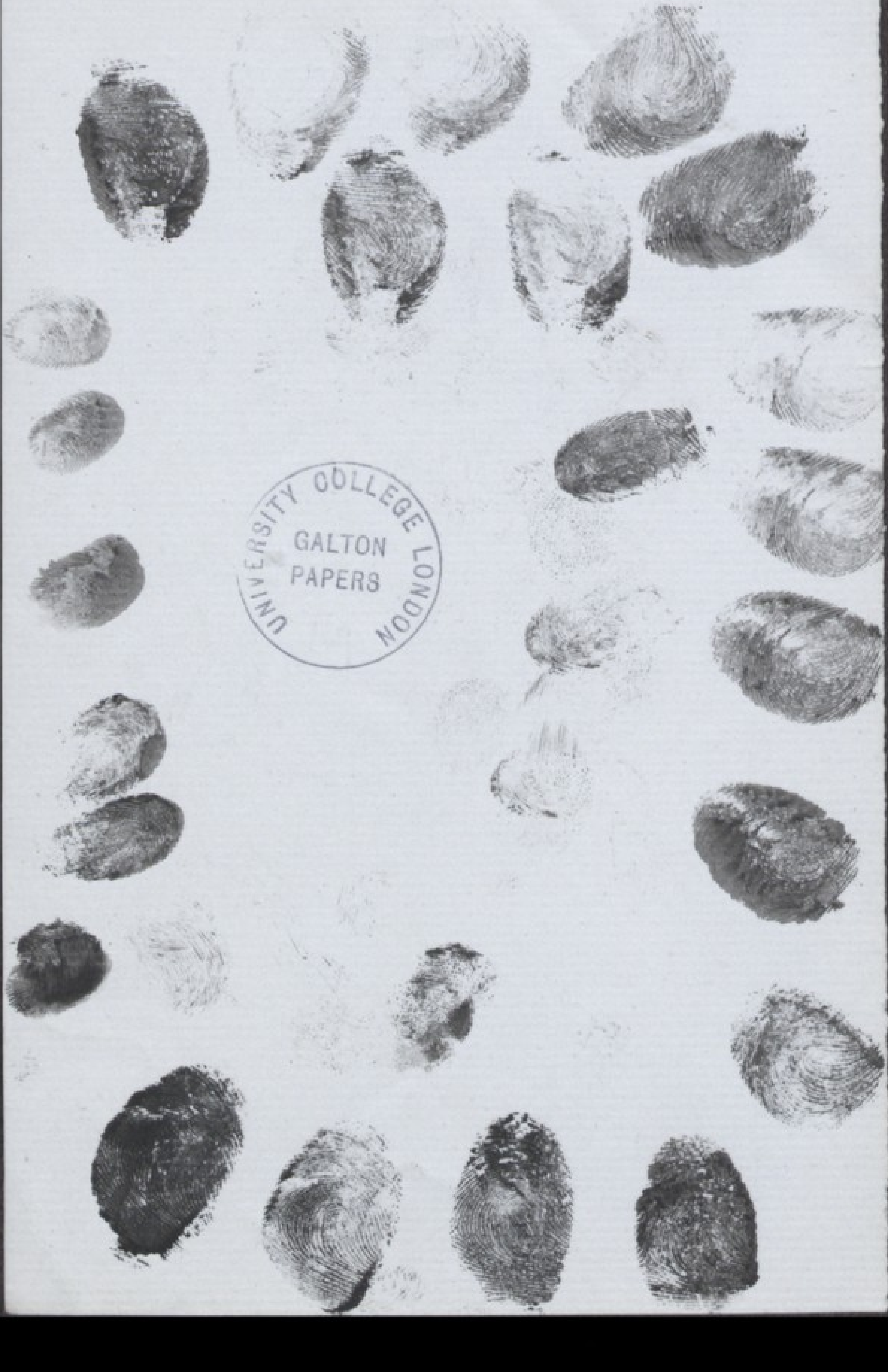


C ms


R
B
A
W
W
C
T
W
A
B
R


W
W
C
A

f. 28



~~Figs 1 & 3 are wood cuts made by photographing of the impression~~ which ~~enlarged to a double~~

The impressions of the finger marks were photographed on an enlarged scale direct upon the wood engravers block, thus the wood cuts are very exact. Those to which I refer are shown in Fig 2. If any one will take a piece of tracing paper & copy them & then lay the paper first on Fig 1 from which they were made & then on Fig 2 he will observe what I refer to. The tracings must be carefully made and a lens should be used even with these enlarged copies. I happen to possess a ~~small~~ pantagraph which I contrived for another purpose, in which a microscope of low magnifying power furnished with cross wire ~~is set~~ forms the axis about which the shorter arm turns & a pencil holder forms that for the longer arm. It proves the a very convenient multiplying arrangement suitable for these marks & for dotting down the ~~relative~~ positions as well as of these marks on an enlarged or ortho. scale & for the measurement of the photographed profiles I spoke of in the last article

5

forehead-notch to lip-parting = 100

			range
range of profile nose	(60) to (20)	=	40
length nose	90 to 60	=	30
	(or 100	50	= 50)
base of nose	50 to 20	=	30
length of upper lip	40 to 10	=	30

absolute length = about 3 in; to measurement in to .03 inch say $\frac{1}{30}$ inch

$4 \times 5 \times 3 \times 3 = 180$

4 1/2
4 1/2

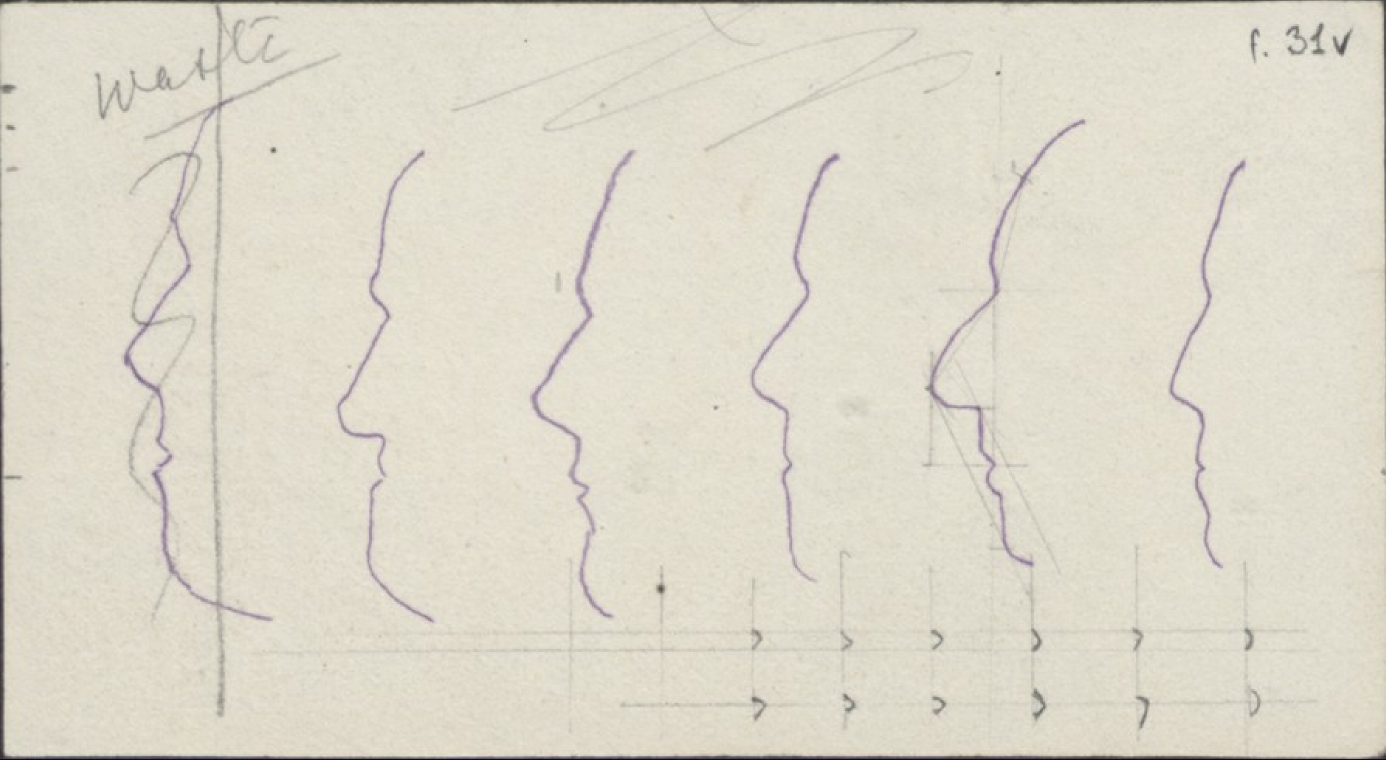
= 155 00[illegible]

a
b
c
d
e

20

	1	2	3	4	5	h
I	cd	ae	a	b	a	b
II	b	d	ellipse c	b	e	e
III	ab	b	e	b	ce	d
IV	a	c	d	c	b	d
V	c	e:	be	b	e	e
VI	b	d	b	a	cd	b

f. 31v



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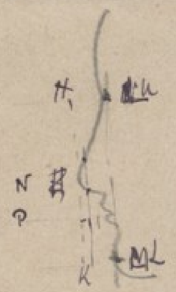

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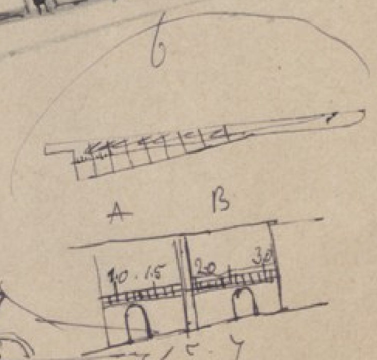

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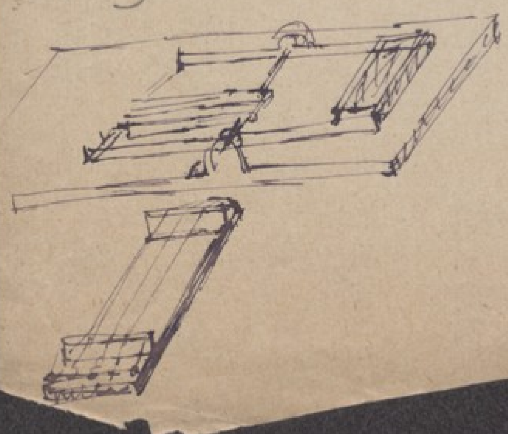
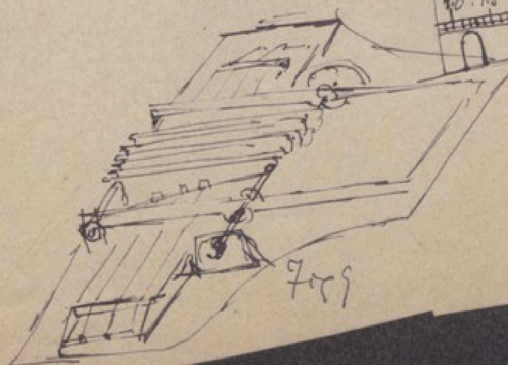




7 & 9

NATURE

Publishing Office:
BEDFORD STREET, STRAND,
LONDON.

Advertisements and business letters to be addressed to the PUBLISHERS.
Editorial Communications to the EDITOR.

24 May 1888

The Editor of Nature presents his compliments to Mr. F. Galton, and will be much obliged if he will send him his lecture on Personal Identification and Description which is announced to be delivered at the Royal Institution on the 25th inst.

F. Galton Esq. F.R.S.
Rutland Gate
S.W.

NATURE

Publishing Office:
BEDFORD STREET, STRAND,
LONDON.

June 5/88

Advertisements and business letters to be addressed to the PUBLISHERS.
Editorial Communications to the EDITOR.

The Editor of Nature presents his compliments, and begs to acknowledge receipt of Mr Galton's MS with diagrams. He does not think it will be necessary for Mr Galton to see the Engraver, as the instructions seem to be perfectly plain.

f. 1

Albemarle Street, W.
May 28th 1888

Dear Mr Galton,

I write to enquire if it will be convenient to you to let us have an early abstract of your discourse last Friday and also if there are any incidental expenses which we should pay

Yours faithfully

Benjamin Vincent

F. 21

Royal Institution,

Albemarle Street, Piccadilly, W.

June 4th 1888

Sir,

I have the honour to inform you that at the General Monthly Meeting held this day it was unanimously

Resolved, That the Special Thanks of the Members of the Royal Institution of Great Britain, be returned to you for your

Discourse on Friday Evening — May 25th on

"Personal Identification and Description".

I am, Sir,

Your very obedient Servant,

Frederick Bramwell,

Hon. Secretary R.I.

Francis Galton, Esq. M.A. F.R.S.

f. 1

Times Office, Printing House Square,
May 22, 1888

Basil H. T. Cooper, B. A. Londin. presents his Loyal Homage to Francis Galton Esq., M. A., F. R. S. &c., & having been honoured with the Commission of his Journal to furnish a condensed report, not exceeding half a column, say 1200 words, of Mr G.'s forthcoming Friday Evening's Discourse on "Personal Identification & Description" at the Royal Institution, thinks he cannot do better than crave, as the best of all possible Summaries, one from the Lecturer's own hand. B. H. C. encloses a P. S. addressed to himself at his private residence, begging the additional favour of a monosyllabic reply. Should it be in the affirmative, he will take for granted that by the first post on Friday morning he may expect at home the coveted favour.

was preserved by the police. The origin of the fire is at present unknown.

12

PERSONAL IDENTIFICATION AND DESCRIPTION.

At the Royal Institution last night Mr. FRANCIS GALTON lectured on personal identification and description. He said he greatly felt the inadequacy of language to express form, when he was dealing with hereditary likenesses, with grouping human features into classes, and with many other topics. The present lecture was the result of the considerable pains that he had taken to overcome this difficulty. There proved to be many alternative ways of doing it, but as he had not yet satisfied himself as to the best, he would avoid details and confine himself to general remarks. It was perfectly possible to define and to measure resemblance, taking the least discernible difference as the unit for each degree of unlikeness. This simple principle could be easily applied to outlines such as those of silhouettes. It was better at first to go even further in the direction of simplicity, and to consider only that part of the outline of the face which lay between the brow and the parting of the lips. The least discernable difference between two silhouettes might be taken as equal to the one-hundredth part of an inch. Though an exceedingly large number of profiles might be drawn that differed by this small amount in some part of their outline, the number that differed by ten times that amount would be comparatively very small. We might aim at producing a collection of standard portraits, drawn with coarse outlines of one-tenth of an inch in width and then reduced to a small scale, to serve as standards of reference. No profile that fell wholly within the two edges of the coarse outline could differ from its centre by more than five grades of unlikeness. This would be a useful and a first degree of approximation; it would not be a likeness in any other sense than that of excluding the very large proportion of profiles that were still more unlike than those that fell within the specified limits. A mechanical apparatus, described further on, afforded the means of rapidly finding the standard or standards to which any given profile conformed. Individuals differed in a measurable manner in so many respects that a person might be identified with considerable precision by a statement of his measures. The lecturer explained the measurements that were most useful for this purpose, and how registers of them could most easily be searched in order to find whether those of a particular person were contained in them or not. Differences that might be measured, or otherwise clearly defined, existed on a small as well as on a large scale. The curious variety of imprints made by the inked finger-tips admitted of being classed and catalogued. They seemed to be singularly persistent, judging from four specimens that were exhibited of the digit marks of Sir W. Herschel, made in the years 1860, 1874, 1883, and 1888 respectively. Though there was a difference of 28 years between the dates of the first and the last, no difference could be perceived between the impressions. The forms of the spirals remained the same, not only in general character, but in minute and measurable details, as in the distance from the centre of the spiral and in the direction at which each new ridge took its rise. Sir W. Herschel had made great use of digit marks for purposes of legal attestation among natives of India. Prisoners were now identified in France by measurements of their heads and limbs according to the ingenious method of M. Alphonse Bertillon. The measures of each prisoner were all entered on the same cards, and the cards were classified according to the successive measures they contained, just as words were arranged in a dictionary according to their successive letters. The classification did not take more note of the measures than by placing each in the category of large, medium, or small, as the case might be. Thus one measurement gave rise to three possible groups, two to nine, three to 27, and so on. The lecturer exhibited the rough working model of an apparatus he had contrived that could select by a single movement those cards out of many hundreds whose measures corresponded within any desired limits with those of any given person. It was free from the objections inherent in all methods of hard-and-fast classification such as that of M. Bertillon, and could act on a large scale and with great rapidity and simplicity. The apparatus consisted of a large number of strips of card, or of metal, pivotted through one of their ends by a common axis, while their other ends rested on a frame that turned about the same axis. When the frame was raised all the cards were lifted by it, when it was lowered the cards dropped each independently of the rest by its own weight. The lower edge of each card was variously notched to indicate the measures of the person to whom it referred. The key that made the selection was a board some 30in. of clear length, with wires stretched lengthways and supported by several bridges. The positions of the wires were adjusted by the same scale as that by which the notches were cut, and the wires were set to represent the measures of the given person. When the board was set crossways under the cards, and these were allowed to fall, they all were checked in their descent by the wires, except those few whose notches corresponded with them. The notches were made wide enough not only to admit the wires but also to allow for some inaccuracy of measurement and misfit. A key of the above length would test 500 cards at once and might be used in quick succession with any number of sets of cards. The profile of a face, he continued, could be measured with much precision on the sharp outline of a photograph. The observed differences in feature were severally small, but they were numerous and more independent of one another than the lengths of the various limbs. The best base from which to measure horizontally seemed to be the tangent line that touched the convexity of the chin and the concavity between the brow and the nose. When the chin was bearded, the position of the concavity must be guessed. A good unit of horizontal scale was given by the distance between the line just mentioned and one drawn parallel to it that just touched the nose. It was better to keep the unit of vertical scale separate, and to use for it the distance between the pupil of the eye and the parting of the lips, measured parallel to the above lines. One of the objects the lecturer had in view in the present inquiry was to discover measurable and independent peculiarities that would assist in hereditary investigations. He had some hope that by noting many of these it might be possible to trace in every person clear evidence of his parentage and near kinship.

ECCLESIASTICAL APPOINTMENT.—The Rev. George Rawlinson, Canon of Canterbury and Camden Professor of Ancient History in the University of Oxford, has accepted the valuable living of Allhallows, Lombard-street, offered him by the Dean and Chapter of Canterbury, which recently became vacant by the death of the Rev. Prebendary Mackenzie.

Times
May 26/88

1. Scotland, E.—Same as No. 0.
2. England, N.E.—Northerly and north-westerly winds, moderate; fair, milder.
3. England, E.—Same as No. 2.
4. Midland Counties.—Same as No. 2.
5. England, S. (with London and Channel).—North-easterly winds, moderate to light; fair, cold.
6. Scotland, W. (and Isle of Man).—Same as No. 0.
7. England, N.W. (and N. Wales).—North-easterly winds, moderate; fine.
8. England, S.W. (and S. Wales).—Same as No. 7.
9. Ireland, N.—Same as No. 7.
10. Ireland, S.—Same as No. 7.

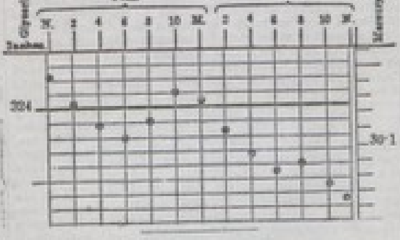
Warnings.—None issued.

By order, ROBERT H. SCOTT, Secretary.

The Times Office, Noon.

Readings of the Jordan Glycerine Barometer (corrected for temperature and reduced to mean sea level), taken at intervals of two hours during the past twenty-four hours.

May 25–26.



Temperature and Hygrometric Condition of the Air in London.

May 26.

Hour of Observation.	Temperature. Air.	Temperature. Dew Point.	Tension of Vapour.	Weight of Vapour in 10 cubic feet of Air.	Drying Power of Air (per 10 cubic feet).	Humidity (Saturation = 100).
	Degrees.	Degrees.	Inches.	Grains.	Grains.	Per cent.
Noon ..	52	44	·288	32	13	73

Minimum Temperature—46deg. | Maximum Temperature—56deg.

Explanation.

The Dew-point is obtained directly, by the use of a Dines's Hygrometer.

The Hygrometric values are calculated by using a modification of Glaisher's Hygrometric Tables, 6th edition.

The "Drying Power" of the air is the weight of vapour which 10 cubic feet of air were still capable of absorbing at the time of observation.

The Humidity of the air (saturation = 100) is what is commonly known as "Relative Humidity."

LATEST CHANNEL WEATHER REPORTS.

(From Lloyd's.)

Dover, May 26, 8 42 a.m.—Wind north-east, moderate; clear. Barometer 29.95; thermometer 53. Cross-Channel steamers will have a smooth passage.

Folkestone, May 26, 10 a.m.—Wind north-north-east, light; weather dull. Barometer 30·05, falling. Smooth passage across Channel.

Prawle Point, May 26, 8 54 a.m.—Wind east, fresh; dull; sea moderate.

Lizard, May 26, 9 27 a.m.—Wind east, fresh; hazy.

THE MAILS.

The Norddeutscher Lloyd steamer Trave, which left Southampton at 7 p.m. on Thursday, 17th inst., arrived at New York at 11 a.m. yesterday.

The Royal Mail Company's steamer Orinoco, from the West Indies, viâ Plymouth and Cherbourg, arrived at Southampton this morning, with passengers, £58,335 in specie for England, and a full cargo. The mails were landed at Plymouth.

(From Lloyd's.)

BALTIMORE, May 26.—The Johnston Line steamer Barrowmore, from Liverpool, has arrived here.

DOVER, May 26.—The German steamer Paula, from Hamburg for New York, passed here between 7 a.m. and 8 a.m. to-day.

GLASGOW, May 25.—The State Line steamer State of Nevada, for New York, left here to-day.

GRAVESEND, May 26.—The Allan Line steamer Nestorian, from Montreal, passed here yesterday for Millwall Dock, not for Royal Albert Dock as reported yesterday. The steamer Stranton, from Madras for London Dock, passed here to-day. The steamers Elderslie, for Hobart, &c.; and Adowa, for Bussorah; and the French steamer San Martin, for Buenos Ayres, left here yesterday.

HALIFAX, May 23.—The Furness Line steamer Damara, for London, left here at noon to-day.

LIZARD, May 26.—The Belgian White Cross Line steamer Pieter de Coninck, from New York for Antwerp, passed here at 5 15 a.m. to-day.

NEWCASTLE, N.S.W., May 26.—The Milburn Line steamer Port Denison, for Batavia, left here to-day.

PERIM, May 25.—The Clan Line steamer Clan Mackay, from Bombay for Dunkirk, the Ocean Steamship Company's steamer Palinurus, from London for Shanghai, the Clan Line steamer Clan Macpherson, from Calcutta for London, and the steamer Cedar Branch, for Bombay, passed here to-day.

PHILADELPHIA, May 23.—The American Line steamer British Princess left here at 6 p.m. to-day.

PRAWLE POINT, May 26.—The Orient Line steamer Iberia, from London for Adelaide, passed here to-day.

QUEBEC, May 26.—The Allan Line steamer Pomeranian, from London, and the steamer Danish Prince, from London, have arrived here. The Donaldson Line steamer Cynthia, from the Clyde for Montreal, has passed Father Point.

SOUTHEND, May 26.—Messrs. Donald Currie's Castle Packet Norham Castle passed here at 9 5 a.m. to-day in tow.

SUEZ CANAL, May 26.—The steamer Teviot, from the Clyde for Hongkong; the Dutch steamer Bromo, from Rotterdam for Batavia; the Messageries Maritimes Company's steamer Anadyr, from Marseilles for Yokohama; the British India steamer Bulimba, from London for Kurcentre or axis a, around which it is caused to revolve, in combination with the rollers E F, arranged to carry the sensitive paper B, which is carried over the rollers C D between the rollers G; the rollers C D being caused to revolve with the instrument A, so that a fresh surface of sensitive film shall be brought continuously within the focus of the lens as the instrument A revolves, substantially as and for the purpose specified.

6. A photographic instrument A, pivotted on its optical centre or axis a, in combination with sensitive film located within the focus of its lens on a circle struck from the optical centre or pivot of the instrument, substantially as and for the purpose specified.

7. A photographic instrument A, pivotted on its optical centre or axis a, a sensitive film located within the focus of its lens on a circle struck from the optical centre or pivot of the instrument, in combination with a narrow passage way located between the lens and its focus, and caused to revolve with the instrument, substantially for the purpose hereinbefore explained.

10770. John Urie, Senior, and John Urie, Junior, both of 83, Jamaica Street, Glasgow, Lanarkshire, Photographic Artists, for "Improvements in photographic printing machines."—Dated August 23rd, 1886.

The claim is for details of exposing machines of the Fontayne type.

Patents Granted in America.

366,527. Ludwig Lendry, New York, N.Y., assignor, by mesne assignments, to Josephine Lester and Nina Lendry, both of same place. "Process of producing designs on glass plates."—Filed September 3, 1886. Serial No. 212,599. (No model.)

Claim.—1. The herein-described process of producing designs on glass plates, consisting of providing a glass plate with a coating consisting principally of Egyptian asphalt, colophony, coal-tar, bicarbonate of potassium, caoutchouc, and ozokerite, and then placing a pattern of the design to be produced on the said plate, after which the plate and its pattern are exposed to the action of light, and the pattern is removed, and the plate is washed with oil, substantially as described.

2. A new article of manufacture, consisting of a glass plate having a permanent coating consisting principally of Egyptian asphalt, colophony, coal-tar, bicarbonate of potassium, caoutchouc, ozokerite, and gum-arabic, and designs printed on the said glass plates with the aid of light and patterns, substantially as described.

3. The herein-described composition of matter used for producing designs on glass plates, consisting of Egyptian asphalt, coal-tar, bicarbonate of potassium, caoutchouc, gum-arabic, colophony, ozokerite, and turpentine or benzine, in the proportions specified.

Correspondence.

PHOTOGRAPHY AND SILHOUETTES.

Sir,—In reply to your request I enclose an average silhouette, which I cut from an ordinary print taken from the original negative. Neater fingers than mine would have cut it out better. Sometimes I have cut out the silhouettes from prints as soon as they were removed from the printing frame, and left them to blacken; they suited my particular purpose, but it is needless to say that their tint was not agreeable. I have sometimes printed them as "blues" (cyanide prints) on the paper used by architects, and these are very effective.

Those who are acquainted with Lavater's original work, of which the small English translation is little better than a caricature, will understand the value of well-made silhouettes. They are particularly useful in studying family characteristics, which, I think, are, on the average, far better observed in profiles than in any other one view of the features. The truth of this statement may be verified in church, where whole families, each occupying a pew, can often be seen sideways, and each family can be taken in and its members compared with a single glance. The instances will be found numerous in which the profiles of a family are curiously similar, especially those of the mother and her daughters. This is most noticeable where their ages and bodily shapes differ greatly, as when the daughters are partly children and partly slim girls, and the mother is not slim at all.

Permit me to take this opportunity of disclaiming a misprint in the very first word of my letter the week before last. It was printed "My"; it should have been "Any." The effect of the "My" is to give a tone of presumption to what I wished to say, quite foreign to my real intention.

Francis Galton.

Dear Sir,—F. Galton's letter reminded of my own attempts about two years ago, one of which I enclose. It may be considered under-printed, also over-exposed. The

few I did excited but little attention. As photos. there is but little work in them, and they could be supplied cheaply. I think F. G.'s plan of cutting out not an advantage.—Yours truly, A. H. Cade.

Cornhill, Ipswich, July 14.

Proceedings of Societies.

Photographic Society of Great Britain.

A special general meeting was held on Tuesday, the 19th inst., in the Gallery, 5a, Pall Mall East, to consider certain alterations and additions to the existing laws of the Society. The chair was occupied by James Glaisher, F.R.S., president.

The Chairman, in opening the proceedings, explained that owing to the important character of the suggested alterations, the Council had been a long time in discussing the form of the new rules, hence the reason for holding the special meeting yearly "Almanac," and I sent him a short article on "Optical Contact," which you will find on page 118 for that year. If you follow out the instructions I give, you will find it an easy matter to mount your prints in optical contact.

And now, ladies and gentlemen, I have finished my task. Much more could be written about this fascinating branch of photography, but I have already exceeded the time allowed. I have told you plainly what little I know, and what I believe to necessary to success. If what I have communicated should, in the smallest degree, be the means of assisting any of my amateur friends to overcome their difficulties, I shall be satisfied; while on the other hand, if you deem me a bore, give me a back seat at next Convention.

Patent Intelligence.

Applications for Letters Patent.

9788. THOMAS SIMPSON SKELTON, 80, Coleman Street, London, E.C., for "Improvement in the preparation of single transfer papers used in producing carbon photographs."—July 12, 1887.

9948. THOMAS PARSONS WATSON, 313, High Holborn, London, for "An improved spring fastening for the shutters of dark slides of photographic cameras."—July 15, 1887.

9954. ARTHUR RAYMENT, 34, Southampton Buildings, London, W.C., for "Improvements in photographic cameras, and in the shutters therefor."—July 15, 1887.

Specifications Published.

6673. ALFRED JULIUS BOULT, of 323, High Holborn, in the county of Middlesex, M.I.M.E., for "Improvements in photographic cameras or instruments." (Communicated from abroad by John Robert Connon, of the village of Elora, in the county of Wellington, in the province of Ontario, Canada, photographer.)—Dated 6th May, 1887.

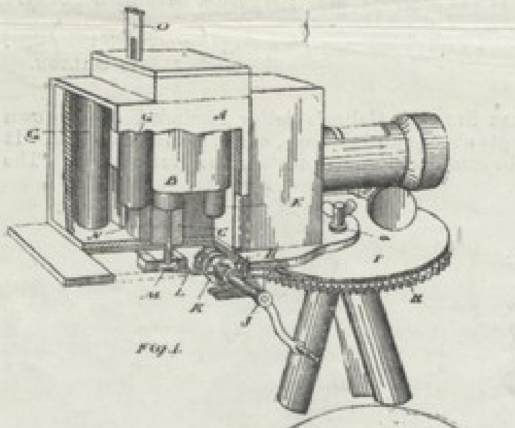


Fig. 1.

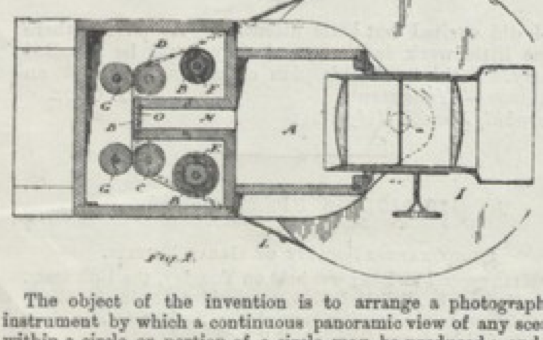


Fig. 2.

The object of the invention is to arrange a photographic instrument by which a continuous panoramic view of any scene within a circle or portion of a circle may be produced; and it consists essentially in pivotting the photographic instrument on the optical centre or axis of the lens, and so arranging the sensitive film that as the instrument revolves the said film shall be presented to the focus of the lens exactly as required to receive the image formed by the lens, substantially as hereinafter more particularly explained.

Fig. 1 is a perspective view, partially in section, showing an instrument constructed in accordance with this invention.

Fig. 2 is a sectional plan of the instrument.

Although the construction of this instrument may be considerably altered from that shown in the drawing, the said construction will be sufficient to illustrate the intention and operation of this invention, so that others skilled in the art of photography will have no difficulty in understanding it.

The first point which must be observed is that the instrument A must be pivoted at *a*, which represents exactly the optical centre or axis of the lens. It is also necessary that the sensitive film, whether it be placed on paper B, glass, or any other substance, must be placed on a radius struck from the optical centre *a*.

In the drawing, the sensitive paper B is shown passing around the two rollers C D, which are located so as to hold the paper B at the proper distance from the optical centre *a* mentioned. This paper B is stored on the roller E, and as it leaves this roller, as hereinafter described, it is wound on the roller F, as hereinafter explained. The rollers G are merely friction rollers for the purpose of holding the paper B against the rollers C D as shown.

A spur wheel H is fixed to the circular top I of the stand. A crank handle J is journalled on the bottom of the instrument A, and has fixed to it a worm-pinion K, which meshes with the spur wheel H as shown. Consequently, the revolving of this crank shaft J will cause the instrument A to revolve upon its pivot *a*. The circular top I is grooved so as to receive the cord L, which passes around the circular top I, and around pulleys M, fixed or attached to the spindle of the rollers C D; consequently, the said rollers must necessarily revolve with the instrument A, causing the paper B to leave the roller E, pass between the rollers C D, and be wound upon the roller F; this latter roller being provided with a suitable spring so as to cause it to take up the slack paper, bringing into the focus of the lens a continuous supply of the sensitive film, so that a continuous panoramic image is produced on the sensitive paper as the instrument is revolved on its axis.

In order that only a small portion of the sensitive film shall be exposed to the action of the lens, a narrow vertical passage-way N is formed, located between the lens and its focus. As it may be sometimes desirable to reduce the width of this passage-way, a slide O is provided to fit into the passage-way N. In this slide a narrow vertical slit is made representing the exact width of the space on the sensitive paper which is wished to be exposed at any one time to the action of the lens.

From this description it will be seen that by arranging a photographic instrument as I have just described, a complete panoramic and continuous view may be secured at one exposure of the entire country embraced within a circle.

Having now particularly described and ascertained the nature of the said invention as communicated to me by my foreign correspondent, and in what manner the same is to be performed, I declare that what I claim is:—

1. A photographic instrument pivotted on the optical centre or axis of the lens in combination with a sensitive film arranged so that as the instrument revolves, the said film shall be presented to the focus of the lens, exactly as required to receive the image formed by the lens, substantially as and for the purpose specified.

2. A photographic instrument pivotted on the optical centre or axis of the lens, in combination with a sensitive film placed on paper, glass, or any other substance located on a radius struck from the optical centre or axis of the lens, substantially as and for the purpose specified.

3. A photographic instrument pivotted on the optical centre or axis of the lens, in combination with a sensitive film placed on paper, glass, or any other substance located on a radius struck from the optical centre or axis of the lens, and of a narrow passage way located between the lens and its focus, substantially as and for the purpose specified.

4. A photographic instrument A, pivotted on its optical centre or axis *a*, around which it is caused to revolve, in combination with the rollers C D, between which the sensitive paper B passes, and which are caused to revolve with the instrument A, so that a fresh surface of sensitive film shall be brought continuously within the focus of the lens as the instrument A revolves, substantially as and for the purpose specified.

5. A photographic instrument A, pivotted on its optical

F. Galton p. 173
Personal Description &c

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

No. 973, Vol. 38.] THURSDAY, JUNE 21, 1888. [Price Sixpence.

Registered as a Newspaper at the General Post Office.]

f. 3r

THURSDAY, JUNE 21, 1888.

THE STEAM-ENGINE.

The Steam-Engine. By G. C. V. Holmes. (London: Longmans, 1887.)

THIS treatise is intended as an elementary text-book for technical students. In many respects it fulfils its purpose, at least better than any book of moderate size with which we are acquainted. It is clearly written; its arrangement, if not the best possible, is orderly; it is so far practical that problems arising in the actual design and use of steam-engines are not ignored, but attacked in a sufficiently elementary way; and the *rationale* of processes involved in the use of steam is explained adequately and correctly on the whole. The woodcuts represent fairly good examples of construction, with the exception of one or two, like those of the injector and exhaust-ejector, which are antiquated, and one or two others so bad that they are obviously mere imaginary sketches. Nevertheless the book fails of being what a really good elementary text-book of the steam-engine might easily be—what, indeed, anyone of Mr. Holmes's competence would make it, if some experience in teaching had shown him the needs and difficulties of engineering students. It is a little to be feared that Mr. Holmes's book is marred by an attempt in part to adapt it to the requirements of some existing examinations on the steam-engine, which are more scrappy and less scientific than the worst of existing text-books. If only a really adequate practical and elementary text-book were written, it would control the examinations instead of needing to be adapted to them.

The treatise includes the mechanics, the thermodynamics, and rules for the design of steam-engines. The portions included under the last head are by far the weakest portions of the book. The scattered discussions of the strength of some portions of engines and boilers are too vague and general to be of practical value. The rules for the strength of fly-wheels at p. 246, and that for area of steam passages at p. 204, are examples of the kind of useless rules which stop short of encountering any one of the actual difficulties of ordinary designing. It is just these portions of the book which seem designed to meet the exigencies of a student cramming for an examination, and the book would be improved by their omission. An elementary treatise on the steam-engine might well leave questions of design on one side, and confine itself to a descriptive account of engines and boilers, with theory enough to explain the actions involved. But then it is neither necessary nor useful in such a treatise to introduce elementary physics and mechanics. A technical student may be assumed to know elementary science. "I have not assumed," says the author, "the slightest acquaintance on the part of the reader with the sciences of heat and motion, and have consequently devoted many pages to the explanation of such parts of these sciences as are necessary for the proper understanding of the working of engines." Hence we find a chapter on the nature of heat, including a discussion of the melting of ice, and the graduation of thermometers. There are definitions of mass, weight, force, and velocity, and arithmetical examples of the laws of motion. Surely all this would only be justifiable in an age when elementary books were scarce and dear. An ordinary student finds it a tiresome obstruction, when the way to the subject of the book is barred by such repetition. On the other hand, a brief but clear and critical account of the methods by which Regnault determined the fundamental constants for steam would have been very useful. It would have shown both the meaning of the terms used, and the probable trustworthiness of the determinations. In place of this, we find only verbal definitions and formulæ.

The thermodynamical portion of the book is probably its best and clearest part, and that in which it is most in advance of any quite elementary book of a similar kind. It must be understood that in criticizing this portion we do not ignore the fact that the author has done a service to elementary technical students.

On p. 67 a diagram is copied from Maxwell, and called a diagram of isothermals of dry saturated steam. It has escaped the author that for dry saturated steam there is no isothermal. At a point in the curve, say at 212°, the steam is saturated: on one side of this it is a mixture of steam and water, or conventionally wet steam; on the other side it is superheated steam. The saturation curve so useful in steam-engine calculations is nowhere mentioned. Further, in any modern treatment of the steam-engine it ought to be recognized that the engineer is always or almost always dealing not with dry saturated steam but with wet steam. The algebraical expressions for the total heat, &c., of wet steam should be introduced along with those for dry steam. Curiously, nowhere in this book can we find an expression for the latent heat of steam, though no quantity is so often required. The total heat is given, and so the latent heat can be inferred, but surely the ordinary approximate expression for latent heat is also useful.

In Chapter III. the theory of perfect engines is given. Following the precedent of treatises of wider scope, the author begins with the laws of expansion of permanent gases. Next the theorem about a reversible engine is given, but in a form in which it is restricted to the case of an air-engine. The efficiency of the reversible engine so obtained is afterwards spoken of as the efficiency of perfect heat-engines in general. But the independence of the result on the nature of the fluid employed is nowhere indicated. The diagram for a perfect steam-engine is given on p. 113. But no elementary student will perceive why the efficiency of this is the same as that of the air-engine, at least without explanation. The only idea ordinary students get from the theorem about the Carnot engine is that the efficiency of *any* engine is proportional to the range of temperature in the cylinder. In the case of the actual steam-engine this is so wrong as to be nearly the reverse of the truth, and the misconception is hardly anywhere adequately guarded against. It is very doubtful whether the Carnot engine ought to be introduced into the elementary theory of the steam-engine. An ordinary indicator-diagram can be taken, and the relation of the heat expended to the heat utilized determined. From the feed measurement and indicator-diagram the steam liquefied at the end of admission and at exhaust can be ascertained. The heat expenditure corresponding to work of admission, expansion, and expulsion can be calculated. From the condenser measurement the heat abandoned can be found, and an estimate formed of the loss by radiation. Repeating the calculation for different degrees of expansion, and perhaps for cases of a jacketed and unjacketed cylinder, really clear notions will be formed of the relative importance of the processes going on in the engine. All this can be done in a perfectly elementary way, and the student will soon perceive that it is in the direct study of the losses of heat, and not in attempts to realize the conditions of a Carnot engine, that improvement is to be sought.

We fail to see the use of reviving the antiquated empirical treatment of Navier and de Pambour given in Chapter IV. De Pambour's equations involve so many assumed quantities that they are practically useless. The author might have remembered that contrary to de Pambour's view the friction of an engine is not proportional to the load, but very nearly independent of it.

Chapter V. deals with the mechanics of the engine. But the simplest graphic methods for finding curves of crank pin effort and acceleration are not given. The next chapter, on slide-valve diagrams, is one of the clearest and most useful in the book.

In Chapter XI. the very difficult question of cylinder condensation is treated on the whole clearly and with insight. But the obscurities of this difficult part of the explanation of the steam-engine are, as might be expected, not quite removed. The author probably attaches much too great importance to radiation from the cylinder sides to the steam, and too little to conduction from the cylinder sides to the water lying on its surface. The following passage will certainly puzzle a student :—

"The second cause—excess of condensation over re-evaporation—is a most fruitful source of waste, and should be most carefully guarded against. It results in the continuous accumulation of water in the cylinder, and consequently causes an amount of waste which goes on increasing with each stroke."

Of course, if the accumulation is continuous the cylinder must get full, which is impossible. In steady working, initial condensation must exactly equal re-evaporation and water carried mechanically to the condenser. Priming and condensation during expansion may for the argument be neglected. What is prejudicial is not excess of condensation over re-evaporation, but retention of water in the cylinder after exhaust.

THE ANIMAL ALKALOIDS.

On the Animal Alkaloids, the Ptomaines, Leucomaines, and Extractives in their Pathological Relations. By Sir William Aitken, Knt., M.D., F.R.S., Professor of Pathology in the Army Medical School. (London: H. K. Lewis, 1887.)

A Treatise on the Animal Alkaloids, Cadaveric and Vital; or, The Ptomaines and Leucomaines chemically, physiologically, and pathologically considered in Relation to Scientific Medicine. By A. M. Brown, M.D. With an Introduction by Prof. Armand Gautier, of the Faculté de Médecine of Paris, &c. (London: Baillière, Tindall, and Cox, 1887.)

THE advancement of modern chemistry has increased our knowledge of the alkaloids occurring in the vegetable kingdom—bodies which are of great importance both in a therapeutical and a toxicological aspect. Since the year 1872, a new mode of natural origin of alkaloids has been discovered, viz. from animal sources, and the knowledge and investigation of these bodies have proved of great service in the study of both physiological and pathological chemical processes.

Ptomaïnes were first discovered in decomposing animal tissues, as their pseudonym of "cadaveric alkaloids" implies. Their presence in these dead tissues introduced a new factor in the *post-mortem* search for poisons in suspected cases—a factor, however, the importance of which has been somewhat exaggerated. A more important result of their discovery has been the explanation of the cases of poisoning by decayed animal foods, such as sausages, tinned and putrid meats, in which they have been found.

Further researches have, moreover, brought to light the fact that similar bodies of an alkaloidal nature may be produced within, and by, the living organism. In this case they may be considered as of "vital" origin, the products, that is, of the metabolism of protoplasm; or they may, in some cases, be the result of the decomposition of albuminoid bodies: in both cases, the term "leucomaïnes" has been used to designate them. A leucomaïne—peptotoxin—has, for example, been found by Brieger as a product of artificial peptic digestion; another has been discovered in the body of the sea-mussel (*Mytilus edulis*), and to its presence were ascribed the symptoms of poisoning which occurred in Wilhelmshaven, in many people who had eaten the shell-fish. These facts, of the origin of poisonous alkaloids by the decomposition of albuminoid bodies, and also in the living animal tissues, open out a wide field of research in pathology, and have perhaps led to more speculation than our present knowledge warrants.

The two books before us deal with the whole subject of poisonous alkaloids. Sir W. Aitken's small work owes its origin to an introductory lecture delivered by him at the Army Medical School at Netley. It is chiefly a short *résumé* of the work done on the subject. The second part of the *brochure* will be found of interest to medical men, as it gives the direction in which modern thought is tending with regard to the part played by poisonous alkaloids in the production of disease. The conclusions drawn can, in the present state of our knowledge, be considered merely as suggestions: many more facts must come to light before the *rôle* played by the "vital" alkaloids in pathological processes can be adequately, or even reasonably, discussed.

Dr. Brown's work is of a more ambitious nature, and purports to be a treatise on the subject of animal alkaloids generally. After commencing with a short history of the subject, the author proceeds to give an account of the methods for extraction of the alkaloids, and of the chemical and physiological properties of ptomaïnes; the "vital" alkaloids, leucomaïnes, being treated in a similar manner. The account of the methods of extraction might, we think, be made more practical by being considered a little more fully, as it is to this part of the book that workers in this field will turn for information.

Of the chemical and physiological properties of these alkaloids, a fairly complete account is given: our knowledge of these properties is, however, up to the present so imperfect, that the researches carried on during the last sixteen years only serve as a basis for future work. Much has yet to be done regarding the physiological action of these bodies; and no progress can be made in this respect until the alkaloids have been extracted in a pure state. It is almost useless, in the interests of science, to speak of the action of alkaloids extracted by various reagents; though, in certain cases of poisoning, the investigation of such an action may be of immediate utility. Dr. Brown has devoted much space to the consideration of the part played by the vital alkaloids in physiological or pathological conditions. In his account he has closely followed the views of M. Gautier, whose researches have thrown great light on the subject.

Dr. Brown's work may be recommended as giving a general account of the present state of our knowledge regarding these alkaloids. S. H. C. M.

PRACTICAL FORESTRY.

Practical Forestry: its Bearing on the Improvement of Estates. By Charles E. Curtis, F.S.T., F.S.S., Professor of Forestry, Surveying, and General Estate Management at the College of Agriculture, &c. (London: *Land Agent's Record* Office, 1888.)

THE present work is described as a reprint of a series of papers on "Practical Forestry," which appeared in the *Land Agent's Record*, and the author's object in republishing his ideas on practical forestry is to promote and encourage the study of true forestry among the British land-owners and land agents, and especially to impress upon students the necessity of acquiring a sound practical knowledge of a branch of land economy so long neglected and ignored. So far so good; but when the author says, "I trust this publication will be the means of spreading this object more widely" (*sic*), we fear that he will be grievously disappointed.

To begin with: the book is written in doubtful English. Though the correct use of the English language is not absolutely essential, yet in order to be a really useful work, a book should be written in language which complies with the ordinary grammatical rules, and which is also intelligible to the class of readers expected to profit by its perusal. The whole book is conceived in a very narrow spirit, and the expressed views of the author are frequently open to question. Take for instance the following passage (p. 40):—

"The great and true principle of thinning is to encourage the growth of those trees which are left, and not to secure a financial present return. This, though important, is quite a secondary consideration, and should at all times be ignored."

We beg to say that the great and true principle of thinning is nothing of the kind. In every instance the owner, or his manager, must consider what the objects of his management are. They may be:—

(1) To produce material of a certain description.

(2) To produce the greatest possible number of cubic feet per acre and year.

(3) To secure the highest possible money return from the property.

(4) To secure the highest possible interest on the invested capital.

(5) To improve the landscape, or to affect the climate, &c.

In each of these cases the method of thinning will be different.

Again, the description given of a true forester (p. 12) is somewhat illusory. If the author thinks that a man who has studied botany, vegetable physiology, geology, entomology, &c., is also able to wield the axe, and use with skill the pruning saw or knife, he is likely to be disappointed in nine cases out of ten. Such ideas are theoretical speculations, and not the result of practical experience.

The chapter on "Soil and Site" is of a very hazy description whenever the author attempts to rise above ordinary platitudes. He promises to describe clearly in future sections the nature of the soils and sites in which the individual trees most delight, but, as far as we can see, he has got over the difficulty by omitting to redeem his promise.

To sum up, the book is not likely to further the object which the author seems to have at heart. The experienced forester will find nothing new in it, and the beginner will only meet with badly arranged statements which are frequently not in accordance with the teaching of science or of practice. Sw.

OUR BOOK SHELF.

Tropical Africa. By Henry Drummond. (London: Hodder and Stoughton, 1888.)

THIS is a brightly-written and most interesting sketch of Mr. Drummond's experiences during a recent journey in East Central Africa. He has no very surprising or exciting adventures to describe, but in the course of his narrative, which is written with a vigour and grace unusual in books of travel, he contrives to convey a remarkably vivid impression of the country through which he passed. Going up the valley of the Shiré River, he visited Lake Shirwa, of which little has hitherto been known; then he went on to Lake Nyassa, and to the plateau between Lake Nyassa and Lake Tanganyika. During the whole of his journey he was a close observer, not only of the physical features of the districts he visited, but of the various classes of phenomena which interested him as a geologist, an ethnographer, and a student of natural history. In one admirable chapter he gives a full and striking account of the white ant, which he had frequent opportunities of studying; in another he brings together many curious illustrations of the well-known fact that among numerous species of animals mimicry is one of the means of self-protection. Before going to Africa, Mr. Drummond had mentally resolved not to be taken in by "mimetic frauds," yet he was "completely stultified and beaten" by the first mimetic form he met. This was an insect—one of the family of the *Phasmidæ*—exactly like a wisp of hay. Another insect, which he often saw, closely resembles a bird-dropping, and the consequence is that "it lies fearlessly exposed on the bare stones, during the brightest hours of the tropical day, a time when almost every other animal is skulking out of sight." Mr. Drummond has of course much to say about the chances of a great future for Africa, and in this connection he presents a good deal of valuable information as to the capacity of the natives for work and as to the wrongs inflicted upon them by vile gangs of slave-traders.

Plotting, or Graphic Mathematics. By R. Wormell, D.Sc., M.A. (London: Waterlow and Sons, Limited, 1888.)

THIS book is intended chiefly for those who have mastered the beginnings of algebra and Euclid, and so is very elementary. The method employed throughout is that of using squares, and preparatory exercises are first given to show the student the different purposes to which they may be applied with facility. Proportion and the determination of areas are the subjects of the first two chapters, followed by a chapter on the tracing of paths of projectiles, with various data. The sections of the cone, such as the parabola, ellipse, and hyperbola, are next described, with various methods of tracing them. The book contains a great number of numerical examples, and concludes with a chapter on the higher graphs and curves of observation.

The Elements of Logarithms. By W. Gallatly, M.A. (London: F. Hodgson, 1888.)

IN this little book of thirty-one pages the various rules and methods of treating logarithms are stated and explained in a simple and precise way, and those beginning the subject would do well to read through these few pages. Numerous examples are put in here and there, and at the end the author has added a collection of questions taken from the Woolwich and Sandhurst examination papers for the years 1880–87.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Thunderstorms and Lightning Accidents.

As the season of thunderstorms and lightning accidents is now approaching, I hope you will kindly allow me to make known through your columns the fact that, in the interests of science, the Institute of Medical Electricity is very desirous of obtaining authentic information concerning lightning accidents, whether fatal or otherwise. I should therefore esteem it a favour if some of the many friends of humanity among your readers will assist us to investigate these phenomena by sending me such particulars of accidents of this nature as they may have personal or trustworthy knowledge of as soon after they occur as possible.

Of course, electrical and physiological details are what we most require, but trustworthy general information is often valuable, and will be gratefully received.

24 Regent Street, S.W. H. NEWMAN LAWRENCE.

Nose-Blackening as Preventive of Snow-Blindness.

I ONLY read Prof. Ray Lankester's letter the other day on the above, which appeared in NATURE of May 3 (p. 7). I have made inquiries among travellers in the snow regions of North America, and find the practice to be quite common and well known, but have met with no one who can explain it. I may say, however, that when I visited New Zealand in 1884 there were in one of the canoes which came off to our ship several naked natives, who had disfigured their faces by blackening their noses and eyes, and running a black fillet round the face, which gave them a villainous aspect; and I, in that insolent ignorance which seems to prevail with all pious people who have dealings with "the heathen of the isles," believed they had got themselves up in this way in order to frighten us. But it may well have been for other reasons. Certainly the sun's heat, reflected from the still waters of the sea, was quite as painful as any I ever felt in the regions of the silver snow. I subsequently found that the black used by these people, who are of a pale complexion, was the oxide of manganese, called in their tongue *labân*.

A. J. DUFFIELD.

The Delaware, Keweenaw Michigan, U.S.A., June 4.

The *Lethrus cephalotes*.

THE beetle which is described in your issue of June 7 (p. 134), by the British Consul at Varna, is probably the *Lethrus cephalotes*, which has proved so destructive to vineyards in East and South-East Europe. It is a dull black beetle, easily recognized by the swollen truncated ends of the antennæ; its length is about 21 mm. It lives chiefly in dry and sandy soil, and during dry weather the beetles leave their holes generally between nine and eleven in the morning and after three in the afternoon, to attack the tender parts of the vine, as Mr. Brophy describes.

Taschenberg is of the opinion that the buds, &c., of the vine which are dragged back to the holes of the beetles serve as food for the larvæ. As the beetles show a marked aversion to water, it is possible that the pest might be lessened by copiously watering the infected areas. ARTHUR E. SHIPLEY.

Christ's College, Cambridge, June 16.

Proposed Fuel-testing Station for London.

WILL you allow me to put before your readers the following proposition for the establishment of such a station, the desirability of which has been much impressed upon me within the last few years? So far as I know, there does not exist anything of the kind in this country where, as on the Continent, coals can be tested for their evaporative power, the gases of combustion analyzed, and all the results carefully reported on by experts. I subjoin a few details of the proposed station, with probable cost. It should, I consider, be placed on a perfectly independent footing, and managed by experts, under a small committee appointed by those who assist with money or otherwise. It might follow generally the lines of existing coal-testing stations, but with all modern improvements.

In this country it is remarkable that neither the sellers of coal take the trouble to find out how much heat they are offering, nor the purchasers how much they are getting for their money, and this notwithstanding the hundreds of millions of tons of coal changing hands yearly. Colliery-owners and coal-merchants, as well as the large consumers, know very little about coal calorimeters, although the former sell so much heat, and the latter try to utilize it to the best advantage. How few of the latter weigh their coal regularly, or keep any weekly record of the quantities of ashes and clinkers, to find out how much dirt and incombustible matter they are paying for! How few know what it costs them in fuel to evaporate one thousand gallons of water into steam, which is one of the best standards of comparison in a given district!

Locality.—The station might be in close proximity to a river, canal, or railway-station, so that the coals could be delivered easily and cheaply, and the steam allowed to escape under pressure without causing annoyance. A small piece of land doubtless could be obtained in such a situation at a low rent. The boiler-shed should be about 35 × 20 feet, with a small additional shed for storing the fuel.

Cost.—It would be desirable to allow at least £700 for a start, to cover the cost of the boiler-shed, chimney, 20 horse-power boiler (if such were considered large enough), and the special arrangements for measuring the feed-water with tanks, scales, feed-pump, injector, gas and coal analyzing apparatus, calorimeters, &c. Seeing that until the objects of the station become known it would probably not pay expenses, the help of guarantors would no doubt be necessary.

Yearly Expenses.—The charge for testing and reporting upon each combustible would probably more than cover eventually the salaries of a technical manager, his assistant, and the stoker. Some arrangement might possibly be made by which the manager and his assistant should only attend when required, at any rate at first, in order to diminish expenses.

The station would require to be advertised and made known in various ways. Colliery-owners would no doubt find it to their advantage to have their different kinds of coal tested and reported upon, so as to offer them to their customers with their ascertained heating value or evaporative power. Large consumers of coal (railway companies, water-works, and others) should know the heating value of the coal they are paying for, and the percentage of incombustibles.

I add a few notes on the temporary and permanent experimental heat stations known to me.

(1) The earliest fuel-testing station was established in 1847 at Brix, in Germany.

(2) Sir H. de la Beche and Dr. Lyon Playfair made a series of

experiments before the year 1851 with different coals suitable for the Navy. These trials were conducted near London, under a small marine boiler at atmospheric pressure.

(3) At the English Government dockyards, various interesting experiments have been made under small marine boilers, and the results published in Blue-books.

(4) Messrs. Armstrong, Longridge, and Richardson published in 1858 an account of some valuable experiments they had made with the steam-coals of the Hartley district of Northumberland, under a small marine boiler, for the Local Steam Colliery Association.

(5) At Wigan many excellent experiments were made by Messrs. Richardson and Fletcher about 1867, to test the value of Lancashire and Cheshire steam-coals for use in marine boilers. The water was evaporated under atmospheric pressure from a small marine boiler. This station was afterwards abolished.

In none of the above do the gases of combustion appear to have been analyzed.

(6) A fuel-testing station was worked at Dantzig in 1863.

(7) An important station was opened at Brieg, on the Oder, by the colliery-owners of Lower Silesia in April 1878, with the primary object of testing the value as fuel of the important coal-seams of that province. After working with the most satisfactory results for two years, and establishing the superiority of the Lower Silesian coal, the experiments terminated in 1880. The testing boilers had each 40 square metres of heating surface. Gases and coals were analyzed.

Existing Continental Stations.—(8) The Imperial Naval Administration Coal-testing Station at Wilhelmshaven, Germany, was established in 1877.

(9) Dr. Bunte's coal-testing station, erected at Munich about 1878, particulars of which have been published in the Proceedings of the Institution of Civil Engineers, vol. lxxiii. Here some hundreds of trials have been reported on and published; much valuable work has been done, and many fuels tested, including coals of the Ruhr valley, Saar basin, Saxon and Bohemian coal-fields, and those of Silesia and Upper Bavaria. The boiler of the station has about 450 square feet of heating surface. The gases and coals are analyzed, and all particulars carefully noted. It is one of the most complete stations I have seen.

(10) In Belgium, near Brussels, there is a Government station for testing fuels, under the administration of the Belgium State railways; locomotive boilers are used. The establishment has been at work for the last two years, but no results are published, as they are considered the property of the Government. Private firms can, however, have their coals tested and reported upon.

(11) The Imperial Marine Station, Dantzig.

(12) Boiler Insurance Company at Magdeburg.

The above is a slight outline of the work already done in this direction.

With the view of obtaining the opinions of those interested in starting a fuel-testing station, I ask you kindly to give this letter publicity. If the necessary sum can be raised, we may hope to have before long a practical and useful establishment in London, and to gain from it many interesting practical results respecting the combustion of fuels. BRYAN DONKIN, JUN.

Bermondsey, S.E., June 11.

The Geometric Interpretation of Monge's Differential Equation to all Conics—the Sought Found.

THE question of the true geometric interpretation of the Mongian equation has been often considered by mathematicians. In the first place, we have the late Dr. Boole's statement that "here our powers of geometrical interpretation fail, and results such as this can scarcely be otherwise useful than as a registry of integrable forms" ("Diff. Equ.," pp. 19–20). We have next two attempts to interpret the equation geometrically. The first of these propositions, by Lieut.-Colonel Cunningham, is that "the eccentricity of the osculating conic of a given conic is constant all round the latter" (*Quarterly Journal*, vol. xiv. 229); the second, by Prof. Sylvester, is that "the differential equation of a conic is satisfied at the sextactic points of any curve" (*Amer. Journ. Math.*, vol. ix. p. 19). I have elsewhere considered both these interpretations in detail, and I have pointed out that both of them are irrelevant; the first of them is, in fact, the geometric interpretation, not of the Mongian equation, but of one of its five first integrals which I have actually calculated (Proc. Asiatic Soc. Bengal, 1888, pp. 74–86); the second is out of mark as failing to furnish such a property of the conic as would lead to a geometrical quantity which vanishes at every point of every conic (Journal Asiatic Soc. Bengal, 1887, Part 2, p. 143). In this note I will briefly mention the true geometric interpretation which I have recently discovered.

Consider the osculating conic at any point, P, of a given curve; the centre, O, of the conic is the centre of aberrancy at P, and as P travels along the given curve, the locus of O will be another curve, which we may conveniently call the *aberrancy curve*. Take rectangular axes through any origin; let (x, y) be the given point P, and α, β the co-ordinates of the centre of aberrancy. Then it can be shown without much difficulty that

$$\alpha = x - \frac{3qr}{3qs - 5r^2},$$

$$\beta = y - \frac{3q(pr - 3q^2)}{3qs - 5r^2},$$

whence

$$\frac{d\alpha}{dx} = \lambda T, \quad \frac{d\beta}{dx} = \mu T,$$

where

$$\lambda = \frac{r}{(3qs - 5r^2)^2}, \quad \mu = \frac{pr - 3q^2}{(3qs - 5r^2)^2},$$

$$T \equiv 9q^2t - 45qrs + 40r^3,$$

p, q, r, s, t being, as usual, the successive differential coefficients of y with respect to x.

If $d\psi$ be the angle between two consecutive axes of aberrancy, ds the element of arc, and ρ the radius of curvature of the aberrancy curve, we have

$$\rho = \frac{ds}{d\psi}, \quad ds^2 = d\alpha^2 + d\beta^2,$$

whence

$$\rho = (\lambda^2 + \mu^2)^{\frac{1}{2}} \cdot T \cdot \frac{dx}{d\psi}.$$

But it is easy to show that

$$\frac{d\psi}{dx} = \frac{q(3qs - 5r^2)}{r^2 + (rp - 3q^2)^2},$$

so that

$$\rho = T \cdot \frac{\{r^2 + (rp - 3q^2)^2\}^{\frac{3}{2}}}{q(3qs - 5r^2)^3}.$$

Now, $T = 0$ is Monge's differential equation to all conics, and when $T = 0$ we have $\rho = 0$. Hence, clearly, the true geometric interpretation of the Mongian equation is:

The radius of curvature of the aberrancy curve vanishes at every point of every conic.[1]

This geometrical interpretation will be found to satisfy all the tests which every true geometrical interpretation ought to satisfy, and I believe that this is the interpretation which, during the last thirty years, has been sought for by mathematicians, ever since Dr. Boole wrote his now famous lines. I will not take up the valuable space of these columns with the details of calculation: they will be found fully set forth in two of my papers which will be read next month before the Asiatic Society of Bengal, and will in due course be published in the Journal.

Calcutta, May 18. ASUTOSH MUKHOPADHYAY.

PERSONAL IDENTIFICATION AND DESCRIPTION.[2]

I.

IT is strange that we should not have acquired more power of describing form and personal features than we actually possess. For my own part I have

[1] The differential equation of all parabolas,

$$3qs - 5r^2 = 0,$$

is also easily interpreted, viz. calling the distance OP between the given point and the centre of aberrancy the *radius of aberrancy*, and the reciprocal of this (= I) the *index of aberrancy*, we have, easily,

$$I = \frac{3qs - 5r^2}{3q\{r^2 + (rp - 3q^2)^2\}^{\frac{1}{2}}},$$

so that the interpretation is that *the index of aberrancy vanishes at every point of every parabola.*

[2] The substance of a Lecture given by Francis Galton, F.R.S., at the Royal Institution on Friday evening, May 25, 1888.

frequently chafed under the sense of inability to verbally explain hereditary resemblances and types of features, and to describe irregular outlines of many different kinds, which I will not now particularize. At last I tried to relieve myself as far as might be from this embarrasment, and took considerable trouble, and made many experiments. The net result is that while there appear to be many ways of approximately effecting what is wanted, it is difficult as yet to select the best of them with enough assurance to justify a plunge into a rather serious undertaking. According to the French proverb, the better has thus far proved an enemy to the passably good, so I cannot go much into detail at present, but will chiefly dwell on general principles.

Measure of Resemblance.—We recognize different degrees of likeness and unlikeness, though I am not aware that attempts have been as yet made to measure them. This can be done if we take for our unit the *least discernible difference.* The application of this principle to irregular contours is particularly easy. Fig. 1 shows two such contours, A and B, which might be meteorological, geographical, or anything else. They are drawn with firm lines, but of different strengths for the sake of distinction. They contain the same area, and are so superimposed as to lie as fairly one over the other as may be. Now draw a broken contour which we will call C, equally subdividing the intervals between A and B; then C will be more like A than B was. Again draw a dotted contour, D, equally subdividing the intervals betw een C and A; the likeness of D to A will be again closer. Continue to act on the same

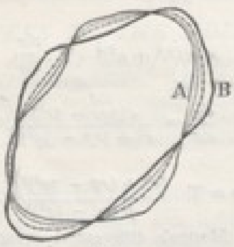


FIG. 1.

principle until a stage is reached when the contour last drawn is undistinguishable from A. Suppose it to be the fourth stage; then as $2^4 = 16$, there are 16 grades of least-discernible differences between A and B. If one of the contours differs greatly in a single or few respects from the other, reservation may be made of those peculiarities Thus, if A has a deep notch in its lower right-hand border, we might either state that fact, and say that in other respects it differed from B by only 16 grades of unlikeness, or we might make no reservation, and continue subdividing until all trace of the notch was smoothed away. It is purely a matter of convenience which course should be adopted in any given case. The measurement of resemblance by units of least-discernible differences is applicable to shades, colours, sounds, tastes, and to sense-indications generally. There is no such thing as infinite unlikeness. A point as perceived by the sense of sight is not a mathematical point, but an object so small that its shape ceases to be discernible. Mathematically, it requires an infinitude of points to make a short line; sensibly, it requires a finite and not a large number of what the vision reckons as points, to do so. If from thirty to forty points were dotted in a row across the disk of the moon, they would appear to the naked eyes of most persons as a continous line.

Description within Specified Limits.—It is impossible to verbally define an irregular contour with such precision that a drawing made from the description shall be undistinguishable from the original, but we may be content with a lower achievement. Much would be gained if we could refer to a standard collection of contours drawn with double lines, and say that the contour in question falls between the double lines of the contour catalogued as number so-and-so. This would at least tell us that none of the very many contours that fell outside the specified limits could be the one to which the description applied. It is an approximate and a negative method of identification. Suppose the contour to be a profile, and for simplicity's sake let us suppose it to be only the portion of a profile that lies below the notch that separates the brow from the nose and above the parting between the lips, and such as is afforded by a shadow sharply cast upon the wall by a single source of light, such as is excellently seen when a person stands side-ways between the electric lantern and the screen in a lecture-room. All human profiles of this kind, when they have been reduced to a uniform vertical

FIG. 2.

scale, fall within a small space. I have taken those given by Lavater, which are in many cases of extreme shapes, and have added others of English faces, and find that they all fall within the space shown in Fig. 2. The outer and inner limits of the space are of course not the profiles of any real faces, but the limits of many profiles, some of which are exceptional at one point and others at another. We can classify the great majority of profiles so that the whole of each class shall be included between the double borders of one, two, or some small number of standard portraits such as Fig. 3. I am as yet unprepared to say how near together the double borders of such standard portraits should be; in other words, what is the smallest number of grades of unlikeness that we can satisfactorily deal with. The process of sorting profiles into their proper classes and of gradually

FIG. 3.

building up a well-selected standard collection, is a laborious undertaking if attempted by any obvious way, but I believe it can be effected with comparative ease on the basis of measurements, as will be explained later on, and by an apparatus that will be described.

Classification of Sets of Measures.—Prisoners are now identified in France by the measures of their heads and limbs, the set of measures of each suspected person being compared with the sets that severally refer to each of many thousands of convicts. This idea, and the practical application of it, is due to M. Alphonse Bertillon. The actual method by which this is done is not all that could be theoretically desired, but it is said to be effective in action, and enables the authorities quickly to assure themselves whether the suspected person is or is not an old malefactor. The primary measures in the classification are four—

namely, the head length, head breadth, foot length, and middle-finger length of the left foot and hand respectively. Each of these is classified according as it is large, medium, or small. There are thus three, and only three, divisions of head lengths, each of which is subdivided into three divisions of head breadth; again, each of these is further subdivided into three of foot length, and these again into three of middle-finger length; thus the number of primary classes is equal to three multiplied into itself four times—that is to say, their number is eighty-one, and a separate pigeon-hole is assigned to each. All the exact measures and other notes on each criminal are written on the same card, and this card is stored in its appropriate pigeon-hole. The contents of each pigeon-hole are themselves sub-sorted on the same principle of three-fold classification in respect to other measures. This process can, of course, be extended indefinitely, but how far it admits of being carried on advantageously is another question. The fault of all hard-and-fast lines of classification, when variability is continuous, is the doubt where to find values that are near the limits between two adjacent classes. Let us take the case of stature, for

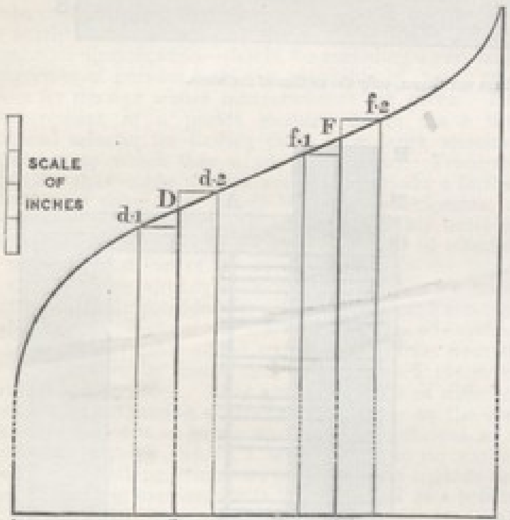


FIG. 4.

illustration of what must occur in every case, representing its distribution by what I have called a "scheme," as shown in Fig. 4.

Here the statures of any large group of persons are represented by lines of proportionate length. The lines are arranged side by side at equal distances apart on a base, A B, of convenient length. A curve drawn through their tops gives the upper boundary of the scheme; the lines themselves are then wiped out, having served their purpose. If the base A B be divided into three equal parts, and perpendiculars, C D, E F, be erected at the divisions between them, reaching from the base up to the curve, then the lengths of those perpendiculars are proportionate to the limiting values between the small and the medium group, and the medium and the large group, respectively. The difference between these perpendiculars in the case of stature is about 2·3 inches. In other words, the shortest and tallest men in the medium class differ only by that amount. We have next to consider how much ought reasonably to be allowed for error of measurement. Considering that a man differs in height by a full third of an inch between the time of getting up in the morning and lying down at night; considering also that measures are recorded to the nearest tenth of an inch at the closest, also the many uncertainties connected with the measurement of stature, it would be rash not to allow for a possible error of at least ± half an inch. Prolong C D, and note the points upon it at the distance of half an inch above and below D; draw horizontal lines from those points to meet the curve at *d*.1, *d*.2, and from the points of intersection drop perpendiculars reaching the base at *c*.1, *c*.2. A similar figure is drawn at F. Then the ratio borne by the uncertain entries to the whole number of entries is as $c_1c_2 + e_1e_2$ to AB. This, as seen by the diagram, is a very serious proportion. There is a dilemma which those who adopt hard and-fast lines of classification cannot avoid: either the fringe of uncertainty is dangerously wide, or else the delicacy with which measures are made is not turned to anything like its full account. If the delicacy is small, the fringe of uncertainty must be very wide; if the delicacy is great, the fringe will be narrow; but then the other advantages of possessing delicate observations are wasted through employing only a few classes. The bodily measurements are so dependent on one another that we cannot afford to neglect small distinctions. Thus long feet and long middle-fingers usually go together. We therefore want to know whether the long feet in some particular person are accompanied by particularly long, or moderately long, or relatively short fingers, though the fingers may in the two last cases be long as compared with those of the general population, and will be treated as long in M. Bertillon's system of classes. Certainly his eighty-one combinations are far from being equally probable. The more numerous the measures the greater would be their interdependence, and the more unequal would be the distribution of cases among the various possible combinations of large, small, and medium values. No attempt has yet been made to estimate the degree of their interdependence. I am therefore having the above measurements (with slight necessary variation) recorded at my anthropometric laboratory for the purpose of doing so. This laboratory, I may add, is now open to public use under reasonable restrictions. It is entered from the Science Collections in the Western Galleries at South Kensington.

Mechanical Selector.—Feeling the advantage of possessing a method of classification that did not proceed upon hard-and-fast lines, I contrived an apparatus that is quite independent of them, and which I call a mechanical selector. Its object is to find which set out of a standard collection of many sets of measures, resembles any one given set within specified degrees of unlikeness. No one measure in any of the sets selected by the instrument can differ from the corresponding measure in the given set, by more than a specified value. The apparatus is very simple, it applies to sets of measures of every description, and ought to act on a large scale with great rapidity, and as well as it does on a small one, testing several hundred sets by each movement. It relieves the eye and brain from the intolerable strain of tediously comparing a set of many measures with each successive set of a large series, in doing which a mental allowance has to be made for a *plus* or *minus* deviation of a specified amount in every entry. It is not my business to look after prisoners, and I do not fully know what need may really exist for new methods of quickly identifying suspected persons. If there be any real need, I should think that this apparatus, which is contrived for other purposes, might, after obvious modifications, supply it.

The apparatus consists of a large number of strips of card or metal, *c1*, *c2* (Fig. 5), say 8 or 9 inches long, and having a common axis, A, passing through all their smaller ends. A tilting-frame, T, which turns on the same axis, has a front cross-bar, F, on which the tips of the larger ends of all the cards rest whenever the machine is left alone. In this condition a counterpoise at the other end of T suffices to overcome the weight of all the cards, and this heavy end of T lies on the base-board S. When the heavy end of T is lifted, as in Fig. 5, its front-bar is of course depressed, and the cards being individually acted on by their own weights are free to descend with the cross-bar unless they are otherwise prevented. The lower edge of each card is variously notched to indicate the measures of the person it represents. Only four notches are shown in the figure, but six could easily be employed in a card of eight or nine inches long, allowing compartments of 1 inch in length, to each of six different measures. The position of the notch in the compartment allotted to it, indicates the corresponding measure according to a suitable scale. When the notch is in the middle of a compartment, it means that the measure is of mediocre amount; when at one end of it, the measure is of some specified large value or of any other value above that; when at the other end, the measure is of some specified small value or of any other value below it. Intermediate positions represent intermediate values according to the scale. Each of the cards corresponds to one of the sets of measures in the standard collection. The set of measures of the given person are indicated by the positions of parallel strings or wires, one for each measure, that are stretched

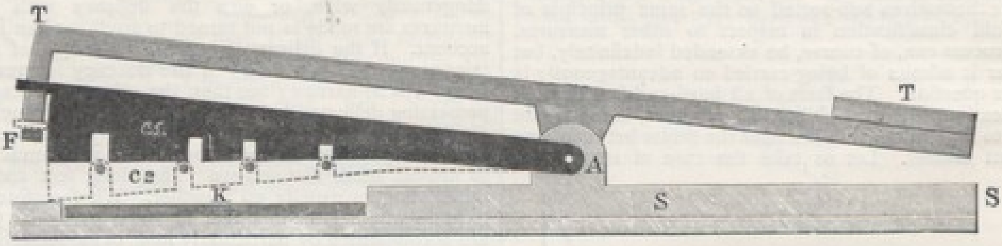
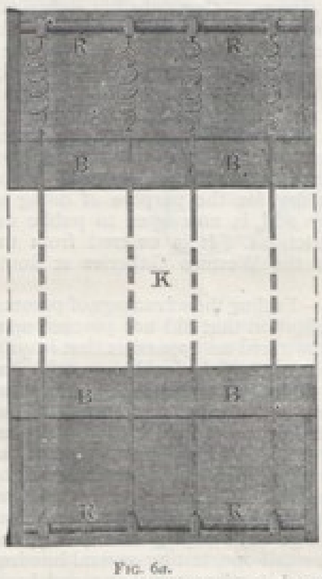


Fig. 5.—Section of the apparatus, but the bridge and rod are not shown, only the section of the wires.



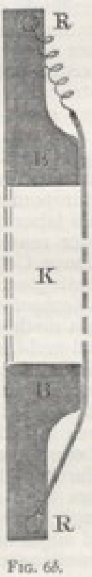


Fig. 6*a*. Fig. 6*b*.
Plan and section of the key-board K.

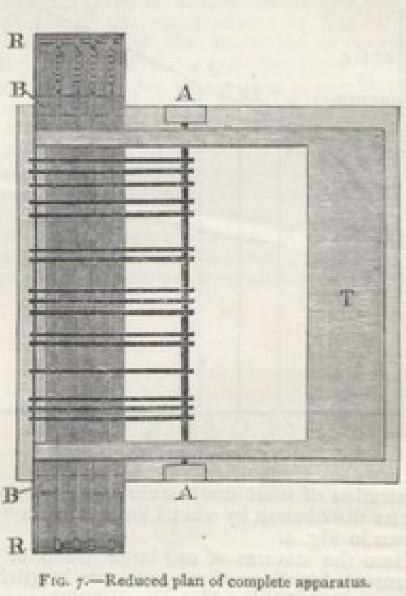


Fig. 7.—Reduced plan of complete apparatus.

Explanation:—A, the common axis; c_1, c_2, the cards T; T, tilting-frame, turning on A (the cards rest by their front ends on F, the front cross-bar of T, at the time when the heavy hinder end of T rests on the base-board S; K, key-board, in which R, R are the rods between which the wires stretch; B, B, are the bridges over which the wires pass.

across bridges at either end of a long board set crossways to the cards. Their positions on the bridges are adjusted by the same scale as that by which the notches were cut in the cards. Figs. 6*a* and 6*b* are views of this portion of the apparatus, which acts as a key, and is of about 30 inches in effective length. The whole is shown in working position in Fig. 7. When the key is slid into its place, and the heavy end of the tilting-frame T is raised, all the cards are free to descend so far as the tilting-frame is concerned, but they are checked by one or more of the wires from descending below a particular level, except those few, if any, whose notches correspond throughout to the positions of the underlying wires. This is the case with the card c_2, drawn with a dotted outline, but not with c_1, which rests upon the third wire, counting from the axis. As the wires have to sustain the weight of all or nearly all the cards, frequent narrow bridges must be interposed between the main bridges to sustain the wires from point to point. The cards should be divided into batches by partitions corresponding to these interposed bridges, else they may press sideways with enough friction to interfere with their free independent action. Neither these interposed bridges nor the partitions are drawn in the figure. The method of adjusting the wires there shown 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

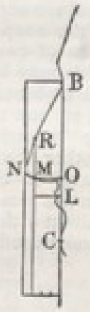


FIG. 8.

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),

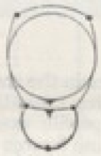


Fig. 1.

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

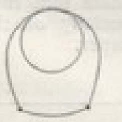


Fig. 3.

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

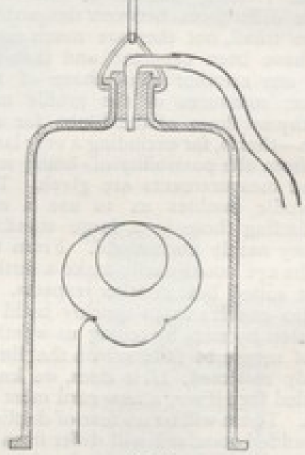


Fig. 6.

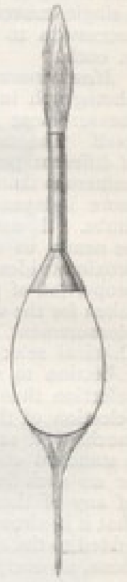


Fig. 7.

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

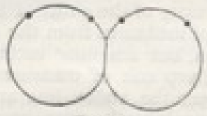


Fig. 8.

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

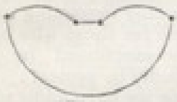


Fig. 9.

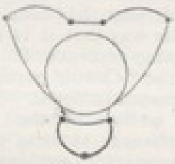


Fig. 10.

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 been likewise engaged in the study of the new instrument they have devised for the measurement of the stellar photographs, and in the preparation of tables of instrumental corrections, and of corrections for the effect of refraction; whilst M. Thiele has been inquiring into the degree of accuracy of which the measures are capable, with most encouraging results, and Admiral Mouchez considers that the precision thus attainable "will permit the carrying out under good conditions of the Catalogue of all the stars down to the 11th magnitude as decided by the Congress." It should be noted, however, that this interpretation of the resolution of the Congress has been challenged, and it has been urged that the Catalogue to be formed was to contain simply as many suitably placed stars as would be necessary as reference points for the great photographic chart, and that stars down to the 11th magnitude might be used for this purpose.

As to the publications of the Observatory, the first volume of the Catalogue, oh.–6h. of R.A., is shortly to be followed by the second, 6h.–12h., the first sheets of which were already in the printers' hands. The volume of Observations for 1882 was published last August, that for 1883 was passing through the press, whilst the reduction of apparent to mean places was completely finished for 1884. The nineteenth volume of the Memoirs was in course of publication, and would contain, besides the works mentioned in the Report for 1886, a memoir on the theory of the figure of the planets, by M. Callandreau, and another on an allied subject, by M. Hamy. Amongst the works published by the individual members of the Observatory, the most important have been M. Lœwy's new method for the determination of the constant of aberration, and a work by M. Wolf, on the pendulum. M. Leveau is still engaged in his work upon Vesta, and M. Bossert is preparing for the determination of a definitive orbit of the Pons-Brooks comet. Under the head of "Matériel" the progress of the new equatorial *coudé* of 2 feet aperture and 60 feet focal length is referred to. Its completion is expected during the present year, but the building for it has not yet been begun.

The chief exception to the record of progress which Admiral Mouchez's Report supplies is found in the short paragraph which records the closing of the astronomical school, on financial grounds. The necessity for this step is to be most deeply regretted.

THE PHOTOGRAPHIC CHART OF THE HEAVENS.

WE lately reprinted from the *Observatory* (NATURE, May 10, p. 38) an article by the editors of that periodical on Dr. Gill's proposal that two million stars should be catalogued. The following is the reply of the editors, printed in the June number of the *Observatory*, to letters addressed to them on the subject by Admiral Mouchez and Mr. E. B. Knobel:—

We print above letters from Admiral Mouchez and from Mr. Knobel, concerning the remarks we made last month on Dr. Gill's proposition to catalogue 2,000,000 stars. There is a somewhat personal implication in both letters, to which we must at once reply before proceeding to treat of the real question at issue—a suggestion that we have been so emphatic in our disapproval of the scheme as to be discourteous to its supporters. We may perhaps venture to doubt whether either writer has done us the honour to read our remarks carefully enough. Admiral Mouchez "nous trouve bien sévère pour un projet aussi bien étudié et venant d'un savant aussi habile et compétent que le Directeur de l'Observatoire du Cap." We have not said a single word in disparagement of the skill and care with which Dr. Gill's paper has been written; we have vehemently objected to the question being raised at all; and that we have objected so vehemently may be taken as a full recognition of Dr. Gill's prominent position, which makes it a matter of necessity to bring all our forces to bear against a scheme which he chooses to advance. Mr. Knobel is perhaps more unjust to us. We have not in an unqualified manner characterized a catalogue of 2,000,000 stars as "an utter waste of time, labour, and money"; but we did use even stronger language about cataloguing stars "for the purpose only of getting their places written down," in order to call attention to the *reductio ad absurdum* of cataloguing towards which we very much fear there is some apparent tendency. And, finally, if we have been so emphatic as to be accused of exaggeration, let us again point out that a scheme, which we contend has not been assented to or even considered by the members of the Astrophotographic Conference, has been quietly launched, and is now so far under way that it is referred to by the President in the opening sentence of his letter as a matter already accepted by the "Comité permanent," and as only remaining to be discussed in detail. Surely it is time for those who have the welfare of the scheme really sanctioned by the Conference to raise their voices loudly in protest!

So much in explanation of the tone we have adopted in speaking of this proposal, and we now return to the letters. The main point of both is that this scheme of a catalogue of 2,000,000 stars has not been originated by Dr. Gill, but was really considered and approved by the Conference. As we have stated above, we hold the opposite opinion,—that although two resolutions of the Conference do mention *a* catalogue, this term cannot be supposed to sanction a catalogue of 2,000,000 stars without further specification. The Conference met to discuss the advisability of making a chart. With the invitations sent out to the various astronomers to attend this Conference there was sent a "programme provisoire" (which, it is to be very much regretted, was not that considered by the Congress). This first "programme provisoire" was dropped, and at the first *séance* of the Congress another was produced. In the first, in article 19 a *catalogue of reference stars* was mentioned, and properly so, but in the second there was no mention of any such catalogue. Mention was made in section 4 of a means of publishing the chart and the form of publication, but up to this time there was absolutely no question before the Conference of publication of a catalogue either of 2,000,000 or any other number of stars. There was no doubt a feeling amongst some astronomers present that a catalogue would be as useful, in their judgment, as the chart; and they took the opportunity of putting forward their views when the question of a second series of plates was brought forward. The taking of this second series of plates was proposed to meet an anticipated difficulty in photographing parts of the heavens where the stars differed greatly in magnitude. It was decided (Resolution 17) that a second series of plates should be taken, in order to insure the greatest precision in the micrometrical measurement of the stars of reference, and to render possible the construction of a catalogue. Here we have the first mention of a catalogue in the resolutions noted. A reference to the minutes of the Congress will show that this resolution was a compromise, for there had already been before the Congress a direct proposition (that of M. Tacchini) for a catalogue, which, however, was not voted upon. The resolution was in fact an endeavour to settle a question that was before the Congress, viz. whether the plates should be so taken as to be capable of accurate measurement; and this is decided by the specification that they shall render possible the construction of a catalogue. The next two resolutions speak of the second series of plates as *destinés à la construction du catalogue*, but nowhere is any direct resolution to be found as to the construction of a catalogue of all the stars.

If these resolutions need interpretation by the light of subsequent consideration at all, we may suggest a very different direction in which they might be modified in actual fact, and in which their spirit would yet be even better represented than by a literal fulfilment. It was pointed out that in taking the photographic plates of stars down to the 14th magnitude in parts of the sky where brighter stars existed, these with the exposure necessary to obtain the 14th magnitude would be very much over-exposed. And it was suggested that it would be advisable to take a second series of plates, as already mentioned (see Resolution 17). Now in some parts of the sky no second series of plates are, from this point of view, at all necessary; whilst in others not one or two, but many series of plates would be necessary in order to do justice to the various magnitudes in that particular part of the sky. For the present this is not the point at issue, but it may serve as an illustration of the sort of interpretation of the resolutions which we should consider legitimate.

In order to come to a proper judgment on the legitimacy of the derivation of Dr. Gill's proposal from the resolutions it is necessary to make some statements, which are not new, but of which the true significance does not seem to have been universally appreciated:—(1) When the plates are obtained they are actual representations of the stars as existing at a given time, and for every purpose except spectrum analysis are as good, if not better, than the visible heavens. If with these plates we have the absolute places of a certain small number of known stars, we have then all the data to make them valuable, either in the present or in the future. (2) The many questions concerning the stars which it is hoped a photographic chart of the heavens would do a great deal towards settling, such as their distribution, their proper motions, their changes of magnitude, and the presence of minor planets, of new stars and the like, can all be best treated by a direct comparison of plate with plate, in any of the various ways in which this can be done. (3) In order to obtain the best results from such an agent as photography it is necessary to use it in its own proper way; and astronomers must recollect that old methods of procedure adapted to other instrumental means may most probably be out of place. We might considerably enlarge on these statements, but for our present purpose it is sufficient to call attention to them.

Now, if Dr. Gill's catalogue were successfully constructed—and there are, alas! many difficulties in the way—its utility in the direction of comparison of our sky with that of the future is wholly limited by one condition, that in the future another exactly similar catalogue be constructed, occupying a similar time. Even then, if any changes were found by means of this comparison of catalogues which might very well be made in the course of fifty or one hundred years, the natural and indeed the proper thing to do would be to immediately compare the original plates. But can it be possible that any man or number of men really think of dealing with such a subject in such a way? If, on the other hand, the object of a catalogue be merely to allow of comets, minor planets, and other bodies being located, surely it would be better to measure the plates as occasion arises, and not to catalogue 2,000,000 stars on the off-chance of having some twenty or thirty positions to settle in the course of a year. And, further, such a catalogue would have this enormous disadvantage, that whilst in some parts of the sky stars of the 11th magnitude would be fairly well spread, in the Milky Way we should have stars clustered in such enormous quantities that it would be an extremely difficult thing to even identify them: in fact, speaking roundly, we should say that if such a catalogue were made, two-thirds of the stars catalogued would lie in the Milky Way. If, contrary to the opinion we have expressed, it is decided to form a very large catalogue, surely it would be better to determine the places of a certain number of stars, of such magnitudes as are found available, in each square degree, and make these the reference stars from which the positions of the other stars on the plate could be obtained.

We are therefore of opinion that, supposing limitless time and money available for such a purpose, the advantages of constructing this catalogue would be doubtful; but even if we waived all these objections and agreed that such a catalogue would be a "nice thing to have," or admitted that since men of the ability and reputation of Admiral Mouchez and Dr. Gill consider such a catalogue necessary it is heresy to inquire the why and wherefore, there would still be left the serious objection that to form a chart of the heavens is the first thing to do, and, take it in as simple a form as possible, it will quite possibly tax the energies of astronomers to their utmost; and that stellar photography being as yet in its infancy it is suicidal to attempt anything which will commit us to a course of action extending over more than a very few years. We could not give a better illustration of the dangers of the opposite procedure than has been supplied by Admiral Mouchez himself. In a recent article he has suggested that there have lately been such improvements in the sensitiveness of plates that we could now go to the 15th magnitude instead of the 14th. With a little ingenuity and less arithmetic it could easily be shown that the whole plan of operations would have become hopelessly futile and obsolete before half the time allowed by Dr. Gill for its completion had elapsed.

But not for one moment do we wish to appear lacking in sympathy with those who have spent and are spending so much time and thought on this subject; it is our great anxiety for the success of the work in which they are co-operating which makes us eager to protest as far as we can against the grand mistake of attempting too much.

THE INCURVATURE OF THE WINDS IN TROPICAL CYCLONES.

THE question of the incurvature of the winds in tropical cyclones is one of such importance to mariners, to enable them to judge their position in a storm, and to escape the hurricane around the central calm, that no apology is needed for adding my independent testimony to that of Prof. Loomis, whose conclusions, given at length in his recent well-known memoir, "Contributions to Meteorology," are quoted in Mr. Douglas Archibald's paper on M. Faye's work "Sur les Tempêtes" in last week's NATURE (p. 149).

In the preparation of a forthcoming work on the weather and climates of India and the storms of Indian seas, I have lately had occasion to re-investigate the above question in the case of cyclones in the Bay of Bengal, on the evidence afforded by the numerous original memoirs and reports prepared by Messrs. Willson, Eliot, Pedler, and other officers of the Indian and Bengal Meteorological Departments; my object being the practical one of determining directly the bearing of the storm-centre from a ship's position; and instead, therefore, of measuring the angle between the wind direction and the nearest isobar, as was done by Prof. Loomis, I have measured with a protractor the angle included between the former and its radius vector, in all cases in which the position of the storm's centre has been ascertained on sufficient evidence. In one other important condition I have also departed from the method pursued by Prof. Loomis. I have restricted the measurements to wind observations of ships at sea, within the influence of the storm, and to those of good observatories on the coast, subject to the same proviso; and have taken no account of those of inland observatories. This difference of procedure is probably the reason that the amount of the incurvature shown by these measurements is somewhat different from that obtained by Prof. Loomis, though the general fact of a great incurvature is thoroughly confirmed. My results are as follow:—

(1) The mean of 132 observations between lats. 15° and 22°, within 500 miles of the storm-centre, gives the angle 122° between the wind direction and its radius vector.

(2) The mean of 12 observations between the same latitudes, within 50 miles of the storm-centre, gives the angle 123°.

(3) The mean of 68 observations between N. lats. 8° and 15°, within 500 miles of the storm-centre, gives the angle 129°.

The observations within 50 miles of the storm-centre in the south of the Bay are too few to afford any trustworthy result.

For seamen's guidance, the following practical rules may be formulated:—

(1) In the north of the Bay of Bengal, standing with the back to the wind, the centre of the cyclone bears about five points on the left hand, or three points before the beam.

(2) In the south of the Bay, it bears about four points on the left hand, or four points before the beam.

(3) These rules hold good for all positions *within the influence of the storm*, up to 500 miles from the storm-centre. On the north and west the influence of the storm rarely extends to anything like this distance, but it does to the east and south.

Since much of this evidence, afforded by the Bay of Bengal cyclones, has been before the public for many years, it is incomprehensible to me how a man of M. Faye's scientific eminence can still assert that in the tropics "the wind arrows display an almost rigorous circularity." If, as may possibly be the case, he relies on the evidence of Mr. Piddington's memoirs, ignoring all subsequent work, it is only necessary to examine those memoirs to find that his data do not bear out that author's conclusions. In the charts which accompany Mr. Piddington's later memoirs, the wind observations are, as a rule, not shown, but only the ships' courses, and the author's interpretation of the positions and tracks of the storms. But the evidence is always fully given in the text, and it will be found that when the wind arrows are plotted therefrom, and are sufficiently numerous to allow of the position of the storm's centre being determined, which is far from being generally the case, they are reconcilable only with spiral courses, having a considerable incurvature.

I do not propose now to enter on a formal criticism of Mr. Piddington's work, the great merit of which, as that of a pioneer in the field of storm-science, no one more fully recognizes than myself; but so much seems necessary in explanation of the apparent glaring discrepancy between his results and those of modern workers in the same field.

The evidence of the cyclones of the Bay of Bengal, those tropical cyclones to which M. Faye appeals as authoritative on the validity of his views, is, then, conclusive against him. There is a strong influx of the lower atmospheric strata into a tropical cyclone, proving, in the most unquestionable manner, the existence of an ascending current over the vortex. This fact is quite independent of any views that may be entertained as to any theory of cyclone origin and movement of translation, but any such theory must harmonize with the fact, and hence I conceive that it is fatal to M. Faye's views. With these, in so far as they are theoretical merely, I have no present concern, but it is obviously a matter of high importance to seamen that they should not be misled as to the facts of the wind's movement in cyclones, and it is because the promulgation of such views as M. Faye's tends to perpetuate an old and now exploded error of fact, that I have to put in my protest against them.

HENRY F. BLANFORD.

Folkestone, June 15.

NOTES.

It should have been stated in our paragraph last week relative to the opening of the Laboratory of the Marine Biological Association at Plymouth that the President, Prof. Huxley, who has given unremitting care to the affairs of the Association during the last three years, would be present if he were not prevented from taking part in any public proceedings by the state of his health. In the absence of the President, one of the Vice-Presidents of the Association, Prof. Flower, will preside. The Honorary Secretary, Prof. Ray Lankester, who founded the Association, and has conducted its affairs to the present issue, will also be present.

Mr. J. J. H. Teall, who now holds a foremost place among the petrographers of this country, has just been appointed to the Geological Survey. We understand that he will be specially charged with the study of the crystalline schists and the problems of regional metamorphism, and that he will be closely associated with the field officers who are mapping these rocks in different parts of Scotland. The Survey is to be heartily congratulated on this appointment. The staff is now remarkably strong, but the problems with which it is confronted are among the most difficult in geology. These problems have never been attacked by such a united force of field geologists and microscopists, who, working together with one common aim, will no doubt raise still higher the scientific reputation of the Survey, increase our knowledge of the history of the most ancient rocks, and throw light on some of the most puzzling questions in geological science.

The electors to the Mastership of Downing College, Cambridge, have, by a unanimous vote, chosen Dr. Alexander Hill, Fellow of the College, to succeed Prof. Birkbeck. Dr. Hill's claim to the appointment sprang from his success as a teacher and worker in biology. No appointment to a Headship has been made on this ground alone since the revival of natural science at the Universities.

On the 4th inst., Dr. Maxwell T. Masters was elected a corresponding member of the Institute of France, in the Botanical Section, in place of the late Prof. Asa Gray. Besides Dr. Masters, the following names appeared on the list of presentation: M. Treub, of Batavia; Mr. Triana, of Paris; M. Warming, of Lund; M. Wiesener, of Vienna. Dr. Masters obtained 39 votes; M. Triana, 5; M. Treub, 1.

The Sorbonne, consulted as to the proposed creation of a Chair for the teaching of Darwinian theories, has not expressed disapproval of the scheme suggested by the Municipal Council of Paris. It has appointed a committee to report on the matter; and it is expected that no serious opposition will be offered to the proposal.

We are glad to learn that a pension of £50 has been granted to Mrs. Balfour Stewart from the Civil List.

On May 25, a complimentary dinner was given at the Queen's Hotel, Manchester, to Prof. Schorlemmer, of the Owens College, by his former pupils, to celebrate the occasion of the conferring of LL.D. upon him by the Senate of the Glasgow University, and to offer their congratulations. In the absence of Sir Henry Roscoe, who had been expected to take the chair, Mr. R. S. Dale, one of Prof. Schorlemmer's eldest pupils and friends, presided. Numerous congratulatory telegrams and letters were received by Dr. Schorlemmer, and early in the evening a letter was read from Sir Henry Roscoe, expressing regret that he could not be present, and testifying to his high appreciation of the ability of his old friend and colleague. Among those from whom congratulatory telegrams were received were Dr. Pauli, Director of the firm of Meister, Lucius, and Brüning, in Hoechst; Prof. Bernthsen, of the Badische Anilin und Sodafabrik, in Ludwigshafen; and Prof. Hermann Kopp, of Heidelberg, the historian of chemistry, who spoke of Prof. Schorlemmer's position as one of the principal pioneers of the science of organic chemistry and one of its foremost exponents, both as a teacher and a writer. Prof. Thorpe, F.R.S., proposed the health, long life, and prosperity of Dr. Schorlemmer, and referred to the fact that Glasgow, which had conferred honour on him, had produced such men as Black and Thomson, names familiar to all chemists.

DR. ASA GRAY left Harvard College in trust, to aid in the support of the Gray Herbarium of Harvard University, the copyrights of all his books, upon condition that proper provision should be made for the renewal and extension of these copyrights by new editions, continuations, and supplements, such as might be needed in the study of botany, and as might best enhance and prolong the pecuniary value of the bequest.

PROF. LOVERING has resigned the Chair of Mathematics and Natural Philosophy which he has held at Harvard for fifty years. In accepting his resignation, which takes effect in the autumn, the President and Fellows of the College have expressed warm appreciation of his services. Prof. Lovering has been President of the American Association, and still presides over the American Academy.

PROF. MCNAB, Swiney Lecturer on Geology in connection with the British Museum, will begin a course of twelve lectures on the fossil plants of the Palæozoic epoch on Monday next, at the Natural History Museum, Cromwell Road.

LAST night the *conversazione* of the Society of Arts took place at the South Kensington Museum.

A *conversazione* will be given by the Royal College of Surgeons, at the College, on Wednesday, June 27; and by the Royal Geographical Society, at Willis's Rooms, on Friday, June 29.

AN International Horticultural Exhibition is to be held at Cologne from August 4 to September 19.

WE have received from Messrs. West, Newman, and Co., samples of two kinds of botanical drying paper. One of the kinds differs but little from that which they have supplied for many years, which was originally manufactured, purposely for drying plants, by a paper-maker of the name of Bentall, who lived at Halstead in Essex, and contributed, a generation ago, to the distributions of the London Botanical Society. This paper has been largely used for the last thirty years, and combines in a very satisfactory manner the merits of a high degree of absorbence with a reasonable toughness. No doubt, for drying plants, it is the best paper that can be got, but yet, excepting grasses, Cyperaceæ, and mosses, one or more changes are required in the first few days to make satisfactory specimens in a climate like that of England. The new paper is quite without glaze, and seems a little more absorbent than the old "Bentall." The other kind is copied from an American model, a paper not made expressly for botanical use, sent to England by the late Dr. Asa Gray. It is twice as thick as the "Bentall," much more rigid, and very absorbent; a serviceable paper to mix with the lighter kind for home use, but too heavy to carry about in large quantities.

ACCORDING to *La Nature*, an immense terrestrial globe, constructed on the scale of one-millionth, will be shown at the Paris Exhibition of 1889. A place will be set apart for it at the centre of the Champ de Mars. The globe will measure nearly 13 metres in diameter, and will give some idea of real dimensions, since the conception of the meaning of a million is not beyond the powers of the human mind. Visitors to the Exhibition will see for the first time on this globe the place really occupied by certain known spaces, such as those of great towns. Paris, for instance, will barely cover a square centimetre. The globe will turn on its axis, and thus represent the movement of rotation of the earth. The scheme was originated by MM. T. Villard and C. Cotard, and *La Nature* says that it has been placed under the patronage of several eminent French men of science.

WE have received a sample of tobacco grown by Messrs. James Carter and Co., at a farm in Kent, and cured by Messrs. Cope Brothers and Co. It represents one of the first experimental crops brought to maturity, and passed through the various processes of manufacture, in this country, since the time of Charles II. The packet is accompanied by a card, on which we find the somewhat discouraging counsel: "Examine leisurely—use warily—smoke sparingly." Mr. Goschen was asked the other evening in the House of Commons whether he would cause an inquiry by experts into the results attending the experiment made by Messrs. Cope, with the view, if possible, of relaxing the fiscal restrictions upon the culture of tobacco in Great Britain. The Chancellor of the Exchequer cautiously replied that "only experience would show the value to smokers of this tobacco, and no inquiry by experts would be so valuable as that practical test. If any hon. member wished to try it, samples would be placed in the smoking-room. It was impossible to give any form of relaxation in the fiscal regulations which would injure the revenue."

ACCORDING to the *Kavkaz* newspaper, a shock of earthquake was felt at Julfa, in the Armenian province of Erivan, on May 15, about midday. The first shock was followed by a stronger one, which lasted for about three seconds, and seemed to have a direction from east to west.

THE Council of the Italian Meteorological Society held its first annual meeting at Turin on Sunday, April 15, under the presidency of Padre Denza. It was decided to hold the third general assembly of the Society at Venice, in September next, just before or after the Congress of the Alpine Club at Bologna. The establishment by the Society of a new Observatory in the Argentine Republic was notified, and also of four new meteorological stations in Italy. The arrangements being made with respect to the hygienic stations at five large cities were explained, as well as the proposed method of publication of the observations. The President submitted the Report of the Geodynamic Committee, nominated at the meeting at Aquila (NATURE, vol. xxxvi. p. 614), with reference to seismological observations and the protection of buildings. The Report, which is printed in the monthly Bulletin of the Italian Meteorological Society for May, consists of nine articles, and will be distributed to the Prefects and Mayors of districts liable to earthquake-shocks.

THE Hydrographer of the Admiralty has issued notices of the recent establishment of the following storm-signals:—(1) By the Japanese Government, at forty-seven stations on the coasts of Japan. A red ball, or one red light, to indicate that strong winds are probable from any direction. A red cone, or three red lights in the shape of a triangle, to indicate that strong winds are probable, at first from the northward or southward, according as the apex is upwards or downwards. (2) By the harbour authorities at Chittagong, relative to the signals at that port. A ball, or three lights placed vertically, to indicate that a severe cyclone is near Akyab, and will probably advance towards Chittagong. A drum, or two lights placed vertically, to indicate the early approach of a severe cyclone, with its attendant storm-wave. We take this opportunity of suggesting the desirability of introducing more uniformity in these signals in different countries, wherever practicable.

THE atomic weight of the element osmium has been re-determined by Prof. Seubert. The necessity for this re-determination has been felt ever since the principle of periodicity began to take firm root in the minds of chemists; and the more recent values arrived at for the atomic weights of iridium, platinum, and gold have tended to render this necessity even more imperative. The natural sequence, according to their chemical and physical properties, of the metals of the platinum group is generally accepted as—osmium, iridium, platinum, gold. Now the atomic weight of iridium as determined in 1878 by Seubert is 192·5, that of platinum as fixed by the same chemist in 1881 is 194·3, and that of gold as estimated last year by Thorpe and Laurie, and by Krüss, is 196·7, while the recognized atomic weight of osmium as given by Berzelius in 1828 is so high as 198·6. Obviously, if the grand conception of Newlands, Mendelejeff, and Lothar Meyer is correct, the atomic value of osmium required most careful revision. Such an undertaking, however, is endowed with peculiar interest owing to the dangerous nature of work with the osmium compounds, and many chemists who have been interested in this subject have been deterred by the knowledge that accidental contact with the fumes of the tetroxide, which are so frequently evolved by the spontaneous decomposition of many osmium compounds, might deprive them of the use of their eyes for ever. Prof. Seubert has happily succeeded without accident in establishing the validity of our "natural classification" by means of the analysis of the pure double chlorides of osmium with ammonium and potassium, $(NH_4)_2OsCl_6$ and K_2OsCl_6. Both these salts were obtained in well-formed octahedral crystals, of deep red colour while immersed in their solutions, but appearing deep black with a bluish reflection when dry, and yielding bright red powders on pulverization. The method of analysis consisted in reducing the double chlorides in a current of hydrogen: in case of the ammonium salt the spongy osmium which remained after reduction was weighed, and the expelled ammonium chloride and hydrochloric acid caught in absorption apparatus, and the total chlorine estimated by precipitation with silver nitrate. In case of the potassium salt the expelled hydrochloric acid was absorbed and determined, and the metallic osmium left after removal of the potassium chloride by washing was weighed. The mean value yielded by all these various estimations is 191·1, thus placing osmium in its proper place before iridium, and removing the last striking exception to the "law of periodicity."

AT a recent meeting of the Washington Society of Anthropology, Mr. H. M. Reynolds read a paper on Algonquin metal-smiths. He expressed the opinion that the working of the copper-mines of Lake Superior is not of such high antiquity as has been supposed, and that it may have been continued until comparatively modern Indian times.

SOME time ago the Smithsonian Institution issued inquiries as to the existence and geographical distribution of "rude and unfinished implements of the Palæolithic type." The *American Naturalist* says that responses have been received from thirty States and Territories. The implements already noted amount to between six and seven thousand, and their distribution extends nearly all over the United States. Several hundreds of implements—none of which seem to have been found in the mounds—have been sent to the Institution. The object of the Institution in undertaking this investigation was to determine whether there was in America a Palæolithic Age, and, if so, whether it had any extended existence.

THE Free Public Libraries and Museum of Sheffield seem to be in a most flourishing condition. According to the last Report, which has just been sent to us, there has been a steady increase in the number of books issued. The number issued during the year ending August 31, 1887, was 410,395. The number issued during the previous year was 399,653, so that there was an increase of 10,742.

MESSRS. LONGMANS, GREEN, AND CO. have sent us a series of their test cards in mechanics, packed in neat little cardboard cases. The questions on the many and various branches of the subject are arranged in three stages. Each stage consists of about thirty cards with six questions on each, and is supplemented by cards containing the answers to all the numerical questions. The questions are excellently chosen, and are arranged in an intelligible and progressive order.

A CAREFUL and very valuable bibliography of the works of Sir Isaac Newton, with a list of books illustrating his life and works, by G. J. Gray, has just been issued by Messrs. Macmillan and Bowes, Cambridge. The bibliography is divided into ten sections: (1) collected editions of works; (2) the "Principia"; (3) "Optics"; (4) "Fluxions"; (5) "Arithmetica Universalis"; (6) minor works; (7) theological and miscellaneous works; (8) works edited by Newton; (9) memoirs, &c.; (10) index.

A NEW edition of the late Prof. Humpidge's translation of Dr. Hermann Kolbe's "Short Text-book of Inorganic Chemistry" (Longmans) has been issued. The greater part of this edition was prepared by Dr. Humpidge last summer. Being unable, owing to failing health, to complete the task of revision, he asked Prof. D. E. Jones, of the University College, Aberystwith, to undertake it, and to see the book through the press.

A REPORT, with admirable illustrative maps, on the geology and natural resources of part of Northern Alberta, and the western parts of the districts of Assiniboia and Saskatchewan, by Mr. J. B. Tyrrell, Field Geologist of the Geological Survey of Canada, has just been published at Montreal. The Report is, to a certain degree, preliminary, but the author hopes that, for the present at all events, it may suffice as a guide to the extent, position, and character of the mineral wealth of the district.

AN interesting paper by Mr. Tyrrell, giving an account of the journeys of David Thompson in North-Western America, has been issued at Toronto. It was read lately before the Canadian Institute, and is published in advance of the Proceedings by permission of the Council. The materials for this narrative are contained in Mr. Thompson's field note-books and journals, which are preserved in the office of the Crown Land Department of Ontario. Mr. Thompson died in 1857 at the age of eighty-seven.

MR. LELAND will shortly send to the printer his work on "Americanisms," which will follow on the "Dictionary of Slang, Jargon, and Cant" now in the press. It will contain much folk-lore in the form of proverbs, songs, and popular phrases, and also the etymology and history of the words, as far as they could be traced. The work will include an account of American dialects, such as Pennsylvanian Dutch, Chinook, Creole, and Gumbo. A number of American scholars will deal with special subjects.

WE have received a copy of the *Tōyō Gakugei Zasshi* (the *Eastern Science Journal*), printed in Japanese characters. This magazine is published monthly, and is edited by a committee, most of whose members are Professors of the Imperial University at Tokio. Nearly 3000 copies of each number are sold.

THE first part of the second volume of the Journal of the College of Science, Imperial University, Japan, has been sent to us. The contents include, besides a mathematical paper, in German, by Dr. P. R. Fujisawa, the following articles in English: on the composition of bird-lime, by Dr. E. Drivers, F.R.S., and Michitada Kawakita; on anorthite from Miyakejima, by Yasushi Kikuchi; the source of *Bothriocephalus latus* in Japan, by Dr. Isao Ijima; and earthquake-measurements of recent years, especially relating to vertical motion, by S. Sekiya.

MESSRS. D. C. HEATH AND CO. (Boston) will publish at once Compayre's "Lectures on Pedagogy: Theoretical and Practical," a companion volume to their Compayre's "History of Pedagogy." It is translated and annotated by Prof. Payne, of the University of Michigan.

PROF. J. VIOLLE has just issued the first part of the second volume of his "Cours de Physique." The present part relates to acoustics.

WE reprint from *Science* of June 1, 1888, the following suggestive paragraph:—"The Committee of the House of Representatives on acoustics and ventilation has actually reported favourably a Bill appropriating seventy-five thousand dollars to subsidize a man who thinks he can construct a steel 'vacuum' balloon of great power. He is to be allowed to use the facilities of one of the navy-yards for the building of his machine, and is to have the money as soon as he has expended seventy-five thousand dollars of private capital upon his air-ship. One of the mathematical physicists of Washington was asked by a member of Congress whether such a balloon could be successfully floated. He set to work upon the problem, and here are some of his results, which are rather curious:—A common balloon is filled with hydrogen gas, which, being lighter than air, causes the balloon to rise and take up a load with it. But, as the pressure of the gas within is equal to the pressure of the atmosphere without, no provision other than a moderately strong silk bag is required to prevent collapse. The inventor of the proposed steel balloon hopes to gain greater lifting-power by using a vacuum instead of gas, the absence of substance of any kind being lighter than even hydrogen gas. But he has to contend with the tendency of the shell to collapse from the enormous pressure of the atmosphere on the outside, which would not be counterbalanced by anything inside of it. The first question which presented itself was, How thick could the metal of the shell be made, so that the buoyancy of the sphere, which would be the most economical and the strongest form in which it could be constructed, would just float it without lifting any load? The computations showed that the thickness of the metal might be ·000055 of the radius of the shell. For example: if the spherical shell was one hundred feet in diameter, the thickness of the metal composing it could not be more than than one-thirtieth of an inch, provided it had no braces. If it was thicker, it would be too heavy to float. Now, if it had no tendency to buckle, which of course it would, the strength of the steel would have to be equivalent to a resistance of more than 130,000 pounds to a square inch to resist absolute crushing from the pressure of the air on a cross-section of the metal. Steel of such high crushing-strength is not ductile, and cannot be made into such a shell. If the balloon is to be braced inside, as the inventor suggests, just as much metal as would be used in constructing the braces would have to be subtracted from the thickness of that composing the shell. Of course, such a shell would buckle long before the thickness of the metal of which it was composed was reduced to ·000055 of its radius. In other words, it is mathematically demonstrated that no steel vacuum balloon could be constructed which could raise even its own weight. This is an illustration of how intelligently Congress would be likely to legislate on scientific matters unguided by intelligent scientific advice."

THE additions to the Zoological Society's Gardens during the past week include two Pig-tailed Monkeys (*Macacus nemestrinus* ♂ ♀) from Java, presented by Mr. C. W. Ellacott; a Bonnet Monkey (*Macacus sinicus* ♀) from India, presented by Mr. J. Wiltshire; a Pig-tailed Monkey (*Macacus nemestrinus*) from Java, presented by Mrs. Gleig; two Spotted Cavys (*Cœlogenys paca* ♂ ♀) from South America, presented by Mr. W. H. Stather; a Mauge's Dasyure (*Dasyurus maugei*) from Australia, presented by Mr. H. R. Brame; three Abyssinian Sheep (*Ovis aries*, var.) from Abyssinia, presented by Mr. A. J. Baker; two Pallas's Sand Grouse (*Syrrhaptes paradoxus*) from the Island of Tiree, Argyllshire, presented by Lieut.-Colonel Irby and Captain Savile Reid, F.Z.S.; a Wapiti Deer (*Cervus canadensis* ♂), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE CONSTANT OF ABERRATION.—In the year 1862, Prof. J. S. Hubbard commenced a series of observations of α Lyræ with the prime vertical instrument of the Washington Naval Observatory, which was continued by either Profs. Newcomb, Harkness, or Hall until 1867. The purpose of these observations had been to obtain corrections to the assumed values of the constants of nutation and aberration, and to afford an absolute determination of the annual parallax of the star. The series was not continued for a sufficient period for the first purpose; and Prof. Asaph Hall, when engaged on the determination of the parallax of α Lyræ by another method, found that these observations would give it a small negative value. From this and other circumstances he was at that time induced to think the observations would not repay the trouble of a careful discussion; but recently, reflecting that they had been skilfully designed, and carried out with care, he resolved to ascertain the result they would furnish for the constant of aberration. The observations commenced 1862 March 25, and extended to 1867 April 25, and were 436 in number. The mean resulting value of the parallax is—

$$\pi = -0''\cdot079 \pm 0''\cdot0134,$$

whilst

$$\text{Constant of aberration} = 20''\cdot4506 \pm 0''\cdot0142,$$

with an average probable error for a single observation of $\pm 0''\cdot174$.

Adopting a parallax of $+0''\cdot15$, the result would be—

$$\text{Constant of aberration} = 20''\cdot4542 \pm 0''\cdot0144.$$

Prof. Hall prefers this latter result, notwithstanding the uncertainty as to the true parallax of the star. The negative result obtained for the parallax may probably be due to the fact that the coefficient of parallax obtains its extreme values in January and July, when the mean temperature is likewise at its extreme points; the January observations also are made in daylight, but the July at night, which would tend to produce a systematic difference in the method of observing. The coefficient of aberration, on the other hand, has its greatest values in April and October, when the conditions of observation will be nearly the same.

The above value of the constant of aberration gives, for the solar parallax—

$$\pi = 8''\cdot810 \pm 0''\cdot0062,$$

Hansen's values of the mean anomaly of the earth, and eccentricity of its orbit being assumed, together with Clarke's value for the equatorial radius, and Michelson and Newcomb's determination of the velocity of light, viz. 186,325 miles per second.

THE MARKINGS ON MARS.—The observations of M. Perrotin at Nice, and M. Terby at Louvain, and, in England, of Mr. Denning at Bristol, have confirmed the presence on the planet of most of the "canals" or narrow dark lines which were discovered by M. Schiaparelli in 1877, and at subsequent oppositions. M. Perrotin has also been able to detect, in several cases, the gemination or doubling of the canals, and M. Terby has observed the same phenomenon in one or two cases, but with much greater difficulty than in the opposition of 1881–82. But some curious changes of appearance have been noted. An entire district (Schiaparelli's *Lybia*) has been merged in the adjoining "sea," *i.e.* its colour has changed from the reddish hue of the Martial "continents" to the sombre tint of the "seas." The district in question is larger than France. To the north of this district a new canal has become visible, and again another new canal has appeared to traverse the white North Polar cap, or, according to M. Terby, to divide the true Polar cap from a white spot of similar appearance a little to the south of it. With the exception of these changes, the principal markings, both light and dark, are those which former oppositions have rendered familiar.

COMET 1888 *a* (SAWERTHAL).—The following ephemeris for Berlin midnight is by Herr Berberich (*Astr. Nach.*, No. 2838), from elliptic elements which he has found for it, and which closely resemble those of Prof. Boss given in NATURE of May 24 (p. 88):—

1888.	R.A. h. m. s.	Decl. ° ′	Log r.	Log Δ.	Brightness.
June 23	0 55 11	46 11·5 N.	0·2760	0·3129	0·042
25	0 57 1	46 40·5			
27	0 58 42	47 8·9	0·2887	0·3173	0·039
29	1 0 16	47 36·6			
July 1	1 1 42	48 3·7	0·3009	0·3212	0·036
3	1 3 0	48 30·2			
5	1 4 9	48 56·0	0·3127	0·3247	0·033
7	1 5 9	49 21·2			
9	1 6 1	49 45·7	0·3241	0·3278	0·031
11	1 6 44	50 9·6			
13	1 7 18	50 32·8 N.	0·3352	0·3306	0·029

The brightness at discovery is taken as unity.

THE Kazan Observatory has celebrated its "Jubilee" by publishing an interesting report about its activity since it was founded by Littrow fifty years ago. The mapping of the stars between 75° and 80°, which was begun by Prof. Kovalsky, was continued and extended by his successor, Prof. Dubyago.

THE Tashkend Observatory has just issued the second volume of its "Works."

ASTRONOMICAL PHENOMENA FOR THE WEEK 1888 JUNE 24–30.

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on June 24

Sun rises, 3h. 46m.; souths, 12h. 2m. 13·7s.; sets, 20h. 19m.: right asc. on meridian, 6h. 14·5m.; decl. 23° 25′ N. Sidereal Time at Sunset, 14h. 33m.

Moon (Full, June 23, 21h.) rises, 19h. 57m.*; souths, 0h. 9m.; sets, 4h. 20m.: right asc. on meridian, 18h. 19·6m.; decl. 21° 5′ S.

Planet.	Rises. h. m.	Souths. h. m.	Sets. h. m.	Right asc. and declination on meridian. h. m.	° ′
Mercury	5 33	13 25	21 17	7 37·2	19 52 N.
Venus	3 23	11 41	19 59	5 53·7	23 36 N.
Mars	13 28	18 53	0 18*	13 6·5	7 39 S.
Jupiter	17 6	21 29	1 52*	15 42·7	18 47 S.
Saturn	6 29	14 19	22 9	8 31·3	19 34 N.
Uranus	12 56	18 36	0 16*	12 49·3	4 35 S.
Neptune	1 59	9 45	17 31	3 56·9	18 47 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Comet Sawerthal.

June.	h.	Right Ascension. h. m.	Declination. ° ′
24	0	0 55·2	46 12 N.
28	0	0 58·7	47 9

Occultations of Stars by the Moon (visible at Greenwich).

June.	Star.	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image. ° °
24	50 Sagittarii	6	22 6	23 16	65 250
28	50 Aquarii	6	2 28	2 59	163 215

June.	h.	
25	9	Mercury stationary.
27	23	Mercury at greatest distance from the Sun.

Meteor-Showers.

	R.A. °	Decl. °		
Near 52 Herculis	253	47 N.	June 25–30.	Swift.
,, δ Cygni	295	40 N.	Slow.	
,, ε Delphini	305	9 N.	June 28.	

Variable Stars.

Star.	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·4	81 16 N.	June 25,	22 54	*m*
			,, 30,	22 33	*m*
R Geminorum	7 0·6	22 53 N.	,, 27,		*M*
δ Libræ	14 55·0	8 4 S.	,, 29,	2 2	*m*
U Ophiuchi	17 10·9	1 20 N.	,, 28,	2 52	*m*
			,, 28,	23 0	*m*
W Sagittarii	17 57·9	29 35 S.	,, 24,	2 0	*m*
T Herculis	18 4·9	31 0 N.	,, 27,		*M*
U Sagittarii	18 25·3	19 12 S.	,, 30,	2 0	*m*
β Lyræ	18 46·0	33 14 N.	,, 28,	22 0	*m*
S Vulpeculæ	19 43·6	27 1 N.	,, 26,		*M*
η Aquilæ	19 46·8	0 43 N.	,, 24,	21 0	*m*
R Sagittæ	20 9·0	16 23 N.	,, 27,		*m*
X Cygni	20 39·0	35 11 N.	,, 26,	22 0	*M*
δ Cephei	22 25·0	57 51 N.	,, 27,	21 0	*M*

M signifies maximum; *m* minimum.

GEOGRAPHICAL NOTES.

LIEUTENANTS KUND AND TAPPENBECK have been conducting an expedition into the Cameroons interior during the latter part of 1887 and the beginning of the present year. Starting from Batanga they succeeded in penetrating as far as 12° 30′ W. long., when, being attacked by Soudan Negro traders they were forced to retreat, both of them seriously wounded. They succeeded in tracing the course of the Beundo or Njong River far into the interior, and brought back much information concerning the people and the products of the country. With regard to general results, they found that the water-parting between the rivers that discharge in the Cameroons region and those that flow into the Congo Basin lies not near the coast as has hitherto been supposed, and therefore it is hoped that a navigable route may be discovered that will lead well into the interior. The water-parting between the left tributaries of the Binué and the rivers in the German Cameroons also lies far in the interior. The division between the Soudan Negroes and the Bantus is not to be looked for in the direction of Adamawa, but southwards is formed by the Zannaga River and eastwards lies at a distance of 150 miles from the coast. Lieutenants Kund and Tappenbeck assert that the area of Mohammedan influence extends much farther south than has hitherto been thought. No signs of volcanic action have been met with as far as the Zannaga River or in the mountains to the north. The profile which accompanies the report shows a coast plain about 70 feet high, succeeded by a sharp slope rising to a height of from 3000 to 4000 feet, beyond which the country slopes gradually to the inner African plateau, about 2500 feet above the sea.

THE June number of Petermann's *Mitteilungen* is mostly occupied with a memoir by Dr. Supan on "A Century of African Exploration," written in commemoration of the centenary of the British African Association, founded in June 1788. Dr. Supan traces the gradual opening up of the continent and its various regions, the text being illustrated by a series of most instructive maps. In indicating what yet remains to be done, Dr. Supan maintains that it is a mistake to assert that the days of pioneer exploration are over. He shows that while a few patches have been surveyed with some care, while of others we have a general knowledge, and while in other regions lines of travel have been run through, there are great regions that still remain absolutely blank. In the north, in the region of the Sahara, which has been so long known to Europe, the blanks are almost greater than elsewhere, leaving ample room for pioneer work, which may very well be carried on alongside of more minute exploration.

TECHNICAL INSTRUCTION.[1]

IN celebrating as we are now doing the fifty-first annual meeting of the Yorkshire Union of Institutes, one's thoughts naturally revert to the foundation of that Union and to the educational progress which our country has made since the earlier years of the century; and round these thoughts will gravitate recollections of the life and labours of your revered President,

[1] Address delivered by Sir Henry Roscoe, M.P., F.R.S., at Castleford, on Wednesday, June 20, on the occasion of the fifty-first annual meeting of the Yorkshire Union of Mechanics' Institutes.

Sir Edward Baines, for in him we have a living picture of the history of the educational progress of the century. Truly, he has been a witness, and an active witness, of English educational reform from his earliest years, nor have his efforts in the great cause from that time forward ever ceased. Was he not even as a boy in Leeds so long ago as 1809 an earnest listener to the expositions of one who may be justly regarded as the founder of our present system of national education, I mean Joseph Lancaster? The name of Baines, again, is intimately connected with those of Birkbeck and Brougham in the great work of founding mechanics' institutes.

The English character is ever prone to consecutive action, sudden revolutions are contrary to its spirit, and this characteristic is evidenced by the present phase of interest in so-called technical education, for this is doing nothing more than carrying out in accordance with the necessities of the hour the old principle enunciated by Birkbeck, Brougham, and Baines in 1825 in the founding of mechanics' institutions, which have for their object the teaching to our workmen the principles of art and science which underlie the trades they practise. This, too, is our definition of technical instruction. We do not attempt to teach trades, but the principles, artistic or scientific, upon which these trades depend. The school can teach how to make the best article, how to apply the principles which lie at the foundation of the manufacture. The workshop, on the other hand, teaches what the workshop alone can teach—how to produce the article most economically. This I take to be the essential distinction between school teaching and workshop practice. The boy at school learns how to do the work well, the man at the factory or shop must learn to do it not only well but most cheaply. If we keep these two parts of the question separate, give to the school what belongs to the school, and to the workshop what belongs to the workshop, we shall avoid all conflict between the so called theorist and the practical man, we shall preserve what is greatly to be prized, our English workshop experience, but add thereto a knowledge of principles which have hitherto been greatly wanting. Each does necessary work; what we desire and need to develop and to foster is the proper union of theory and practice, without which the supremacy in manufacturing industry, the chief glory and mainstay of our country, will be endangered in the industrial warfare in which all civilized nations are now engaged.

This, then, is the problem which Baines sought to solve, and which your Union and all ardent educationists of the present day are striving to accomplish. For this end we now seek Government aid, and are asking for national recognition of a national necessity. What else is the meaning of the Bills for the promotion of technical education now before Parliament? We ask simply for powers to develop and to strengthen the work which mechanics' institutes were founded to accomplish. We desire to carry on that work on sound lines; that, whilst asking for Imperial aid and for the imprimatur of a national system, we shall be left to decide for ourselves the exact mode of carrying out that system which each locality and each special industry knows is best adapted to satisfy its peculiar requirements. These should be the main objects of any Technical Bill. Are these objects properly put forward, and are these conditions properly safe-guarded in the Government Technical Bill now before Parliament? This is the pressing question of the hour. It is for you, and for similar associations throughout the length and breadth of the land, to say whether this is so or not, to satisfy yourselves on this point, and to urge your representative in Parliament—than whom none is more willing or more able to assist you—to see that your claims and opinions on this subject are made known to the Government which is responsible for bringing this great subject forward. For, gentlemen, it is a great question, one which lies at the foundation of the future welfare—I had almost said the future existence—of the nation.

May I, then, venture to call your attention to one or two of the salient points in this Bill, and to point out to you what I consider some of its valuable provisions as well as some of its defects? In the first place, then, the chief and leading principle of the Bill is the recognition that the time has arrived for giving national aid, whether from local rates or from Imperial sources, for the promotion of technical instruction. The establishment of this principle is one, I venture to think, of the highest possible importance, which if once admitted may well cover a multitude of minor defects. Still, every benefit may be purchased too dear, and it is well to look at the conditions with which this concession to public opinion is coupled. Here I am speaking to educationists, but I am also speaking in Yorkshire and to Yorkshiremen, who have always upheld, and especially at the present moment do uphold, the standard of Liberal opinion in political as well as in educational matters, and I therefore feel that in expressing my opinion against certain conditions attached to the Bill—conditions which are diametrically opposed to the ideas and principles upon which the Liberal party has always acted—I say in expressing these objections I may claim your support as well as your attention.

Clause 2 of the Bill makes it compulsory on every School Board adopting its provisions as to technical instruction—that is, upon every School Board undertaking to rate its district to the limited penny in the pound—to aid the supply of technical instruction in any other public elementary school not under its management in like manner as it aids the supply of such instruction in its own schools. This clause, which as you all will see may be most sweeping in its effects, must be entirely rejected; indeed, it could not stand one hour's scrutiny in the House of Commons, for it offends against the cardinal principle that those who pay the rates should have a voice, either directly or indirectly, in the spending of them, and this is not provided for. But whilst strongly objecting to this compulsory clause—the only compulsory one in the Bill—I, for one, am willing to consider, and to deal fairly with, the just claims of the voluntary schools; for although I am a believer in the Liberal creed, I am before all things an educationist, and I cannot forget that if we are to have our children made more fit for succeeding in the modern battle of life, we must endeavour to bring to bear upon them all, without distinction of creed or of party, the lever which will raise them in the social scale and enable them to use their heads and their hands to their own benefit, and therefore to that of the nation of which they form the units.

Hence, remembering that more than one-half of our population are educated in voluntary schools, and that in many localities these schools are the only ones in existence, and moreover that they are doing excellent educational work, I, speaking for myself, whilst strongly opposed to any compulsory powers, do not feel the same difficulty in admitting the provisions of the first clause in the Bill by which "any School Board in England may from time to time supply, or aid the supply of, such manual or technical instruction or both, as may be required, for supplementing the instruction in any public elementary school in its district, whether under its own management or not." This clause, you will perceive, enables School Boards if they think fit to assist voluntary schools in their districts by aid from the rates for the special purposes of technical instruction, and through the School Board the ratepayers have a voice as to whether their rates shall or shall not be thus spent. But here comes in the limiting clause that not more than 1*d.* in the pound shall be spent. I object to this limit. It will obviously be very difficult for any School Board to ascertain how far the expenses of giving technical instruction can be accurately defined, and I should prefer to leave the amount spent on this object to the good sense and judgment of the locality as represented by the School Board. But how about districts which possess no School Board? Are they to be left out in the cold? No. Provision is made in a further clause by which any local authority having adopted the Free Libraries Acts may hand over to the voluntary schools in its district a sum not exceeding 1*d.* in the pound for the purpose of supplying technical education to be given in its district public elementary schools. Here again the clause is a permissive one only, and the local authority as representing the ratepayers is the judge of whether and how far such aid is to be given. I do not like the plan of mixing up the vexed question of free libraries with that of technical education, and should much prefer the names of the authorities to be simply scheduled, as I see grave objections to the necessary *plébiscite* in districts which have not already adopted the Acts. Still I do not know that on this account I should wish to see the Bill rejected.

Another grave defect in the Bill is a limit is placed on the teaching of technical subjects in Board schools at the seventh standard. This deals a fatal blow at the higher elementary schools. Thus in the Central School in Manchester at the present moment no fewer than 500 scholars who have passed Standard VII. are now learning the sciences—subjects included within the term technical instruction. These scholars cannot continue thus to be taught under the Bill. We must have a similar provision introduced to that in the Scotch Bill, by which the Boards are empowered to use the rates for the maintenance of higher-grade schools; and these matters must be attended to if we are to have a Technical Bill worthy of the name. The higher technical education, as that given in the Colleges, may be assisted by rates levied by local authorities or by Imperial grants, in addition to those made now by the Department. All acknowledge the importance of this higher training. If the head is not educated, the hands are apt to get into mischief. Hence, as these University Colleges can never be self-supporting, it is greatly to be hoped that they will receive that national aid which their importance to the State demands.

But we have a second Bill before the House of Commons—one introduced by myself on behalf of the National Association for the Promotion of Technical Education. I naturally prefer the provisions of my own Bill to those of the Government. They are much simpler, less clogged and hampered by conditions, and confer the same benefits as the Government Bill proposes to confer, with one exception only, viz. aid from the rates to voluntary schools, for to this many of my friends are strongly opposed; but, so far as I am myself concerned, I am free to admit that I should not object to see the difficulty settled by permissive powers being given to the School Boards to aid voluntary schools in their district, just as it is proposed that local authorities shall have power to do the same where no School Boards exist; for, as I have pointed out, the ratepayers have it in their power to refuse such payments by electing members who will oppose such an application of the rates.

Now, to turn to the more immediate question relating to your Union, you may, I think, be gratified with the results of your fifty-one years' work. You can look back upon half a century of admirable endeavour. You have now 260 institutions in union, containing upwards of 500,000 members and 14,000 technical students. You have spent half a million of money in buildings contributed by voluntary subscriptions, with the exception of 1 per cent. derived from S.K. grants for building. All the members of your committees are unpaid, and many of them have been at work for you all their lives. Your claims for national aid are therefore high, and such aid is much needed, for, though the progress you have made is great, you have not nearly accomplished all that has to be done. We want continuation evening schools established on a new and generous basis. We want a new and more elastic evening school code. We want to emancipate from the rigid lines and requirements of payment on individual results. We want an attendance and merit grant for evening continuation schools—say 12*s.* per head for attendance of sixty nights to insure good and continuous teaching. Above all, we wish that existing institutions should be rendered effective. The 260 institutes are in existence, but need help.

When we look abroad we see that both Governments and municipalities vie with each other in aiding technical schools. They are proud to do so, for they know their value. "Do you suppose," said an intelligent German to me, "that we, weighted as we are with heavy taxation for our military and civil services, would willingly further tax ourselves for the purposes of technical schools unless we were convinced that the outlay will repay us over and over again?" This is German opinion, and it is the opinion which we need to inculcate in the minds of our own people, for then we shall get what we want.

Nor need we be ashamed of the beginnings which we have already made; many of our existing institutions will bear favourable comparison with Continental models. Take Huddersfield for example; the school there exactly meets the requirements of the district, and it has already exerted a very marked and beneficial influence on the trades of the district, especially as concerns dyeing and design. This school cost £20,000, all raised by voluntary effort, but though doing excellent work it is heavily in debt, and its friends have difficulty in raising funds to keep it going—not for lack of pupils, for the school is largely attended, but for the reason that such higher schools cannot be self-supporting, and the greater the number of pupils the greater the cost. Surely, if our people understood their true interests as well as our neighbours and competitors do, they would not rest until such an institution is placed in a position to do all it can to raise the condition of their industries by supplanting the too common and worn-out rule of thumb by scientific knowledge always new and always productive. Then again at Yeadon, a small place, you have a school which cost £7000 to build, and in which 350 students are being instructed. But here, too, funds are urgently needed to carry on the work. Surely there ought not to be many who grudge spending a penny in the pound on such objects. In Castleford itself, your Mechanics' Institute has done during its forty years of life, and is now doing, good work. The building is, however, too small for the requirements of the day; your numbers have increased from 80 to 210, and the necessary appliances for teaching science and technology are deficient. Let us hope that when the Technical Bill becomes an Act, Castleford will be one of the first to take advantage of its provisions.

But you may ask, What good will come to our leading industries here—coal and glass—by your technical education? How shall the employers and employed benefit therefrom? In the first place, then, there is no industry in which the value of even a little scientific training is so important for both masters and men as in that of coal-getting. Such a training may, for instance, be, and indeed has often been, the means of saving hundreds of valuable lives. One ignorant man may place in jeopardy or even sacrifice by a single careless act the lives of his comrades, an act which no one acquainted with the properties of explosive gases would dare to commit. In a thousand other ways scientific knowledge—which after all is only organized common-sense—will help all concerned in this great industry. So again in glass-making, how great is the aid given by scientific and artistic knowledge. What a step was the introduction of the Siemens regenerative tank furnace, and how much more remains to be achieved. Then your bottle trade might, by the application of artistic knowledge, be made the foundation of a higher and more tasteful industry which might successfully compete with the wares of Bohemia and Venice. Why not? Are not our workmen both mentally and physically superior to the foreigner? I believe them to be so. They only need teaching, and that we have hitherto withheld from them.

It has been well said that whilst we have confined our attention to improving our machines, the Germans have devoted themselves to educating their men. Let us lose no time in following their lead. "What we fear," said one of the masters to me, "is not either free trade or protection. What we fear is that some day you English will wake up to the necessity of educating your manufacturing population as we do, and then with your racial and physical advantages it will become difficult, if not impossible, for us to compete with you." Let us, then, take to heart the old adage that victory comes to the strong, but remember that it is not to the bodily strong, but only to the strong mentally and morally that the victory comes. Let us see that in this struggle for existence our people are healthy and vigorous in all these three essentials, and act upon the true and eloquent words of Huxley, "You may develop the intellectual side of a people as far as you like, and you may confer upon them all the skill that training and instruction can give, but if there is not underneath all that outside form and superficial polish the firm fibre of healthy manhood and earnest desire to do well, your labour is absolutely in vain."

THE INTERNATIONAL GEOLOGICAL CONGRESS.

ADMIRABLE arrangements have been made for the London meeting of the International Geological Congress, from September 17 to 22 next. The following details are taken from a printed letter signed by the General Secretaries, Mr. J. W. Hulke and Mr. W. Topley. The meetings will be held in the rooms of the University of London, Burlington Gardens, where accommodation for the Council, Committees, Exhibition, &c., has been granted by the Senate of the University. There is a refreshment-room in the building, and there are several restaurants and hotels in the immediate neighbourhood. Arrangements will be made at one of these restaurants for a room to be set apart for the social meetings of members of the Congress. The opening meeting of the Congress will take place on Monday evening, September 17, at 8 p.m., when the Council will be appointed, and the general order of business for the session will be determined. The ordinary meetings of the Congress will be held on the mornings of Tuesday, the 18th, and succeeding days, beginning at 10 a.m. In the afternoons there will be visits to Museums, or to places of interest in the neighbourhood of London. Arrangements for the evenings will be made at a later date. The ordinary business of the Congress will include the discussion of questions not considered at Berlin, or adjourned thence for fuller discussion at the London meeting. Amongst these are: the geological map of Europe; the classification of the Cambrian and Silurian rocks, and of the Tertiary strata; and some points of nomenclature, &c., referred to the Congress by the International Commission. Miscellaneous business will also be considered. In addition to these questions, the Organizing Committee proposes to devote a special sitting to a discussion on the Crystalline Schists. An Exhibition will be held during the week of the Congress, to which geologists are invited to send maps, recent memoirs, rocks, fossils, &c. Foreign members of the Congress are invited by the Council of the British Association to attend the meeting of that Association at Bath. During the week when the Association meets, there will be short excursions in the neighbourhood of Bath, and longer excursions will be made after the meeting. At these excursions excellent sections of the Lower Secondary and Upper Palæozoic rocks will be visited. Excursions will take place in the week after the meeting of the Congress (September 24 to 30). The number of these will depend upon the number of members desirous of attending, and upon the districts which they most wish to visit. The excursions at present suggested are :—(1) The Isle of Wight (visiting the Ordnance Survey Office at Southampton on the way)—Cretaceous, Eocene, Oligocene. (2) North Wales—Pre-Cambrian and the older Palæozoic rocks; West Yorkshire (Ingleborough, &c.)—Silurian and Carboniferous Limestone. (3) East Yorkshire (Scarborough, Whitby, &c.)—Jurassic and Cretaceous. Should the number of members be so large as to make additional excursions necessary, they will probably be :—(4) Norfolk and Suffolk—Pliocene (Crag) and Glacial beds. (5) To the Jurassic rocks of Central England. The short excursions during the week of the Congress will probably be to Windsor and Eton, to St. Albans, to Watford, to Brighton, to the Royal Gardens at Kew, and to other places of interest. Brief descriptions of the districts to be visited in these excursions will be prepared (with illustrative sections, &c.), and will, if possible, be sent to members before the meeting. The full Report of the London meeting will be issued soon after the close of the session. It will contain, in addition to reports of the ordinary business of the Congress, the Report of the American Committee on Nomenclature (about 230 pp.); the Memoirs on the Crystalline Schists (about 150 pp.), and reports of discussion on the same; and probably a reprint, with additions, of the Report of the English Committee on Nomenclature (about 150 pp.).

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The Burdett-Coutts Scholarship in Geology has been awarded to Mr. M. Hunter, B.A., Queen's College.

The degree of M.A. *honoris causâ* has been conferred on Dr. S. J. Hickson, the Deputy Linacre Professor, and on Mr. Wyndham R. Dunstan.

Scholarships in Natural Science are announced for competition, at Merton and Corpus jointly on June 26, at Magdalen on October 9, and at Balliol, Christ Church, and Trinity jointly on November 20. Information may be had from the science tutors of the various Colleges.

A statute is being discussed by Congregation, which will place the biological sciences on the same footing as the physical sciences so far as the examinations for pass degrees are concerned, and it is hoped that the changes to be introduced will increase the numbers of the biological and medical schools.

Mr. F. J. Smith, of the Millard Laboratory at Trinity, has been appointed University Lecturer in Mechanics and Experimental Physics.

CAMBRIDGE.—An amended report on the Natural Science Examinerships has just appeared, but the scheme proposed is very complex. It having been found difficult to get examiners to undertake the honours, and ordinary degree, and M.B. examinations combined, it is proposed to separate the elementary examination work, and appoint two examiners each in elementary chemistry, in elementary physics, and in elementary biology, while two examiners in each subject of the Natural Sciences Tripos are to be appointed as before, and two in pharmaceutical chemistry, for the second M.B. Thus there will be twenty-four examiners in all. The examiners are to be paid a minimum of fifteen, twenty, or thirty pounds each, with a payment of five shillings for each Tripos candidate in their subject, or one, two, and four shillings per candidate in other examinations. Moreover, it is required that all papers and all practical work in honours shall be examined by both examiners in a subject. Both examiners are to be present at all oral work in their subject; and all examiners must be present at the meeting for arranging the class-list for any examination. We prognosticate that the list of examiners, if at all worthy of the University, will not largely consist of non-residents, under the new scheme. The worst mistake perhaps that the University makes is in continuing the one-sided ordinary degree examinations in single subjects, such as geology, botany, and zoology; for all combined there were only four candidates in the last academical year; and for these there were six separate examinations provided, though two were not held. The chemistry "special" attracts a number of candidates, who might be much better employed in preparing for the First Part of the Natural Sciences Tripos. It would be far easier to work the Natural Science Examinations if these were abolished. It is absurd to keep up a machinery of examination which is tabooed even by candidates. The Tripos is a success, which the specials are not, and still more liberal payments and regulations ought to be made. It ought to be remembered that the graduates pay heavy degree fees in addition to examination fees.

The examiners for 1888 in the Second Part of the Mathematical Tripos were Edward John Routh, Sc.D., Peterhouse; James Whitbread Lee Glaisher, Sc.D., Trinity College; Joseph John Thomson, M.A., Trinity College; Andrew Russell Forsyth, M.A., Trinity College. The names, in each class and in each division, are arranged in alphabetical order, and not in order of merit. All the candidates passed the Mathematical Tripos, Part I., in June 1887.

Class I.—Division 1.—Baker, B.A., Joh.; Berry, B.A., Trin.; Flux, B.A., Joh.; Mitchell, B.A., Trin. Division 2.—Brown, B.A., Christ's; Clay, B.A., Trin.; Iles, B.A., Trin.

Class II.—Little, B.A., Trin.; Norris, B.A., Joh.; Peace, B.A., Emman.; Soper, B.A., Trin.

Class III.—None.

The faint hope that there was till lately that a Geological Museum might soon be begun has been dissipated by the Financial Board having reported that the University has no funds available at present, although the Sedgwick Fund has £19,000 in hand to supplement the University contribution.

The late Sir Charles Bunbury's valuable herbaria have been presented to the University by Lady Bunbury.

At the Annual Scholarship Election at St. John's College, on June 18, the following awards in Natural Science were made:—Foundation Scholarships continued or augmented—Seward, Rolleston, Rendle, Turpin, Groom, d'Albuquerque; Foundation Scholarships awarded—Hankin, Horton-Smith, Locke, Baily, Simpson; Exhibitions awarded—d'Albuquerque, Hankin, Horton-Smith, Blackman, Schmitz. In Mathematics, the following awards were made:—Foundation Scholarships continued or augmented—Baker, Flux, Norris, Orr, Sampson, Harris, Rudd, Bennett; Foundation Scholarships awarded—Palmer, Carlisle, Burstall, Monro, Cooke, Lawrenson; Exhibitions awarded—Sampson, Harris, Monro, Dobbs, Reeves, Bennett, Burstall, Cooke, Lawrenson, Brown, Finn, Kahn, Salisbury, Schmitz, Shawcross; Proper Sizarship awarded—Finn. Wright's Prizes to Simpson, Hankin, Blackman, for Science; and Orr, Burstall, Reeves, for Mathematics. The Herschel Prize to Salisbury, for Astronomy; the Hockin Prize for Electricity not awarded. The Hutchinson Studentship of £60 a year for two years is awarded to Mr. G. S. Turpin for research in Organic Chemistry; and the Hughes Prize to Orr (Senior Wrangler) and Brooks (Senior Classic).

SCIENTIFIC SERIALS.

American Journal of Science, June.—Note on earthquake-intensity in San Francisco, by Edward S. Holden. The object of this paper is to obtain an estimate of the absolute value of the earthquake-intensity developed at San Francisco during the American historic period, based on the very complete records collected by Thomas Tennant. The intensity of each separate shock (417 altogether) is assigned on the arbitrary scale of Rossi and Forel. The total average intensity during the 80 years from 1808 to 1888 is found to be nearly equal to the intensity of 28 separate shocks as severe as that of 1868, and the 417 shocks of known intensities correspond to 33,360 units of acceleration.—On the relations of the Laramie Group to earlier and later formations, by Charles A. White. The author's further studies of this group, by some geologists referred to the Tertiary, by others to the Cretaceous ages, lead to the conclusion that the upper strata form a gradual transition from the latter to the former, while there is strong presumptive evidence of the Cretaceous age of the greater part of it.—The gabbros and diorites of the "Cortlandt Series" on the Hudson River near Peekskill, New York, by George H. Williams. With this paper the author concludes for the present his elaborate petrographic studies of the extremely varied massive rocks of the "Cortlandt Series," as it has been designated by Prof. J. D. Dana. He treats in detail the gabbro, diorite, and mica-diorite varieties of norite occurring chiefly in the south-western portion of the area.—Three formations of the Middle Atlantic slope (continued), by W. J. McGee. In this concluding paper the whole subject of the Columbia formation is recapitulated, the general conclusion being that it is much older than the moraine-fringed drift-sheet of the North-Eastern States, and that while th evertebrates of its correlatives suggest a Pliocene origin, both stratigraphy and the invertebrate fossils prove that it is Quaternary. Thus the Columbia formation not only enlarges current conceptions of Quaternary time, and opens a hitherto sealed chapter in geology, but at the same time bridges over an important break in geological history, between the Tertiary and Quaternary epochs.—A comparison of the elastic and the electrical theories of light with respect to the law of double refraction and the dispersion of colours, by J. Willard Gibbs. The main object of this paper is to show the great superiority of the electric over the elastic theories of light as applied to the case of plane waves propagated in transparent and sensibly homogeneous media. The phenomena of dispersion here studied corroborate the conclusion which seemed to follow inevitably from the law of double refraction alone.—Mr. Henry J. Biddle contributes some valuable notes on the surface geology of Southern Oregon, visited by him during the summer of 1887.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 7.—"An Additional Contribution to the Placentation of the Lemurs." By Prof. Sir Wm. Turner, Knt., M.B., LL.D., F.R.S.

In 1876 the author contributed to the Royal Society a memoir "On the Placentation of the Lemurs," which was published in the Philosophical Transactions of that year (vol. clxvi. Part 2). The gravid uteri which he examined and described were from specimens of *Propithecus diadema*, *Lemur rufipes*, and *Indris brevicaudatus*.

In April of the present year he received from Mr. F. E. Beddard, Prosector to the Zoological Society of London, the gravid uterus of a Lemur, which was *Lemur xanthomystax*.

The examination of this gravid uterus confirmed the conclusions to which both Alphonse Milne Edwards[1] and the author had arrived independently from previous investigations, that the placenta in this important group of animals is diffused and non-deciduate, and that the sac of the allantois is large and persistent up to the time of parturition. In these important respects, therefore, the Lemurs, are, in their placental characters, as far removed from man and apes as it is possible for them to be.

Although the author is not disposed to attach too much weight to the placenta as furnishing a dominant character for purposes of classification, yet he cannot but think that animals which are megallantoid, non-deciduate, and with the villi diffused generally over the surface of the chorion, ought no longer to be associated in the same order with animals in which, as in the apes, the sac of the allantois early disappears, and the villi are concentrated into a special placental area, in which the fœtal and maternal structures are so intermingled that the placenta is highly deciduate. Hence he is of opinion that the Lemurs ought to be grouped apart from the Apes in a special order, which may be named either with Alphonse Milne Edwards *Lemuria*, or with Victor Carus and others *Prosimii*.

The fœtus possessed an imperfect covering, external to the hairy coat, and quite independent of the amnion, composed of a cuticular membrane. It corresponded with the envelope named by Welcker *epitrichium*, and described both by him and by the author as present in *Bradypus* and *Cholœpus*. But it occurred in the fœtus both of *Lemur xanthomystax* and *Propithecus diadema* in flakes and patches, and not as a continuous envelope as in the Sloths.

Physical Society, May 26.—Mr. Shelford Bidwell, F.R.S., Vice-President, in the chair.—The following communications were read:—Note on the governing of electromotors, by Profs. W. E. Ayrton and J. Perry. In a paper read before the Society of Telegraph-Engineers in 1882 the authors deduced the conditions of self-regulation of electromotors for varying load when supplied either at constant potential or with constant current. The conditions involved "differential winding," *i.e.* the use of a shunt motor with series demagnetizing coils. With this arrangement fairly good regulation has been obtained, but owing to want of economy the methods have not been developed further. Since then another arrangement, in which a simple shunt motor is used, and a few accumulators placed in series with the armature, has been devised for working in a constant current system. By means of a suitable switch, the accumulators can be charged when the motor is at rest. On the assumption that the E.M.F. of motors is given by $E = n(p + tZ)$, where n = speed, Z = number of turns on magnets, and p and t are constants, it is shown that the speed at which a motor will govern is given by

$$n = \frac{s + a + a'}{t},$$

and the constant current

$$C = \frac{e - np}{a + a'},$$

where s and a are the resistances of the shunt and armature respectively, and e and a' the E.M.F. and resistance of the accumulators. Since a and a' may be small and np not large, the value of e need not be great to give a considerable value for C, and thus only a small number of accumulators will be required.—On the formulæ of Bernoulli and Haecker for the lifting-power of magnets, by Prof. S. P. Thompson, read by Prof. Perry. The formulæ referred to are $P \propto \sqrt[3]{W^2}$ and $P = a\sqrt[3]{W^2}$ respectively, where P = lifting-power, W = mass of magnet, and a a constant depending on the material and shape of the magnet. These formulæ, the author shows, are equivalent to saying that the lifting-power of magnets in which the magnetic induction, B, has been carried to an equal degree, is proportional to the polar surface, and that Haecker's coefficient a is proportional to B^2 through the surface. Assuming the induction uniform over the surface, it is shown that

$$P = \frac{1}{8\pi} B^2 A,$$

where A = area of surface, and this gives a very convenient method of determining B from measurements made upon the pull exerted at a given polar surface. If P be measured in kilogrammes and A in square centimetres, the formula for B becomes

$$B = 5000 \sqrt{\frac{P}{A}};$$

and if the measurements be made in pounds and inches, the constant becomes 1317. It will be readily seen that the greater power of small magnets in proportion to weight does not require for its explanation the sometimes alleged fact that small pieces of steel can be more highly magnetized than large ones, for if B be the same, the lifting-power will be proportional to the polar surface, and not to weight, and hence must necessarily be greater relatively to weight in small magnets. In the case of electromagnets for inductions between 6000 and 16,000, between which the permeability, μ, is approximately given by

$$\mu = \frac{16{,}000 - B}{3{\cdot}2},$$

the lifting-power is shown to be

$$P = A\left(\frac{3{\cdot}2\ Si}{Si + 2{\cdot}56l}\right)^2,$$

where P is in kilogrammes, A in square centimetres, Si = ampere turns, and l = mean length of the magnetic circuit.—Experiments on Electrolysis; Part ii., Irreciprocal Conduction,[1] by Mr. W. W. Haldane Gee and Mr. H. Holden. An abstract was read by the Secretary. The authors have observed, when strong sulphuric acid is used as an electrolyte, the electrodes being of platinum, that the decomposition nearly ceases, if, by decreasing the resistance in circuit, it is attempted to increase the current beyond a certain maximum. When this condition (called the insulating condition) is arrived at, reversing the current immediately restores the conductivity. Experiment shows that the current density is an important factor, and that the composition,

[1] "Histoire Naturelle des Mammifères de Madagascar," forming vol. vi. chap. ix. of Grandidier's "Histoire de Madagascar."

[1] Irreciprocal conduction is said to occur if a reversal of the direction of a current causes any change in its magnitude.

viscosity, and temperature of the electrolyte, as well as the previous history of the electrode, have considerable influence on the current density at which the insulating condition occurs. The seat of the insulating layer is found to be at the anode; and the authors believe it due to very concentrated acid formed around the electrode, whose specific resistance is very high. Experiments were also made with carbon and gold electrodes, and phosphoric acid, caustic potash, soap, and sodium benzoate were used as electrolytes, the results of which seem compatible with the concentration hypothesis above stated. The paper contains an historical and critical account of allied phenomena, and tables expressing the numerical results obtained by the authors are given.

Linnean Society, June 7.—Mr. Carruthers, President, in the chair.—The following were nominated Vice-Presidents: Mr. F. Crisp, Dr. Maxwell Masters, Dr. John Anderson, Mr. C. B. Clarke.—An exhibition under the microscope of decalcified and stained portions of the test of *Laganum depressum* was then given by Prof. Martin Duncan, who made some very instructive remarks on the structural characters to be relied on for discriminating the species.—Mr. D. Morris, of Kew, exhibited some drawings of a Fungus (*Exobasidium*) causing a singular distortion of the leaves of *Lyonia*, from Jamaica.—A paper was then read, by Mr. H. N. Ridley, on the natural history of Fernando Noronha, in which he gave the general results of his investigations into the geology, botany, and zoology of this hitherto little-explored island.

Royal Meteorological Society, May 16.—Dr. W. Marcet, F.R.S., President, in the chair.—The following communications were read:—Report of the Wind Force Committee on experiments with anemometers conducted at Hersham, by Mr. G. M. Whipple and Mr. W. H. Dines. A whirling apparatus, with arms 29 feet radius, was rotated by means of a small steam-engine. On the arms of the whirler four different anemometers were placed. Each experiment lasted fifteen minutes, the steam-pressure remaining constant during the run. For the Kew standard anemometer, with arms 2 feet long, the experiments give a mean value for Robinson's factor of 2·15; and for two smaller instruments the factor is 2·51 and 2·96. Mr. Dine's helicoid anemometer gave very satisfactory results, the mean factor being 0·996.—On the measurement of the increase of humidity in rooms by the emission of steam from the so called bronchitis kettle, by Dr. W. Marcet, F.R.S. The author described a number of experiments which he had made by steaming a room with a bronchitis kettle, and ascertaining the rise and fall of the relative humidity from readings of the dry- and wet-bulb thermometers. He found that the air in the room could not be saturated, the relative humidity not exceeding 85 per cent.

Entomological Society, June 6.—Dr. D. Sharp, President, in the chair.—Mr. Pascoe brought for exhibition a book of fine plates of *Mantidæ*, drawn by Prof. Westwood, which it had been hoped would have been published by the Ray Society.—Mr. E. Saunders exhibited a species of Hemiptera, *Monanthia angustata*, H-S., new to Britain, which he had captured by sweeping, near Cisbury, Worthing. The insect is rather closely allied to the common *Monanthia cardui*, L.—Mr. McLachlan exhibited a species of *Halticidæ*, which had been sent him by Mr. D. Morris, Assistant Director of the Royal Gardens, Kew, who had received them from Mr. J. H. Hart, of the Botanic Gardens, Trinidad, with a note to the effect that they had attacked young tobacco and egg-plants badly in that island. Mr. Jacoby had, with some reserve, given as his opinion that it might possibly turn out to be *Epitrix fuscata*, Duv., a species which had been described from Cuba.—The Rev. H. S. Gorham exhibited a collection of beetles lately captured in Brittany including *Diachromus germanus*, L., *Onthophagus taurus*, L., *Hister sinuatus*, Ill., and other species which are exceedingly rare, or altogether wanting in Britain, and yet occur very commonly in the north of France.—Mr. White exhibited living larvæ of *Endromis versicolora*, from near Bristol, and remarked that when quite young they are nearly black, owing to being very thickly spotted with that colour; the body-colour is green, and after two or three changes of skin the spots disappear. Mr. White also exhibited two preserved larvæ of *Phorodesma smaragdaria*, which he had recently taken, and made some remarks concerning the so-called "case," which this insect is said to construct from the leaves of its food-plant, *Artemisia maritima*. This he did not consider to be really a case, but he had discovered that the larva possessed on its segments certain secretory glands, at the apex of each of which there is a bristly hair; this appears to retain pieces of the plant, which are probably fixed firmly afterwards by means of the secreted fluid. These pieces are very irregularly distributed, and their purpose does not seem quite evident.—Mr. Lewis exhibited about three hundred specimens of the genera *Hetærius*, Er., and *Eretmotus*, Mars. The most remarkable of these was *Hetærius acutangulus*, Lewis, discovered last year by Mr. J. J. Walker near Tangier, and recently taken by him at San Roche, in Spain.

PARIS.

Academy of Sciences, June 11.—M. Janssen, President, in the chair.—A study of the refrigerant mixtures obtained with solid carbonic acid, by MM. Cailletet and E. Colardeau. These researches seem to show that the ether generally used in combination with snow and carbonic acid for the purpose of obtaining intense cold, plays a much greater part than has been supposed in lowering the temperature of the mixture.—Representation of the attitudes of human locomotion by means of figures in relief, by M. Marey. The figure of a runner at a given moment is here reproduced from a relief obtained by M. Engrand by means of the photochronograph. It is pointed out that a continuous series of such figures, obtained by this process, would be of great service in determining for artists and physiologists the successive changes of attitude in running and walking.—Determination of the mean level of the sea, by means of a new instrument, by M. Ch. Lallemand. In a previous note (*Comptes rendus*, May 28, 1888) the principle was described of this apparatus, which is here figured and named the *medimaremeter*. It gives the mean sea-level without any mechanical adjustments, and almost without the need of calculations.—On the artificial reproduction of hydrocerusite, on the chemical composition of this mineral species, and on the constitution of white lead, by M. L. Bourgeois. These synthetic researches throw much light on the hitherto problematical nature of hydrocerusite, as well as on the constitution of white lead (ceruse), in which the author distinguishes only two definite substances, both existing in nature—hydrocerusite and cerusite. Analysis shows that the formula of the artificially prepared hydrocerusite is $3PbO,2CO_2,HO$, or $2(PbO,CO_2) + PbO,HO$, which is no doubt that of the natural substance also.—On the variations of the personal equation in the measurement of double stars, by M. G. Bigourdan. Thiele supposes that the personal equation of each observer remains somewhat constant during a "season of observations," and then takes a different value for another period, the duration of the "seasons" varying from a few days to several months. But according to Struve these variations are rapid, occurring in a few hours, and lasting only a single night. The observations of the author tend to show that these apparently contradictory views are capable of being reconciled, both being to a certain extent true.—On the determination of some new rings of Saturn lying beyond those already known, by Dom Lamey. These were first vaguely perceived by the author in 1868, and have been repeatedly observed since February 12, 1884, with the 16 cm. refractor in the clearer atmosphere of the Grignon Observatory. They are four in number, and are visible as well-defined elliptical rings in the regions intermediate between Mimas and Titan, first and sixth satellites of Saturn. The semi-diameter of the planet being taken as 1, the semi-diameter of the rings, measured from the middle of the most intense region, would be $2·45 \pm 0·05$; $3·36 \pm 0·02$; $4·90 \pm 0·50$; $8·17 \pm 0·23$. They were also independently observed by two of the author's fellow-workers, and cannot therefore be explained away as optical illusions due to the terrestrial atmosphere or any other sources of error.—On a point in the history of the pendulum, by M. Defforges, with remarks by M. C. Wolf. In connection with Kater's memoir of 1818, presented to the Royal Society, on the "convertible" pendulum, and his repudiation of de Prony's claim to priority of invention, M. Defforges announces the discovery of some documents in the Ecole des Ponts et Chaussées fully confirming de Prony's claim. M. Wolf, however, points out that these documents (undated, but no doubt written in 1800) were never published, and certainly unknown both to Bohnenberger when he announced the project of a pendulum with reciprocal axes (1811), and to Kater when he rejected de Prony's claim to priority of invention (1818). Hence, although de Prony now appears to have been the precursor, the rights of Bohnenberger and Kater remain intact as discoverers of the principles to which is due the revolution effected in the observations of the pendulum during the present century.—On a correction to be made in Regnault's determinations of the weight of a litre of the elementary gases, by M. J. M. Crafts. The error already pointed out by Lord Rayleigh is here corrected for air, N, H, O, and CO_2.—Experiments with a non-oscillating pendulum, by M. A. Boillot. It is shown that the oscillating pendulum, which in Foucault's experiment demonstrates the movement of the globe, may be used for the same demonstration by suppressing the oscillatory action and operating in a room.—Measurement of the velocity of etherification by means of electric conductors, by M. Negreano. A process is explained for measuring the rapidity of the chemical reactions which take place between certain resisting bodies at the moment their electric resistances become varied. These resistances have been measured according to the method indicated by Lippmann.—On a diamantiferous meteorite, which fell on September 10/22, 1886, at Novo-Urei, in the Government of Penza, Russia, by MM. Ierofeieff and Latchinoff. Analysis of this specimen, weighing 1762 gr., shows that it contains 1 per cent. of very fine carbonado, or diamond dust, besides 1·26 of amorphous carbon. The other chief substances were—peridot, 67·48; pyroxene, 23·82; and nickled iron, 5·45.

BERLIN.

Physical Society, June 1.—Prof. von Helmholtz, President, in the chair.—Dr. Lummer gave an account of experiments which he had made on the determination of the focal length of lenses by the method of Abbe in Jena. The method is based upon the equation $f = \frac{a}{\beta_1 - \beta_2}$; where f is the focal length, a the distance of two objects from the lens, and β_1 β_2 the respective magnifications of their images. The speaker discussed first the way by which Abbe had arrived at the above equation, and then went thoroughly into an explanation of the methods for measuring the amount of magnification of the images. It must suffice here to say briefly that the magnification was measured by a microscope directed along the principal axis of the lens, and at right angles to its surface, the microscope then being moved backwards and forwards, until the upper and lower ends of the image were visible. Prof. von Helmholtz explained that during his physiological-optical researches he had already determined the focal lengths of lenses by the measurements of the magnification, in accordance with the formula given above, admitting at the same time that his methods were perhaps less exact.—Dr. Lummer then gave an abstract of a paper on the movement of air in the atmosphere, which he had recently read before the Academy of Sciences. In solving the problem, he had made use of the principle of mechanical similarities. When the hydrodynamic equation for a given motion is known, it is only necessary to multiply all the factors by n in order to represent the motion in much larger dimensions. Accordingly if the conditions of the occurrence of air currents, such as take place in the atmosphere, have been experimentally determined in the laboratory for 1 cubic metre of air, and if the atmosphere is assumed to be 8000 metres high, then the space, time, and moment must be multiplied by 8000, while on the other hand the internal friction must be taken as being only 1/8000 of that which has been determined by experiment. It follows from this that the internal friction is of very small account; but as against this, the friction of the earth's surface has a considerable influence and cannot be neglected. Supposing a mass of air moving horizontally is considered, then a series of particles of air, which were at the outset vertically each above the other, will finally place themselves along a curve of sines as the result of friction at the earth's surface. Calculation shows that it would require a period of 42,000 years before the motion was reduced to one-half as the result of internal friction. The speaker then considered the atmosphere as made up of rings of air which surround the earth in coincidence with the parallels of latitude: each of these rings of air has its own moment of rotation, which depends on its radius, and is therefore greatest at the equator and least at the poles. If the air which is streaming upwards at the equator were to stream down again to the earth in higher latitudes, it would be moving with a velocity far exceeding that of any known storm, even at the latitude of 30°. Since the internal friction of the air is so small that it may be neglected, the speaker proceeded to point out the other factors which have an influence in slowing down the air as it falls. He regards them as being the vortex motions which take place in the atmosphere at the discontinuous surfaces of two masses of air moving with different velocities. These vortex motions cause the adjoining layers of the two masses of air to mix, and thus diminish their velocity. This is the explanation of the calms, trade-winds, sub-tropical rains, and other phenomena which occur in the atmosphere. It would occupy too much space to give even a brief statement of how these conclusions are arrived at.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

A Course of Practical Instruction in Botany, Part 1, 2nd edition: Prof. F. O. Bower (Macmillan).—Lessons in Elementary Mechanics, Stage 2: W. H. Grieve (Longmans).—Observations on the Embryology of Insects and Arachnids: A. T. Bruce (Baltimore).—Smithsonian Report, 1885, Part 2 (Washington).—Birdsnesting and Bird-skinning, 2nd edition: M. Christy (Unwin).—An Elementary Treatise on Mensuration: E. J. Henchie (School Books Publishing Co.).—First Elements of Experimental Geometry: P. Bert; translated (Cassell).—Introductory Inorganic Analysis: E. H. Cook (Churchill).—Origin and Growth of Religion as illustrated by Celtic Heathendom: Prof. J. Rhys (Williams and Norgate).—Sierra Leone: or the White Man's Grave: G. A. Lethbridge Banbury (Sonnenschein).—Explorations and Adventures in New Guinea: Capt. J. Strachan (Low).—Longmans' School Geography for Australasia: G. G. Chisholm (Longmans).—On the Dicotylinæ of the John Day Miocene of North America: E. D. Cope.—On the Mechanical Origin of the Dentition of the Amblypoda: E. D. Cope.—The Theory of the Tides: J. Nolan (Dulau).—The Perissodactyla: E. D. Cope (Philadelphia).—The Mechanical Origin of the Sectorial Teeth of the Carnivora: E. D. Cope (Salem).—Recent Advances in our Knowledge of the Law of Storms: F. Chambers (Bombay).—Causation of Pneumonia: H. B. Baker (Lansing).—Quarterly Journal of the Royal Meteorological Society, April (Stanford).—Quarterly Weather Report, Part 3 (Eyre and Spottiswoode).—Hourly Readings, 1885 (Eyre and Spottiswoode).—Travaux de la Société des Naturalistes de St. Pétersbourg, vol. xix. 1888, Section de Géologie et de Minéralogie (St. Pétersbourg).—Notes from the Leyden Museum, vol. x. Nos. 1 and 2 (Brill, Leyden).—Madras Journal of Literature and Science, Session 1887–88 (Madras).—Proceedings of the Academy of Natural Sciences of Philadelphia, Part 1, 1888 (Philadelphia).—Internationales Archiv für Ethnographie, Band i. Heft 3 (Trübner).

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ROYAL SOCIETY, at 4.30.—Further Researches on the Physiology of the Invertebrata: Dr. Griffiths.—Muscular Movements in Man, and their Evolution in the Child; Dr. Warner.—On the Electromotive Changes connected with the Beat of the Mammalian Heart, and of the Human Heart in particular: Dr. Waller.—On the Plasticity of Glacier and other Ice: J. C. McConnel and D. A. Kidd.—On the Organization of the Fossil Plants of the Coal Measures, Part XV.: Prof. W. C. Williamson, F.R.S.—A Study of the Thermal Properties of Propyl Alcohol: Profs. Ramsay and Young.—And other Papers.

CHEMICAL SOCIETY, at 8.—Ballot for the Election of Fellows.—Chlorofumaric and Chloromaleic Acids; their Derivatives and Magnetic Rotations: Dr. W. H. Perkin, F.R.S.—Combustion by means of Chromic Anhydride: C. F. Cross and E. J. Bevan.—Metoxylenesulphonic Acids: Dr. G. T. Moody.—Researches on Isomeric Change: Dr. H. E. Armstrong, F.R.S.—A New Method for the Production of Mixed Tertiary Phosphines: Dr. N. Collie.

SATURDAY, JUNE 23.

PHYSICAL SOCIETY, at 3.—On the Photometry of Colour; Capt. Abney, R.E., F.R.S.—Note on Continuous Current Transformer: Prof. S. P. Thompson.—On the Existence of Undulatory Movement accompanying the Electric Spark: Ernest H. Coote.—On an Optical Model: Prof. Rücker, F.R.S.

TUESDAY, JUNE 26.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—Exhibition of Pottery, &c., from Recent Excavations in New Mexico: Arthur S. Burr.—The Nicobar Islanders; E. H. Man.

EDINBURGH.

THURSDAY, JUNE 28.

MINERALOGICAL SOCIETY, at 7.—A Mangano-Magnesian Magnetite: Prof. Albert H. Chester.—The Distribution and Origin of the Mineral Albertite in Ross-shire: Hugh Miller. (Communicated by the Local Secretary.)—The Rock-forming Feldspars and their Determination: Alex. Johnstone, and Dr. A. B. Griffiths. (Communicated by the Local Secretary.)—A Scottish Locality for Bornite: Rev. W. W. Peyton.—With several Papers by Prof. W. I. Macadam.

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THURSDAY, JUNE 28, 1888.

THE EARLY CORRESPONDENCE OF CHRISTIAN HUYGENS.

Œuvres Complètes de Christian Huygens publiées par la Société Hollandaise des Sciences. Tome Premier: Correspondance 1638–1656. (La Haye: Martinus Nijhoff, 1888.)

NEVER before, we venture to assert, even in this age of "complete editions," has so colossal a literary monument been raised to the memory of a great man as the edition of the works of Christian Huygens, of which the first instalment now lies before us. In a huge and splendid volume of 621 quarto pages, is contained the correspondence, from his ninth to his twenty-eighth year, of the "young Archimedes," as his friends delighted to call him. Yet out of 2600 documents in the hands of the Commission charged by the Amsterdam Academy of Sciences with the superintendence of the publication, no more than 365 have as yet been printed. Seven additional tomes, at least as massive as that just now issued from the press at the Hague, will be needed to bring to completion the initial section of the comprehensive record. The works of Huygens, edited and inedited, will follow, with an elaborate biography, so that we may safely assume that the present century will not see the end of an enterprise the pecuniary responsibility of which has been generously undertaken by the Scientific Society of Holland.

We have nothing but praise to accord to the manner in which it has so far been conducted. All selective difficulties were indeed spared to the Commission; for the collection at Leyden was of such exceptional value that their resolution to print everything it contained admitted of no cavil, and was arrived at without hesitation. Room was, however, left for discretion as to the manner of presenting to the public the materials at their disposal; and it has been wisely exercised. The notes are elucidatory without being obtrusive; the prefatory remarks are few and to the point; the indexes (of which there are no less than five) afford a satisfactory clue to a labyrinth of close upon four hundred letters in Latin, French, and Dutch, miscellaneous in their contents, and necessarily chronological in their arrangement. They are of great and varied interest. Scientific history, the dispositions and modes of thought of "men of light and leading" in the seventeenth century, the manners and customs of the time, are all in turn illustrated by them; above all, their perusal offers singular advantages for studying the development of the powerful and active mind of the protagonist in the life-drama they partially unfold.

Christian Huygens was born at the Hague, April 14, 1629. Every educational advantage which the age could afford was showered upon him. His father, Constantine Huygens, was distinguished as a statesman, a poet, a man of letters, and a musician. Himself a product of the most varied culture, he desired that none of the brilliant faculties early apparent in his two elder sons should rust in disuse. They were accordingly taught to sing and play the lute as well as to compose Latin verses; they attended the juridical lectures of Vinnius, and studied mathematics under Van Schooten; they were accomplished in dancing and drawing no less than in Greek, rhetoric, and logic; they travelled to see the world and improve their manners; they could, as occasion required, play the courtier, or work as skilled mechanics. The native turn of each was, however, different. Constantine excelled in the lighter branches of literature; Christian promptly shot ahead of him in geometry. Study and invention went, with him, in this direction, hand in hand. Before he was seventeen, he had begun to strike out original lines of investigation, and the promise of these juvenile essays was discerned, among the first, by Descartes. Mersenne about the same time opened a correspondence with him, and predicted for him greatness beyond that of the towering figure of Archimedes.

He made his *début* in print in 1651 with a treatise on quadratures, to which he appended a refutation of the theorems on the same subject of Gregory of St. Vincent, with the unusual result of gaining (besides many admirers) a friend in the person chiefly interested in the controversy. The little book was received with acclamations of praise. At once and everywhere, the genius of its author was acknowledged. The mathematicians of France, England, and Germany vied with those of Holland in doing him honour. He was lauded as "Vieta redivivus," placed on a level with Pappus and Apollonius, hailed as the great coming light of science. Yet it was not in pure mathematics that his brightest laurels were to be gathered. Many lesser men did more to help on the great revolution in method which signalized his age. He remained, throughout its progress, constant to the ancient models, and looked on, indifferent or averse to changes the full import of which he failed to realize. His extraordinary ability was, however, never more conspicuous than in his successful grappling with problems—such as that of the isochronous curve—unapproachable by geometers of a more common-place type without the aid of the calculus; and there is reason to think that, had he lived longer, he would have reinforced his powers by its adoption. It appears from a letter of Leibnitz to him, of October 1, 1693, that he was just then, eighteen months before his death, "beginning to find the convenience" of the infinitesimal mode of calculation, and had gone so far as to express publicly his approbation.

The most interesting part of the correspondence now before us refers to Huygens's observations on Saturn. As early as November 1652, we find him making inquiries as to the best manner of preparing and polishing lenses. Assisted by his brother Constantine, he prosecuted the subject with a diligence for which he half apologized to his learned friends, and which produced unwelcome gaps in his communications with them. By the commencement, accordingly, of 1655, he was in possession of a telescope of 12 feet focal length, undoubtedly the best produced up to that date. It showed him, not only the phases of Venus and the satellites of Jupiter, but—March 25, 1655—"aliud quid memorabile," unseen by Fontana or Hevelius, namely a Saturnian moon, afterwards named Titan, the sixth counting outward from the planet, the first in order of terrestrial detection. He concealed and endeavoured to secure his discovery, after the fashion set by Galileo, in an anagram which was widely circulated, and expounded in the following year. The precaution was nevertheless insufficient to prevent a claim to priority being put forward. Dr. Wallis, the Savilian Professor of Geometry, prepared on behalf of his friends Wren and Neile, a storage-battery of fame in the shape of a counter-anagram, which—if Huygens's private notes are to be relied upon—he fraudulently interpreted as an announcement similar in purport to that imparted to him from the Hague. Some unexplained circumstance possibly underlies a transaction on the face of it highly discreditable to our countrymen. The pretensions of the English observers were at any rate quickly and quietly withdrawn, and Huygens was left in undisturbed enjoyment of the credit most justly due to him.

Shortly after his return from Paris, late in 1655, he constructed a telescope of 23 feet, magnifying one hundred times; and the comparison of the observations it afforded him with those of the previous year enabled him at once to penetrate the mystery of Saturn's enigmatical appendages. His hypothesis as to their nature, wrapt up in the customary logogryph, was appended to his little tract on the Saturnian satellite, with an accompanying prediction of the future changes of figure to be expected in the planet. Its verification, however, falls outside the limits of the publication we are at present concerned with. Nor does it include any mention of the novel sight disclosed to Huygens by his improved instrument in the constellation of Orion, where a certain "hiatus" in the firmament permitted (as he supposed) the pure, faint splendour of the empyrean to shine through on his amazed vision.

Huygens had an eminently sane and sagacious mind. His fortunate intuitions were numerous, and the investigations they suggested were singularly solid and complete. A great part of his work was thus fitted to be, and has actually become, the substructure of the modern scientific edifice. He was, however, less happy in the few cases in which, relaxing his habitual prudence, he gave the rein to speculation. His prevision that the measure of discovery in the solar system was filled by the disclosure of Titan, was belied with scarcely civil haste by Cassini's further detections hopelessly overthrowing the numerical balance between six primary and six secondary bodies. And the surmises which constituted the bulk of his "Cosmotheoros" were, for the most part, infelicitous. Yet he reprehended, as woven out of figments, the Cartesian theory of the origin of the universe, and concluded with the wise and memorable words:—"To me it would be much if we could understand how things actually are, which we are far enough from doing. How they were brought about, what they are, and how begun, I believe to be beyond the range of human ingenuity to discover, or even by conjectures to approach."

A. M. CLERKE.

NORWEGIAN GEOLOGY.

Bömmelöen og Karmöen med Omgivelser. Geologisk beskrevne af Dr. Hans Reusch. (Kristiania: Published by the Geological Survey of Norway, 1888.)

THE attention of geologists in all parts of the world has for some years been concentrated upon the crystalline schists, which have so long presented insuperable difficulties to those who would explore their origin. Little by little the darkness has been rising from these ancient foundation-stones of the earth's crust; and though a long time must probably still elapse before their history can be even approximately sketched, there can be no doubt that we are now at last on the right road of investigation. Fresh evidence is continually being obtained from the most widely-separated regions, and each additional body of facts goes to support the view that the schistose rocks are the records of gigantic terrestrial displacements, whereby portions of the crust have been pushed over each other, and so crushed and deformed as to acquire new internal rock-structures. Out of these mechanical movements, with their accompanying chemical transformations, a true theory of metamorphism will no doubt eventually be evolved. In the meantime it is too soon to generalize; what we need is a far larger mass of observations. The subject is a wide one, for it involves the labours of the field-geologist, the petrographer, the mineralogist, the chemist, and the physicist. And only by the united exertions of these fellow-workers can we hope for good progress and solid results.

The most recent contribution to the question of the origin of the crystalline schists has just appeared in the form of a handsome volume, by Dr. Hans Reusch, on the Bömmel and Karm Islands off the mouth of the Hardanger Fjord. It consists of a mass of detailed observations on the structure of the crystalline rocks of that part of the Scandinavian coast, and furnishes an admirable array of fresh data for the study of the problems of regional metamorphism. Dr. Reusch's previous researches on the compressed conglomerates and metamorphosed fossiliferous rocks of the same district were of the utmost value in the discussion of the question, and he now augments these by new details from the surrounding region.

Especially important are the numerous illustrations of the effects of pressure and stretching in the production of the well-known structures of the crystalline schists. The strangely deceptive resemblance to stratification resulting from these processes is exhibited in many examples. Excellent instances are likewise given of the production of foliation in dykes. Eruptive diabases and gabbros are shown to pass into dioritic rocks, and hornblendic schists and granite into various foliated compounds. More novel features of the essay are the careful studies of the deformation and foliation of what were unquestionably at one time ordinary sedimentary deposits—sandstones, conglomerates, and limestones. It is shown, for instance, that in a mass of still recognizable conglomerate the planes of stratification are cut across, almost at right angles, by those of foliation, while the lines that mark the direction of stretching or deformation slant upwards across the latter.

Dr. Reusch brings forward some remarkable observations regarding the connection between conglomerates and granitic rocks. He thinks that in some places what is now granite has resulted from the metamorphism of what was originally a breccia or conglomerate composed of fragments of granite, gneiss, quartzite, and quartz. The quartzite and quartz, being less liable to change, remain still visible, while the granite and gneiss have passed into common granite. In another locality he finds what he believes to be evidence of the passage of a conglomerate into augen-gneiss. Without in any way calling in question the accuracy of his observations, a geologist who has had much experience among the crystalline schists in districts where great thrust-planes and other proofs of powerful displacements prevail, will recall examples of breccias that might at first be taken to be sedimentary masses, but which have eventually proved to be portions of rocks crushed during the disturbances that produced the schistose structure. Coarse pegmatites, for example, may be traced through various stages of comminution, until they pass at length, along the plane of movement, into finely fissile rocks, that in some cases might be mistaken for shales, in others for eruptive rocks with the most exquisitely developed flow-structure. The "eyes" in some augen-gneisses are almost certainly fragments resulting from the crushing of largely crystalline rocks, such as coarse pegmatites.

Dr. Reusch shows that in Scandinavia, as in the north-west and north of the British Isles, the axes of the great terrestrial plications run, on the whole, from north-east to south-west, and that as they have involved Upper Silurian strata in their folds, the movements must be of later date than some part, if not the whole, of the Upper Silurian period. His essay is most welcome as a valuable contribution to one of the most perplexing problems in geology. It once more shows him to be a careful and intrepid field-geologist, and, at the same time, a skilful worker with the microscope. This combination of qualifications fits him in a special manner for the researches to which he has devoted himself with so much ardour and success. His volume is copiously illustrated with figures in the text, and a selection of coloured geological maps. English geologists will also welcome in it a copious English summary of the contents. We may confidently predict that, before long, some of his drawings will be reproduced in the text-books as standard representations of the facts of regional metamorphism. A. G.

TRAVELS IN ARABIA DESERTA.

Travels in Arabia Deserta. By C. M. Doughty. 2 Vols. (Cambridge: University Press, 1888.)

MR. DOUGHTY'S book takes us back to the age of the old travellers. His wanderings were in countries where not only no European had preceded him, but where he had to travel with his life continually in his hand. He travelled alone, and without any of the equipment which the modern explorer considers a necessity of existence, living with the Beduin of the desert, and sharing with them their wretched subsistence. Even the style in which he writes is a style in which it is safe to say no Englishman has written for the last two hundred years, and while it attracts us by its quaintness it makes us not unfrequently wonder what is exactly the author's meaning. Indeed, were it not for the very excellent index, it would often be almost impossible to find one's way through the labyrinth of Mr. Doughty's sentences or to ascertain the exact chronology of his route.

Mr. Doughty seems to have been born under an evil star. While he possesses most of the requisites of a successful traveller—a love of adventure, an insatiable curiosity, indomitable patience, and extraordinary powers of endurance—he lacks, on the other hand, just those qualities which would have smoothed his journey and made his life more comfortable. He is a man, by his own confession, of blunt and plain speech, improvident and forgetful, with an old-world belief in the falsity of Mohammedanism and the Koran, and the iniquity of countenancing them even by a politic word. His explorations took place at the time of the war between Turkey and Russia, when the fanaticism of the Mohammedans of Arabia was excited to the utmost, and he had to leave Damascus at the outset of his journey without any letters or help from the British Consul. The latter, indeed, declared that "he had as much regard of" him, would he "take such dangerous ways, as of his old hat." It is no wonder that Mr. Doughty complains of conduct which caused him "many times come nigh to be foully murdered."

His explorations were conducted in Central Arabia, a country which is less known than Central Africa. He accompanied the Mecca pilgrims as far as "the kella" or fort of Medain, where he lived with the Turkish garrison, visiting from time to time the ruins of Medain Salihh, and taking squeezes of the Nabathean inscriptions there. After some months he joined the nomad Beduin, and wandered with them in various directions, visiting the lava crags on the west and Teyma on the north-east. Eventually he made his way to Háyil in the Nejd—a centre of Wahabi fanaticism—where a sort of settled government was established under Ibn Rashîd. From Nejd he was forwarded, along with some Beduin, to Kheybar, not far to the north of Medineh, where he found himself once more within what was nominally Turkish territory, and was arrested as a spy. Released after a while, he was sent back again, for reasons which are never explained, to Háyil, and here his troubles began. The people of the place would not receive the Christian stranger a second time; his Beduin escort were afraid of bringing him back to Kheybar, and after a series of misadventures he was finally deserted near Aneyza, a town considerably to the south of Háyil. The governor and leading merchants of Aneyza fortunately befriended him, and he at last found his way to Taif and Jedda, though not without being first stripped of the little that still belonged to him, and narrowly escaping with his life.

Mr. Doughty was a careful observer, and he has not only made important additions to our geographical knowledge of Arabia, but also to our geological knowledge of it. The inscriptions he obtained at Medain Salihh and elsewhere have been published by the French Government, and important inferences have been drawn from them. They prove not only that a powerful and civilized State existed in this part of Arabia far on into the Christian era—a fact which was already known—but that this State was Nabathean in its language and character. M. Berger has come to the conclusion that before the rise of Mohammedanism the Arabic of the Koran was the language of Mecca only and the surrounding district, the Nabathean with its Aramaic affinities prevailing in the northern part of Arabia, and the Himyaritic in the south. It seems clear, at all events, that the Nabathean and Himyaritic civilizations once adjoined one another, and that their overthrow marked the triumph of the Beduin children of Ishmael. Since Mr. Doughty's travels, Prof. Euting and M. Huber (who was afterwards murdered by the Hharb Arabs) have visited Medain Salihh and Teyma, and carried away with them a large number of valuable inscriptions. One of these, on a stêlê discovered at Teyma, is now in Paris.

It is interesting to find Mr. Doughty confirming the statement that the final *n* of classical Arabic is still pronounced in the Nejd. His remarks on the diseases prevalent among the natives are also curious, though it is difficult to believe that the ophthalmia from which he had himself suffered is due to drinking cold water before going to bed. Everyone, however, who has had much experience of the Beduin will agree with the character he gives of them. The Egyptians have a proverb: "He who shows a Beduin the way to his door will have long sorrow"; and the traveller is unfortunate who is compelled to intrust himself to their tender mercies.

A. H. S.

OUR BOOK SHELF.

Charts showing the Mean Barometrical Pressure over the Atlantic, Indian, and Pacific Oceans. (London: Published by the Authority of the Meteorological Council, 1888.)

THESE charts are issued in the form of an atlas, and deal in a very complete manner with the barometer means and range of all oceans. The months for which separate charts are given are February, May, August, and November, which have been selected to represent the mean values for winter, spring, summer, and autumn respectively in either hemisphere. In addition to the large charts, which give the material in considerable detail, there are four index charts, on a smaller scale, which exhibit for the same months the isobars, or lines of equal pressure, over the entire globe. These are followed by four charts, on the same scale, showing the range of barometrical pressure. The observations have been derived from logs and documents deposited in the Meteorological Office; logs and remark-books of Her Majesty's ships, furnished by the Admiralty; published narratives of various voyages, and various published results of other nations; also observations at coast stations and islands obtained from all available sources. The number of observations obtained from the Meteorological Office logs for the several oceans are: the Atlantic Ocean, 339,300; the Indian Ocean, 162,000; the Pacific, 88,300.

The barometrical means are given in large figures for areas of 5° of latitude by 5° of longitude, and for the benefit of those who require the material in greater detail smaller figures are given to show the means for areas of 2° of latitude by 2° of longitude, the several means being obtained from the daily averages. The range to the nearest tenth of an inch for each 5° area is placed over the mean for that area, and the number of observations under it; so that the charts not only supply the navigator with all the detail he is likely to require, but afford opportunity of the values being combined by other compilers with material of a similar nature. The isobars are given for each tenth of an inch, and the free use which has been made of the barometrical values for the coast stations greatly enhances the degree of dependence of the several lines. To facilitate the use of the charts for the navigator, the observations are corrected for a constant altitude of 11 feet above the sea, and are reduced to 32° F., but are not corrected for gravity; a table is, however, given on the face of each chart to facilitate this correction.

The general charts which give the isobars of the globe show very conspicuously the prevalence of high-pressure areas in each ocean in each of the four seasons. Change is of course shown in the distribution of pressure, but there is the same tendency to the persistency of high reading. It is seen that these areas oscillate and alter somewhat in intensity with the season, but there are many characteristics in common. The northern Indian Ocean, which is much more surrounded by land, is, however, an exception, the high pressure being situated over the northern part of the ocean, in November and February, and decreasing southwards; whilst in May and August the pressure is lowest in the north and increases southwards, this change being intimately related to the monsoon winds. The charts of range show well the influence of season, the largest differences occurring in the winter months in each hemisphere. In February the range to the west of the British Islands is 2·0 inches, whereas in August it is only one-half as great. The effect of latitude on the amount of range is very evident, the values near the equator being very small. These charts, which have been compiled by Nav.-Lieut. Baillie, R.N., are considerably in advance of any previous work of a similar nature, and will materially aid in explaining the general circulation of the wind over the globe, barometric pressure and wind being so intimately co-related.

Commercial Mathematics. (London: Longmans, Green, and Co., 1888.)

THIS volume is the continuation of a series of books on commercial education, and specially adapted for candidates preparing for the Oxford and Cambridge Schools Examination Board. Arithmetic is first dealt with, the first chapter consisting of an account of the decimal system in France. Moneys, weights, and measures, of Germany, Italy, Spain, Portugal, and Russia, are next discussed, followed by numerous examples; and the first part concludes with a chapter on "Exchange." Algebra is the subject of Part II., which extends as far as quadratic equations, including involution and evolution, and a chapter on the methods of testing algebraical results. The examples are very numerous throughout, and the book ought to be much in demand by the above-mentioned students and others. The volume concludes with a list of results of the various examples.

A Wanderer's Notes. By W. Beatty-Kingston. In Two Vols. (London: Chapman and Hall, 1888.)

FOR about thirteen years Mr. Beatty-Kingston acted as a newspaper correspondent, and in this capacity he had to visit many centres of life on the Continent. In the present volumes he offers a selection from the innumerable pen-and-ink sketches taken during his "multifarious peregrinations." The work, we need scarcely say, has no strictly scientific interest; but it is fresh and amusing, and will no doubt give pleasure to many a reader who has never had an opportunity of seeing the places described in its lively pages. The author is particularly successful in the chapters devoted to Germany, where he seems to have had exceptional means of making himself acquainted with the characteristics of the various classes of the community.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The "Sky-coloured Clouds" again.

THESE clouds have reappeared. Last night was the first occasion I have noticed any very distinct display of them this year; but I first saw them on June 12, and again on the 14th; and I think I saw them on June 13 and 17, but was not sure. Previous to that, on May 15 and 16, the green sky, when the sun had set, was of unusual brightness, showing, as I thought, a tendency to the formation of these clouds. Each summer they appear to be growing fainter since they were first generally noticed in 1885.

This year's observations were made in Cornwall, with the exception of last night's, which was at Sunderland.

Sunderland, June 26. T. W. BACKHOUSE.

Earth Pillars in Miniature.

I HAVE taken two photographs of an interesting specimen I obtained from the cliffs here. The stone is composed of very fragile sand-rock containing fragments of flint. A large mass of this became detached from the higher part of the cliff, and some of the pieces chanced to fall on a ledge upon which dry sand was constantly pouring in windy weather. The action of this falling sand wore away all parts of the surface of the stone save those protected by the small embedded fragments of flint, and hence the formation of these miniature pillars.

Owing to the extreme incoherency of the substance, I unfortunately lost one of the most perfect pillars before the photograph was taken.

I conclude that the formation of these pillars was the work of a very few days—perhaps hours. On visiting the spot a few days later, all traces of sand-action had been obliterated by rain. An analogous case was that described by Mr. Blake ("Geol. Miscell. Tracts," 10) as occurring in the Pass of San Bernardino, California; the surface of the granite had been worn by blown sand, but the garnets therein stood out in relief upon long pedicles of feldspar, as a proof of their superior hardness. CECIL CARUS-WILSON.

Bournemouth, June 23.

Egg-masses on *Hydrobia ulvæ*.

CAN any of your readers give me information in regard to the eggs of the Gastropod *Hydrobia ulvæ*?

At a recent excursion of the Biological Society to Hilbre Island, while crossing the great stretch of wet sand which lies in the estuary of the Dee, it was noticed that the surface was covered in some places with vast numbers of *Hydrobia*. Some of these were brought back to the laboratory in their wet sand; and, on being put in a dish of sea-water, the mollusks were found next day to have crawled out of the sand, and I then noticed that nearly every specimen had several little rounded excrescences scattered over the surface of its shell. On examining these, it was found that each was a little mass of small sand grains, in the centre of which was a clear jelly containing several segmenting ova or young embryos. They were undoubtedly molluscan eggs, as I kept them alive until one or two had reached a veliger stage; but did they belong to the *Hydrobia* or to some other mollusk? No other mollusk was, however, noticed in any abundance in the neighbourhood. Has, then, the *Hydrobia* acquired the habit of laying its eggs upon its neighbours' shells, as being the only comparatively stable objects to be found in the fine shifting sands around it? Possibly the method of oviposition of *Hydrobia* is already known, but I have not come across any reference to it. W. A. HERDMAN.

Zoological Laboratory, University College, Liverpool, June 23.

Interpretation of the Differential Equation to a Conic.

MAY I ask, with reference to Mr. Asutosh Mukhopadhyay's geometrical interpretation of the above in NATURE of the 21st inst., how to draw a *curve* at *every* point of which the radius of curvature vanishes, or the curvature is infinite?

Is it not evident that the osculating conic of a conic is the conic itself, and the "aberrancy curve" therefore a *point*, the centre of the conic?

The "sought found," then, is the fact that a conic is a conic!

June 24. R. B. H.

The Nephridia of Earthworms.

THE last number of the *Quarterly Journal of Microscopical Science* has just come into my hands, containing a paper, by Mr. Beddard, on the nephridia of certain earthworms. In November of last year I read a paper, before the Royal Society of Victoria, on the anatomy of the large Gippsland earthworm, *Megascolides australis*. This, which reaches the length of 6 to 8 feet, is, I believe, the largest recorded earthworm, and its nephridial system is of great interest, corresponding closely in many points to that described by Mr. Beddard, in the above paper, as present in *Acanthodrilus multiporus* and *Perichæta aspergillum*. My drawings have been for some time in the lithographers' hands, but as it will still be one or two months before the full paper is published, I should be glad to draw attention to the, in some ways, still more interesting features of the nephridial system in *Megascolides australis*. The nephridia are very evident, and can be divided clearly into two sets.

(1) A great number of small vascular-looking little tufts lining the body-wall, save in the mid-dorsal and ventral lines, especially abundant in the segments containing the reproductive organs (segments 11–19). They have no internal opening.

(2) A series of much larger nephridia, one pair of which only is present in each of the segments in the middle and posterior regions of the body—that is, from about segment 120 to segment 500, or whatever may be the number of the last segment, which varies according to the worm's size. They are placed in the anterior part of each segment, whilst the smaller nephridia form a ring round the body-wall posteriorly. Each one has the usual ciliated funnel opening through the septum into the segment in front.

Throughout the body, where the smaller nephridia occur, there is a network of intra-cellular ducts lying immediately beneath the peritoneal epithelium in connection with the nephridia, and giving off an irregularly arranged series of branched ducts opening externally. Ventrally, also, there appears to be on either side, in the middle and posterior portions of the body, a longitudinal duct running from segment to segment within the most ventral pair of setæ: into this duct open, first, the larger nephridia, and, secondly, the most ventrally placed small nephridia of the same segment; the latter, again, are united with the network of ducts connected with the ring of smaller nephridia.

In the case of the latter there appear to be two somewhat differently formed sets of external openings. All over the body, except in the clitellar region, where there is a great glandular development in the body-wall, the duct leading to the exterior is intercellular, small, and composed of minute cubical cells; in the clitellar region, on the other hand, the duct, though similarly intercellular, is much swollen out, slightly coiled, and always provided with a distinct coiled blood-vessel running by its side: its lining cells form a flattened epithelium.

The external opening itself is formed of cells of the epidermis, so modified as to present very much the external appearance of a taste-bulb—that is, they form a sphere with the cells thicker in their middle parts, and the two ends attached to the poles of the sphere, the duct passing right up through the centre. This structure of the external opening is common to all the ducts in the body, but is more clearly made out in the case of those referred to.

The large size and ciliated funnels of the paired nephridia distinguish these clearly from the more numerous smaller ones, which are devoid of internal openings, and are without a doubt homologous with those of *Acanthodrilus* and *Perichæta*. At the same time it is important to note that histologically the network of ducts and the longitudinal duct, which are intimately connected with each other, are precisely similar in structure, and, *a priori*, might be expected to have a similar origin, *i.e.* to be derived from the same germinal layer.

Leaving out of consideration at present the question dealt with by Mr. Beddard and others as to the homology of the larval nephridia of Chætopods, and assuming the existence of a genetic relationship between the adult nephridial system of Platyhelminths and Chætopods, the following questions suggest themselves with regard to the various nephridial structures present in different forms:—

(1) Are the longitudinal ducts in *Lanice*, the embryo of *Lumbricus* and *Megascolides*, homologous with each other? Before this can be determined the development of each must be known.

(2) Granted, of which there can be little doubt, that the smaller nephridia of *Megascolides* are homologous with the nephridia of *Perichæta* and *Acanthodrilus*, are not the large nephridia of the former, which are completely wanting in both

of these, homologous with the nephridia of other worms, such as *Lumbricus*, to which they are at all events suspiciously similar in arrangement and structure?

(3) What is the relationship of the large to the smaller nephridia? Are they modifications of the latter, or independent later developments?

(4) In either case the Platyhelminth system must be more closely represented by the small nephridial bodies devoid of internal openings and provided with a network of ducts such as is found in *Perichæta*, *Acanthodrilus*, and *Megascolides*, than by the more specialized paired nephridia of such a form as *Lumbricus*.

Possibly the course of development as represented in living forms may be somewhat as follows:—

(1) A series of numerous nephridia present in each segment devoid of internal openings, and connected by a continuous network of ducts, as in *Perichæta*.

(2) The aggregation of these smaller nephridia into tufts in various parts, as in the posterior region of *Acanthodrilus*; the subsequent enlargement of certain of these nephridia and the acquirement by them of secondary internal openings. It is interesting to note in *Megascolides* that in the anterior part of the body, where the small nephridia are scattered over the whole body-wall of the segment, large nephridia are absent, whilst they are present in the posterior region, where the small nephridia are confined to a ring in the posterior part of the segment. In this case, as the nephridia become aggregated into tufts in the anterior part, the ducts connecting them with those in the posterior region of the segment next in front will become fewer, until when, as in *Megascolides*, only a single, modified, large nephridium remains on either side anteriorly, there will be simply one duct from segment to segment uniting with a network of ducts in the region where the small nephridia still persist.

It is interesting to note that the aggregation of the smaller nephridia, and on this supposition the modification of certain of them to form the larger ones, commences in the posterior region of the body.

In certain worms, such as *Acanthodrilus*, the connection of the network of ducts from segment to segment seems to have been lost, at any rate in the adult: aggregation of these in the neighbourhood of the setæ, and subsequent modification, would give rise to a certain number of nephridia in each segment without any longitudinal duct.

(3) The next stage is reached in such a form as *Lanice*, where the longitudinal duct persists, but all trace of the smaller nephridia is lost.

(4) The final stage is present in most earthworms where, in the adult, all traces of both small nephridia and longitudinal duct are lost, though the latter is present, as in *Lumbricus*, during development.

These lead to three conclusions, two of which are practically identical with those of Mr. Beddard:—

(1) That the smaller nephridia without internal openings, irregularly scattered, and with a network of ducts such as are seen in *Acanthodrilus*, *Perichæta*, and *Megascolides*, are homologous with the nephridial system of Platyhelminths.

(2) That the larger nephridia typical of most earthworms are secondary modifications of certain of the smaller ones subsequent to their aggregation into groups; the modified ones acquiring each an internal opening.

(3) That there is no homology between the longitudinal duct of *Lumbricus*, *Lanice*, *Megascolides*, &c., with that of the Platyhelminths, since it has only been developed in the above forms in connection with the larger nephridia and as a modification of the original network, and has thus had its origin within the Chætopod group.

W. BALDWIN SPENCER.

Melbourne University, May 3.

Strange Rise of Wells in Rainless Season.

MY attention has been directed to a letter published by you a few weeks ago (May 31, p. 103) under the above heading. It would appear that there is something mysterious in the eyes of the author of the communication in question in the fact that the water in two wells at Fareham rose several feet in the month of March, as he states, "after a continuance of north-east wind, *without rain*, but with half a gale blowing"; so that it would appear that there was some connection between the north-easterly gale and the rise of the water.

In this, however, the author is entirely mistaken; the rise of water in the wells in question is nothing more than the ordinary seasonable rise due to percolation. For twelve years past I have been carrying on constant observations of the underground water-supplies in various parts of this country, and it is quite true, as mentioned by the writer of the letter, that ordinarily the water in wells rises in the winter and falls in the summer; but this is by no means an exceptional rule, for in the present season there have been two low waters, the last of which occurred in the southern counties on the 8th of March in the present year. After that date commenced a very wet period, and before the end of the month over 2½ inches of rain had absolutely passed through the ground as measured by my percolation gauges. The water in a well on the Surrey hills, which had been falling up to March 8, rose before the end of the month over 30 feet, which rise was entirely due to the replenishment from rainfall. I may point out that there are many wells at the present time in which the water is still rising, while in others in the same districts the water is falling, for the simple reason that as a rule underground water follows the same law as water flowing in a river, and that the floods or high waters descend from the highest to the lowest districts, so that at present in wells situated in high positions the water is falling, while the crest of the wave of high water in the same watershed has not yet been reached in the lower levels of the district.

That the water in wells *does* fluctuate under certain conditions of the wind there is no doubt, as I have already drawn attention both to the fluctuations which take place in the water-levels of wells under barometric pressure and also in the volume of water discharged from the ground with a fall of the barometer. It should be noted that the rise of water in wells when due to barometric changes coincides with the fall of the barometer. Now a north-easterly wind as a rule is accompanied by a high barometer, and therefore is not likely to influence the rise of water in a well. During the month of March the rainfall was above the average, while there were comparatively few days with easterly winds, the only time when it could be termed a half-gale from the north-east occurring on the 19th of March, by which time the water in all the wells had made a considerable rise, due simply to ordinary percolation. Thus there is no mystery attaching to the rising of the water in these wells at Fareham. The rise simply took place from the replenishment of the springs, which this year occurred at a period somewhat different from ordinary years.

BALDWIN LATHAM.

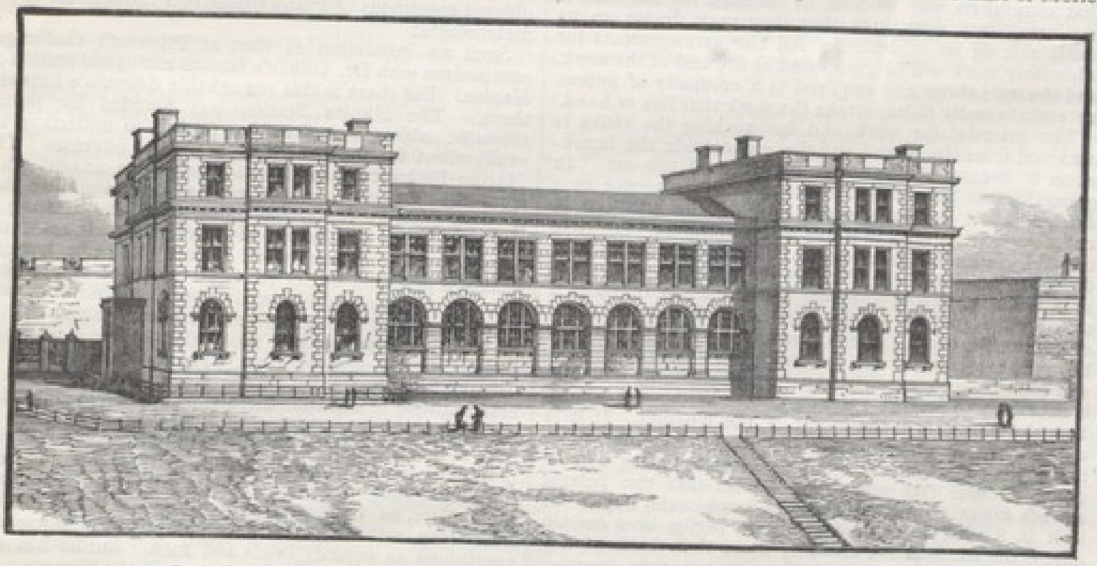
7 Westminster Chambers, Westminster, June 21.

THE OPENING OF THE MARINE BIOLOGICAL LABORATORY AT PLYMOUTH.

THE Laboratory at Plymouth, which is now ready for work, is remarkable as being the first institution in this country designed purely for scientific research which has been originated and firmly established by the efforts of scientific men appealing to the generosity and confidence of wealthy individuals and corporations who desire the progress of knowledge for practical ends and the general good of the community.

It may be said that the Marine Biological Association will begin its active career on and after Saturday next. On that day Prof. Flower will, on behalf of the Association, declare that the Laboratory at Plymouth, which is now complete, is open for the purposes of biological research. The opening of the Laboratory may be said to mark an epoch in English zoological science, just as the opening of the Stazione Zoologica at Naples, which is essentially a German undertaking, marked an epoch in German science. It is true that small sea-side laboratories have already been established in the United Kingdom—at Granton, St. Andrews, and Liverpool Bay; but none of them can compare with the present undertaking in size and importance, and none can offer such advantages to the investigator.

The present institution, it may be remembered, is historically the outcome of the International Fisheries Exhibition held in London in 1883. That Exhibition served partly as an amusement to Londoners, but it also performed a far more important service—it directed people's minds towards the importance of our fisheries, and made them in some slight degree acquainted with the conditions under which those fisheries are worked. At the close of the Exhibition a large balance was left in the hands of its promoters, and it was hoped by many leading men of science that the money thus obtained would be utilized, in part at least, for the purpose of encouraging investigations upon the habits and economy of food-fishes. But the money was appropriated to other purposes, excellent in themselves, though useless as a means of promoting the welfare of the fishing industry. Prof. Lankester, however, nothing daunted by this want of success in obtaining funds from the surplus of the Fisheries Exhibition, and feeling that it was time to strike whilst people's minds were awakened to the importance of our fisheries and to the lack of scientific knowledge concerning them, determined to found an Association for the purpose of encouraging the study of the marine fauna of the British coasts, and with the consent and co-operation of the officers of the Royal Society called a meeting for this purpose in the rooms of the Society on March 31, 1884. The meeting was eminently successful. The Duke of Argyll proposed a resolution to found the Marine Biological Association of the United Kingdom, and was supported by the most eminent biologists in the country. An appeal was made for subscriptions in aid of the Association's projects, and was soon liberally responded to. His Royal Highness the Prince of Wales graciously consented to be patron of the Association, and gave liberally to its funds; the scientific Societies, the City Companies, the Universities, and finally Her Majesty's Government, joined the list of subscribers; and in a short time the Association was in a position to undertake the building of a laboratory. After some debate as to the most suitable locality for a laboratory, Plymouth was selected, partly because it is a large and important fishing port, partly because the richness of the marine fauna of the Sound and neighbouring shores was extolled by such eminent authorities as the late Dr. Gwyn Jeffreys, Mr. C. Spence Bate, and Prof. Charles Stewart. The Association was fortunate in securing a magnificent site for the Laboratory from the War Office. For this site, than which a better could not be found, the Association is greatly indebted to the Earl of Morley,



South Front of the Laboratory of the Marine Biological Association, on the Citadel Hill, Plymouth.

then Under-Secretary of State for War, and to Sir Andrew Clarke, Inspector-General of Fortifications. The site granted is that part of the fosse of the Citadel lying to the south of the portion of the Citadel wall known as King Charles's Curtain; it has a frontage towards the sea of 265 feet, and extends some 240 feet southwards of the Citadel.

The Laboratory which has been erected upon this site is admirably adapted to the purposes of the Association. It is, indeed, more than a laboratory, it is also an aquarium, whose tanks are extensive and fitted with every improvement that modern science can suggest. The total cost of building, machinery, and fittings, including all fees, has been about £12,500. The structure comprises a central portion with a wing at either end. The east wing is almost wholly taken up by the residence of the Director, and needs no further comment. The west wing has on the ground floor the caretaker's rooms, and a receiving-room into which the results of the day's fishing will be brought for examination. On the first floor are chemical and physiological laboratories, and on the second floor a library, a work-room, and lavatory. The main part of the building contains on the ground floor the aquarium or tank-room, and on the first floor the large laboratory. The tank-room is fitted with slate and glass tanks, of which one on the northern side is a noble window tank, 30 feet in length, 9 feet in breadth, and 5 feet deep. There are three large window tanks on the north side, nine smaller window tanks on the south side, and a series of five table tanks in the middle of the room. The tanks are supplied with salt water from two reservoirs, capable of holding 50,000 gallons each. From these the salt water is led by means of pumps through vulcanite pipes into the tanks; the openings of the pipes are placed rather more than a foot above the level of the water in the tanks, and are provided with nozzles through which the water is forced at high pressure, so as to form jets descending deep into the tank and carrying with them a quantity of atmospheric air. Circulation has been established in the tanks for the last fortnight, and there is every reason to be satisfied with the arrangements for aërating the water. The jets carrying down the air deep into the water of the tank cause it to be filled with minute bubbles so as to resemble champagne, and all the animals that have hitherto been placed in the tanks are thriving in a remarkable manner, which is the more surprising as new tanks are generally supposed to be highly injurious to organisms introduced into them at an early a date. It would be too much to expect that tanks which have been so lately put up should be fully stocked within a fortnight, nevertheless they will present to the visitors on Saturday next a sufficiently interesting collection of local marine forms. For the rest the tank-room is a plain room, without any attempt at ornamentation. It is felt that the scientific nature of the institution must be kept in the foreground, and therefore nothing has been done to make the aquarium a place of popular amusement.

The main laboratory is at present fitted with seven compartments, each to contain a single naturalist, along its north side. When the necessity arises, similar compartments will be placed along the south side. In the centre of the room is a series of slate and glass tanks supplied with salt water from the circulating pumps. Beneath these a convenient shelf has been arranged, so that naturalists will be able to arrange for themselves any temporary apparatus that they may devise on as small a scale as is desired. All the arrangements for laboratory work will be completed at the end of the week, and the only thing now required is a company of ardent naturalists ready to undertake the work that lies to hand.

The material for work and for stocking the tanks is obtained from the Sound and the sea outside the breakwater by means of the trawl, dredge, and tow-net. In general a small shrimp-trawl is used in preference to a dredge, as it is much wider and equally effective in collecting the animals that live at the bottom. Hitherto the Association has been content to hire fishing-boats for dredging and trawling. Most of the work has been done in a small hook-and-line boat, the *Quickstep*, of about 6 tons burden, and on special occasions the trawler *Lola*, of 50 tons burden, has been hired. But this method of hiring is too expensive to be continued; the Association will soon have to purchase boats, and probably will find it necessary to acquire a steam-boat. Without a steam-boat the station is at the mercy of the weather. If it is a dead calm—and calms are frequent in summer along the south coast—no dredging or surface netting can be done, a cruel fate when one knows that the pelagic surface fauna swarms thickest on bright calm days. Or if it is wished to explore a certain region on a certain day, if the winds prove contrary more than half the day is lost in beating up to the station; in any case one may generally expect to have a contrary wind on either the outward or the homeward journey. Such losses of time and material are most prejudicial to an institution like the Marine Biological Association. A steam-launch has been found necessary at all other marine stations. Dr. Dohrn has two, the *Johannes Müller* and the *Francis Balfour*, at Naples; and the Granton Station is well provided for by the steam-yacht *Medusa*. But the funds of the Association have been well nigh exhausted in the building of the Laboratory. If a steam-launch is found requisite, it will be necessary to make another appeal to its friends, which, let it be hoped, will be as heartily responded to as the first appeal for funds for building the Laboratory.

It was stated in the early part of this article that the Association would begin its active existence on the 30th. It would have been more proper to say its active public existence, for its staff has been active for some time past. Under the guidance of Mr. W. Heape, the late Superintendent, a careful though necessarily incomplete exploration of the Sound has been made, and numbers of animals have been identified, preserved, and put aside for future reference. Mr. Heape has also drawn up a complete list of the fauna and flora of the Sound, as recorded up to the present date, and a very formidable list it is.[1] Botanists will note that there are more than 250 species of marine Algæ recorded from the neighbourhood, and some of them are extremely rare. Zoologists will see that there is an unlimited field in certain groups, particularly in the Crustacea and the Mollusca, but that some of the most interesting forms, the "pets of the laboratory," such as Amphioxus and Balanoglossus, are absent. But to say that they are absent means only that other less familiar forms are present, and that these old favourites have not been recorded. A good authority states that Amphioxus can be found in the immediate neighbourhood, whilst it is confidently expected that both Balanoglossus and Amphioxus can be introduced from the Channel Isles, and kept alive in the tanks. The zoologist need not fear that he will be hindered by the poverty of the fauna; there is material enough and to spare. The remarkable Hydroid, *Myriothela*, occurs at low-tide mark in considerable quantities. The interesting Actiniæ, *Edwardsia* and *Peachia*, are to be found. Appendiculariæ and Sagittæ are taken in hundreds in the tow-net. *Antedon rosaceus* is abundant a quarter of a mile from the Laboratory, and magnificent specimens of Pinna will attract the interest of the malacologist.

Such an institution as that at Plymouth challenges comparison with Dr. Dohrn's famous zoological station at Naples. But there is this remarkable difference between them. The Naples Station was founded for purely scientific objects: it does not profess to undertake investigations for the benefit of economic interests. The Marine Biological Association receives an annual grant from the Treasury, on the express understanding that it shall conduct researches upon questions relating to the life-history and habits of food-fishes. It must not be supposed that this work is not scientific because it has a practical object in view. Science is not only the art of thinking correctly, but of observing and recording correctly, and correct observations and records of the life-history of our food-fishes are just what are wanted at the present time. The work of Mr. J. T. Cunningham, Naturalist of the Association, is an admirable example of scientific method as applied to a practical investigation. Mr. Cunningham has been working for several months at the development of fishes, with the view of obtaining and artificially fertilizing their ova and rearing their young in captivity. His results are necessarily incomplete, as he has been working in a half-finished laboratory, without gas or water, and under unfavourable conditions as regards boats and men. But he has succeeded in tracing out the life-history of the "merry sole" (*Pleuronectes microcephalus*), and has acquainted himself with such important facts concerning the development of the common sole, that he confidently expects to be able to hatch out the young next season, his experiments this year having failed only for want of the proper apparatus. He has also recorded the interesting fact that the herring spawns continuously from January to June in the Channel, and appears to have no definite breeding-season as it has in northern waters; and has discovered important facts relative to the breeding of the mackerel, conger, and pilchard, which will be made public as soon as his researches are complete. He has now stocked one of the large tanks in the aquarium with conger, and hopes in a short time to give a final opinion on the obscure question of the breeding of this fish. Not less interesting than Mr. Cunningham's researches are those of Mr. Weldon on the breeding of the common lobster, and the rock-lobster or craw-fish (*Palinurus*). Another of the tanks in the aquarium is occupied by the "berried" females of these forms, whose bright colours and active movements are as attractive to the casual spectator as their study is interesting to the zoologist and fisherman. So much has been

[1] Mr. Heape's list will be published in the forthcoming number (No. II.) of the Journal of the Marine Biological Association.

The question of whether the flame is excited at the nodes or at the loops—whether at the places where the pressure varies most, or at those where there is no variation of pressure, but considerable motion of air—is one of considerable interest from the point of view of the theory of these flames. The experiment could be made well enough with such a source of sound as I am now using; but it is made rather better by using sounds of a lower pitch, and therefore of greater wave-length, the discrimination being then more easy. Here is a table of the distances which the screen must be from the flame in order to give the maximum and the minimum effect, the minimum being practically nothing at all.

Table of Maxima and Minima.

Max.	Min.
1·1	
	3·0
4·5	
	5·9
7·5	
	8·9
10·3	
	11·7
13·0	
	14·7
15·9	

The distance between successive maxima or successive minima is very nearly 3 cm., and this is accordingly half the length of the wave.

But there is a further question behind. Is it at the loops or is it at the nodes that the flame is most excited? The table shows what the answer must be, because the nodes occur at distances from the screen which are even multiples, and the loops at distances which are odd multiples; and the numbers in the table can be explained in only one way—that the flame is excited at the loops corresponding to the odd multiples, and remains quiescent at the nodes corresponding to the even multiples. This result is especially remarkable, because the ear, when substituted for the flame, behaves in the exactly opposite manner, being excited at the nodes and not at the loops. The experiment may be tried with the aid of a tube, one end of which is placed in the ear, while the other is held close to the burner. It is then found that the ear is excited the most when the flame is excited least, and *vice versâ*. The result of the experiment shows, moreover, that the manner in which the flame is disintegrated under the action of sound is not, as might be expected, symmetrical in regard to the axis of the flame. If it were symmetrical, it would be most affected by the symmetrical cause—namely, the variation of pressure. The fact being that it is most excited at the loop, where there is the greatest vibratory velocity, shows that the method of disintegration is unsymmetrical, the velocity being a directed quantity. In that respect the theory of these flames is different from the theory of the water-jets investigated by Savart, which resolve themselves into detached drops under the influence of sonorous vibration. The analogy fails at this point, and it has been pressed too far by some experimenters on the subject. Another simple proof of the correctness of the result of our experiment is that it makes all the difference which way the burner is turned in respect of the direction in which the sound-waves are impinging upon it. If the phenomenon were symmetrical, it would make no difference if the flame were turned round upon its vertical axis. But we find that it does make a difference. This is the way in which I was using the flame, and you see that it is flaring strongly. If I now turn the burner round through a right angle, the flame stops flaring. I have done nothing more than turn the burner round and the flame with it, showing that the sound-waves may impinge in one direction with great effect, and in another direction with no effect. The sensitiveness occurs again when the burner is turned through another right angle; after three right angles there is another place of no effect; and after a complete revolution of the flame the original sensitiveness recurs. So that if the flame were stationary, and the sound-waves, came, say, from the north or south, the phenomena would be exhibited; but if they came from the east or west, the flame would make no response.

This is of convenience in experimenting, because, by turning the burner round, I make the flame almost insensitive to a sound, and I am now free to show the effect of any sound that may be brought to it in the perpendicular direction. I am going to use a very small reflector—a small piece of looking-glass. Wood would do as well; but looking-glass facilitates the adjustment, because my assistant, by seeing the reflection, will be able to tell me when I am holding it in the best position. Now, the sound is being reflected from the bit of glass, and is causing the flame to flare, though the same sound, travelling a shorter distance and impinging in another direction, is incompetent to produce the result (Fig. 1).

I am now going to move the reflector to and fro along the line perpendicular to that joining the source and the burner, all the while maintaining the adjustment, so that from the position of the source of sound the image of the flame is seen in the centre of the mirror. Seen from the source, it is still as central as before, but it has lost its effect, and as I move it to and fro I produce cycles of effect and no effect. What is the cause of this? The question depends upon something different from what I have been speaking of hitherto; and the explanation is, that we are here dealing with a diffraction phenomenon. The mirror is a small one, and the sound-waves which it reflects are not big enough to act in the normal manner. We are really dealing with the same sort of phenomena as arise in optics when we use small pin-holes for the entrance of our light. It is not very easy to make the experiment in the present form quite simple, because the mirror would have to be withdrawn, all the while maintaining a somewhat complicated adjustment. In order to raise the question of diffraction in its simplest shape, we must have a direct course for the sound between its origin and the place of observation, and interpose in the path a screen perforated with such holes as we desire to try.

The screen I propose to use is of glass. It is a practically perfect obstacle for such sounds as we are dealing with; but it is perforated here with a hole (20 cm. diameter), rendered more evident to those at a distance by means of a circle of paper pasted round it. The edge of the hole corresponds to the inner circumference of the paper. We shall thus be able to try the effect of different-sized apertures, all the other circumstances remaining unchanged. The experiment is rather a difficult one before an audience, because everything turns on getting the exact adjustment of distances relatively to the wave-length. At present the sound is passing through this comparatively large hole in the glass screen, and is producing, as you see, scarcely any effect upon the flame situated opposite to its centre. But if (Fig. 2) I diminish the size of the hole by holding this circle of zinc (perforated with a hole 14 cm. in diameter) in front of it, it is seen that, although the hole is smaller, we get a far greater effect. That is a fundamental phenomenon in diffraction. Now I reopen the larger hole, and the flame becomes quiet. So that it is evident that in this case the sound produces a greater effect in passing through a small hole than in passing through a larger one. The experiment may be made in another way, by obstructing the central in place of the marginal part of the aperture in the glass. When I hold this unperforated disk of zinc (14 cm. in diameter) centrically in front, we get a greater effect than when the sound is allowed to pass through both parts of the aperture. The flame is now flaring vigorously under the action of the sonorous waves passing the marginal part of the aperture, whereas it will scarcely flare at all under the action of waves passing through both the marginal and the central hole.

This is a point which I should like to dwell upon a little, for it lies at the root of the whole matter. The principle upon which it depends is one that was first formulated by Huygens, one of the leading names in the development of the undulatory theory of light. In this diagram (Fig. 3) is represented in section the different parts of the obstacle. C represents the source of sound, B represents the flame, and A P Q is the screen. If we choose a point, P, on this screen, so that the whole distance from B to C, reckoned through P, viz. B P C, exceeds the shortest distance B A C by exactly half the wave-length of the sound, then the circular area, whose radius is A P, is the first zone. We take next another point, Q, so that the whole distance B Q C exceeds the previous one by half a wave-length. Thus we get the second zone represented by P Q. In like manner, by taking different points in succession such that the last distance taken exceeds the previous one every time by half a wave-length, we may map out the whole of the obstructing screen into a series of zones called Huygens' zones. I have here a material embodiment of that notion, in which the zones are actually cut out of a piece of zinc. It is easy to prove that the effects of the parts of the wave traversing the alternate zones are opposed; that whatever may be the effect of the first zone, A P, the exact opposite will be the effect of P Q, and so on. Thus, if A P and P Q are both allowed to operate, while all beyond Q is cut off, the waves will neutralize one another, and the effect will be immensely less than if A P or P Q operated alone. And that is what we saw just now. When I used the inner aperture only, a comparatively loud sound acted upon the flame. When I added to that inner aperture the additional aperture P Q, the sound disappeared, showing that the effect of the latter was equal and opposite to that of A P, and that the two neutralized each other.

[If A C = a, A B = b, A R = x, wave-length = λ, the value of x for the external radius of the nth zone is

$$x^2 = n\lambda \frac{a+b}{ab};$$

or, if $a = b$,

$$x^2 = \tfrac{1}{2}n\lambda a.$$

With the apertures used above, $x^2 = 49$ for $n = 1$; $x^2 = 100$ for $n = 2$; so that

$$\lambda a = 100,$$

the measurements being in centimetres. This gives the suitable distances, when λ is known. In the present case $\lambda = 1{\cdot}2$, $a = 83$.]

Closely connected with this there is another very interesting experiment, which can easily be tried, and which has also an important optical analogy. I mean the experiment of the shadow thrown by a circular disk. If a very small source of light be taken—such a source as would be produced by perforating a thin plate in the shutter of the window of a dark room with a pin, and causing the rays of the sun to enter horizontally—and if we interpose in the path of the light a small circular obstacle, and then observe the shadow thrown in the rear of that obstacle, a very remarkable peculiarity manifests itself. It is found that in the centre of the shadow of the obstacle, where the darkness might

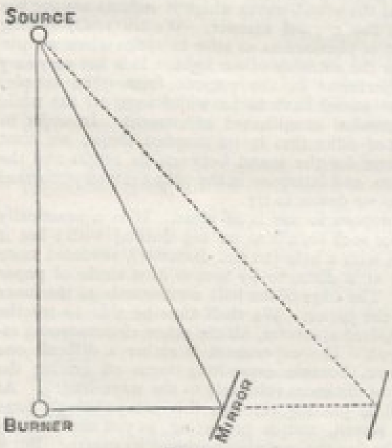


FIG. 1.

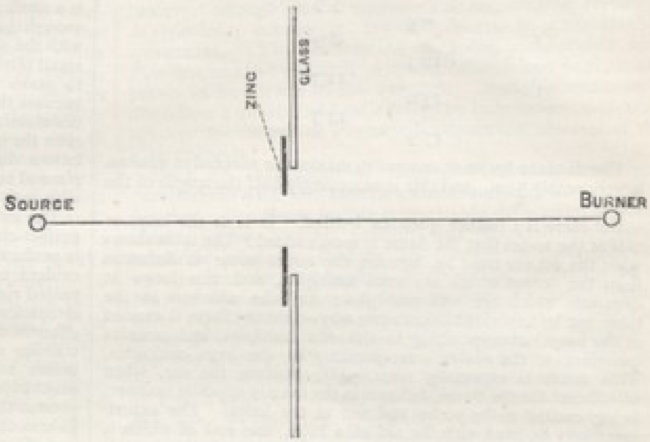


FIG. 2.

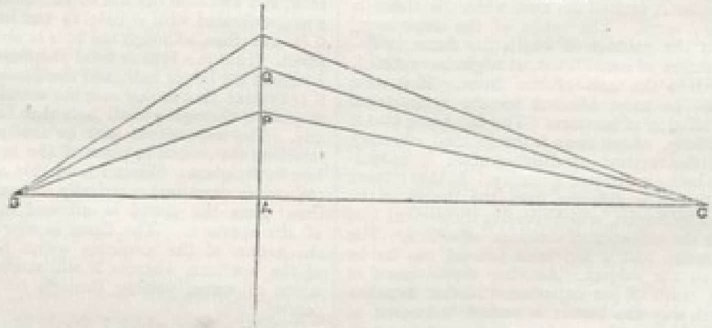


FIG. 3.

be expected to be greatest, there is, on the contrary, no darkness at all, but a bright spot, a spot as bright as if no obstacle intervened in the course of the light. The history of this subject is curious. The fact was first observed by Delisle in the early part of the eighteenth century, but the observation fell into oblivion. When Fresnel began his important investigations, his memoir on diffraction was communicated to the French Academy, and was reported on by the great mathematician Poisson. Poisson was not favourably impressed by Fresnel's theoretical views. Like most mathematicians of the day, he did not take kindly to the wave theory; and in his report on Fresnel's memoir, he made the objection that if the method were applied, as Fresnel had not then done, to investigate what should happen in the shadow of a circular obstacle, it brought out this paradoxical result, that in the centre there would be a bright point. This was regarded as a *reductio ad absurdum* of the theory. All the time, as I have mentioned, the record of Delisle's observations was in existence. The remarks of Poisson were brought to the notice of Fresnel, the experiment was tried, and the bright point was rediscovered, to the gratification of Fresnel and the confirmation of his theoretical views. I don't propose to attempt the optical experiment now, but it can easily be tried in one's own laboratory. A long room or passage must be darkened: a fourpenny bit may be used as the obstacle, strung up by three hairs attached by sealing-wax. When the shadow of the obstacle is received on a piece of ground glass, and examined from behind with a magnifying lens, the bright spot will be seen without much difficulty. But what I propose to show you is the corresponding phenomenon in the case of sound. Fresnel's reasoning is applicable, word for word, to the phenomena we are considering just as much as to that which he, or rather Poisson, had in view. The disk (Fig. 4), which I shall hang up now between the source of sound and the flame, is of glass. It is about 15 inches in diameter. I believe the flame is flaring now from being in the bright spot. If I make a small motion of the disk, I shall move the bright spot and the effect will disappear. I am pushing the disk away now, and the flaring has stopped. The flame is still in the shadow of the disk, but not at the centre. I bring the disk back again, and when the flame comes into the centre it flares again vigorously. That is the phenomenon which was discovered by Delisle and confirmed by Arago and Fresnel, but mathematically it was suggested by Poisson.

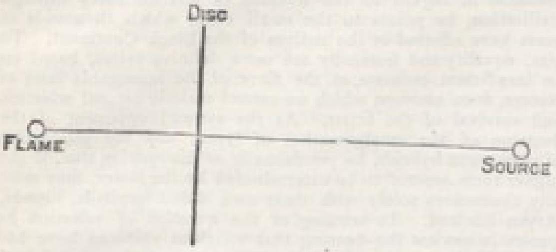


FIG. 4.

Poisson's calculation related only to the very central point in the axis of the disk. More recently the theory of this experiment has been very thoroughly examined by a German mathematician, Lommel; and I have exhibited here one of the curves given by him embodying the results of his calculations on the subject (Fig. 5).

The abscissæ, measured horizontally, represent distances drawn outwards from the centre of the shadow O; the ordinates measure the intensity of the light at the various points. The maximum intensity O A is at the centre. A little way outwards, at B, the intensity falls almost, but not quite, to zero. At C there is a revival of intensity, indicating a bright ring; and further out there is a succession of subordinate fluctuations. The curve on

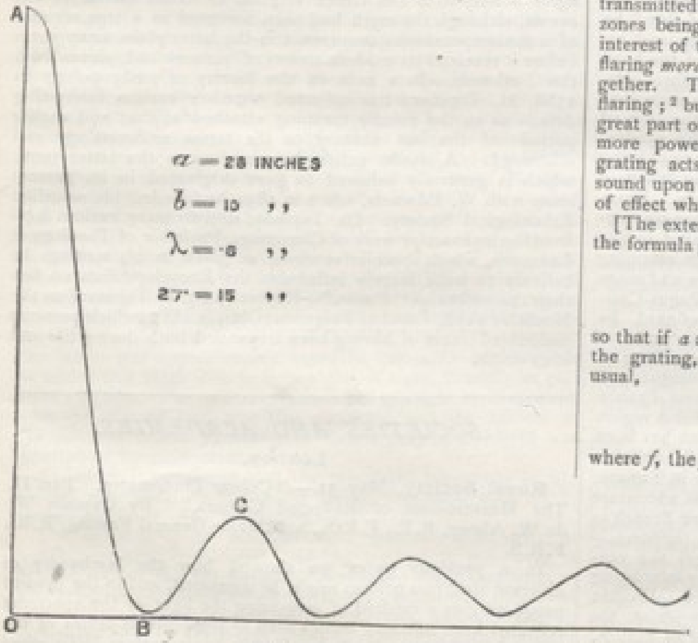


FIG. 5.

the other side of O A would of course be similar. This curve corresponds to the distances and proportions indicated. *a* is the distance between the source of sound and the disk; *b* is the distance between the disk and the flame, the place where the intensity is observed. The numbers given are taken from the notes of an experiment which went well. If we can get our flame to the right point of sensitiveness, we may succeed in bringing into view not only the central spot, but the revived sound which occurs after you have got away from the central point and have passed through the ring of silence. There is the loud central point. If I push the disk a little, we enter the ring of silence, B;[1] a little further, and the flame flares again, being now at C.

Although we have thus imitated the optical experiment, I must not leave you under the idea that we are working under the same conditions that prevail in optics. You see the diameter of my disk is 15 inches, and the length of my sound-wave is about half an inch. My disk is therefore about thirty wave-lengths in diameter, whereas the diameter of a disk representing thirty wave-lengths of light would be only about $\frac{1}{1000}$ inch. Still, the conditions are sufficiently alike to get corresponding effects, and to obtain this bright point in the centre of the shadow conspicuously developed.

I will now make an experiment illustrating still further the principle of Huygens' zones, which I have already roughly sketched. I indicated that the effect of contiguous zones was equal and opposite, so that the effect of each of the odd zones is one thing, and of the even zones the opposite thing. If we can succeed in so preparing a screen as to fit the system of zones, allowing the one set to pass, and at the same time intercepting the other set, then we shall get a great effect at the central point, because we shall have removed those parts which, if they remained, would have neutralized the remaining parts. Such a system has been cut out of zinc, and is now hanging before you. When the adjustments are correct, there will be produced, under the action of that circular grating, an effect much greater than would result if the sound-waves were allowed to pass on without any obstruction. The only point difficult of explanation is as to what happens when the system of zones is complete, and extends to infinity, viz. when there is no obstruction at all. In that case it may be proved that the aggregate effect of all the zones is, in ordinary cases, half the effect that would be produced by any one zone alone, whereas if we succeed in stopping out a number of the alternate zones, we may expect a large multiple of the effect of one zone. The grating is now in the right position, and you see the flame flaring strongly, under the action of the sound-waves transmitted through these alternate zones, the action of the other zones being stopped by the interposition of the zinc. But the interest of the experiment is principally in this, that the flame is flaring *more* than it would do if the grating were removed altogether. There is now, without the grating, a very trivial flaring;[2] but when the grating is in position again—though a great part of the sound is thereby stopped out—the effect is far more powerful than when no obstruction intervened. The grating acts, in fact, the part of a lens. It concentrates the sound upon the flame, and so produces the intense magnification of effect which we have seen.

[The exterior radius of the *n*th zone being *x*, we have, from the formula given above—

$$\frac{1}{a} + \frac{1}{b} = \frac{n\lambda}{x^2};$$

so that if *a* and *b* be the distances of the source and image from the grating, the relation required to maintain the focus is, as usual,

$$\frac{1}{a} + \frac{1}{b} = \frac{1}{f},$$

where *f*, the *focal length*, is given by—

$$f = \frac{x^2}{n\lambda}.$$

In the actual grating, eight zones (the first, third, fifth, &c.) are occupied by metal. The radius of the first zone, or central circle, is 3 inches, so that $x^2/n = 9$. The focal length is necessarily a function of λ. In the present case $\lambda = \frac{1}{2}$ inch nearly, and therefore $f = 18$ inches. If *a* and *b* are the same, each must be made equal to 36 inches.]

SCIENTIFIC SERIALS.

Revue d'Anthropologie, troisième série, tome iii., 1888 (Paris).—Stratigraphic palæontology in relation to man, by M. Marcellin Boule. Rejecting as unauthenticated all evidence of human existence in the Tertiary age, the author considers the

[1] With the data given above the diameter of the silent ring is two-thirds of an inch.

[2] Under the best conditions the flame is absolutely unaffected.

grounds on which we may assume that the so-called Saint Acheul flint instruments, found in alluvial beds of undoubted Quaternary origin, supply the most ancient testimony of man's presence on the surface of the earth. While attaching great importance to the careful elucidation of the chronological order in which the oldest traces of man appear relatively to the different series of the Quaternary formations, he points out the imminent risk of losing the few opportunities which still remain of studying this connection between the objects found and the nature and order of sequence of the beds in which they were deposited, owing to the most interesting finds having long been made to swell the collections of our Museums without reference to their value as exponents of the problems of our primitive history. M. Marcellin Boule considers that palæologists have erred in assuming that all beds containing the same fossil remains must necessarily belong to the same epoch, and that sufficient importance has not been attached to the fact that the same deposit often contains a mixture of animal forms belonging both to so-called northern and southern types. In explanation of these and many other anomalous phenomena, he thinks we may derive important help from a careful consideration of the intermittence and recurrence of glacial action. In regard to this point he recognizes the great value of the labours of British and American as well as Scandinavian and German geologists when compared with those of the majority of their French *confrères*; and, following the lead of our own palæontologists, he refuses to believe that any traces of human existence can be referred to pre-glacial ages, although some may perhaps be assigned to inter-glacial periods; while he considers that in certain northern lands, as Denmark and Southern Sweden, where there is a complete absence of Palæolithic objects, their non-appearance may be explained by the ice-covering not having been entirely removed in these regions till the dawn of the age of polished stone.—The tibia in the Neanderthal race, by Prof. Julien Fraipont. As a further exposition of the views which the author, in concert with M. Lohest, had expressed in regard to the effect on the maintenance of the vertical position of the obliquity and curvature of the femur in the "men of Spy," he now attempts to show, from the observations of others, and his own anatomical experiments, that in this inclination of the head of the femur we have a characteristic common to the anthropoids. An ingeniously devised series of determinations of the variations of the axis of the head of the tibia in recent man, the men of Spy, the gorilla, and other anthropoids, shows the gradual straightening of the axis as we ascend from the latter to existing man, in whom there is a well-marked tendency to the fusion of the axis of the head of the tibia with that of the body. From a careful comparison of the gradual anatomical changes presented in man since his earliest representative appeared in the Quaternary age, M. Fraipont believes we are justified in assuming that the human race has progressively acquired a more and more vertical posture.—On the population of the ancient Pagus-Cap-Sizun, "Cape du Raz," by MM. Le Carguet and P. Topinard. In considering the map of France from an ethnographic point of view, French anthropologists are generally agreed in regarding as specially Celtic the region which includes Brittany, Auvergne, and the entire mass of mountains extending through Central France and Savoy. The population of the eastern portion of this region is more brachycephalic than that of the western, which has been largely affected by admixture with the blonde, tall, dolichocephalic races whose presence is traceable everywhere in Europe, although more definitely the further north we go. This admixture of types is most strongly marked in Brittany, where French is the spoken tongue in Haute-Bretagne, and Breton (apparently a dialect derived from an ancient Kymric language) the predominant tongue in Basse-Bretagne. Among the many interesting localities of the latter region, special attention is due to Pointe du Raz, which, from the nature of its rocky boundaries on the land side, and its position further west than any other in France, has been virtually cut off from communication with the rest of the country, in consequence of which its population presents relatively fewer marks of mixed origin. M. Topinard supplies an interesting report on the geological, historical, and ethnological characteristics of the Cape du Raz district, and thus enhances the value of the series of observations regarding the population of this far west of France which have been supplied by M. Le Carguet, and may be generally summarized as leading to the inference that the "Capiste" race is essentially Breton in regard to the predominance of blue eyes with dark hair, and their generally low stature, these characteristics being associated with a disposition in which courage and energy are blended with strongly marked avarice and a love of greed; while in other respects they show evidence of a strongly-marked Celtic type.—Heredity in political economy, by M. de Lapouge. In this sequel to his former articles on "Inequality among Men," the author urges that it is the duty of the State to use all means at its disposal to eliminate the degenerate, and multiply the favoured elements of which the community is composed. As an ultra-pessimist in regard to the advance of inferior races through civilization, he points to the small effect which thousands of years have effected in the natives of the Black Continent. To him, equality and fraternity are mere delusive terms, based on an insufficient estimate of the force of the immutable laws of Nature, from amongst which we cannot exclude natural selection and survival of the fittest. As the avowed opponent of the doctrine of the amalgamation of types, and the production of permanent hybrids, he proclaims it as his opinion that, if the higher races are not to be exterminated by the lower, they must ally themselves solely with their own dolichocephalic, blonde, Aryan kindred. In treating of the question of selection he passes in review the bearing that religious opinions have had among different races in determining various degrees of consanguinity which were to be recognized as natural barriers against intermarriage among relatives. Considered generally, M. de Lapouge's article is a protest against futile attempts in the assumed name of philanthrophy to raise inferior types at the expense of those whom history from its earliest dawn has shown us to have been the leaders and pioneers in every path of human progress.—In a note on the recurrence among the Provençals of the present day of the myth of Ibicus, M. le Dr. Bérenger-Férand draws attention to the numerous characteristics derived from Hellenic antiquity which are still to be met with on the site of ancient Greek settlements. The modern tale of the detection of a murder through a reference by the murderers themselves to the birds which had been near the spot where the deed was done, is current both at Toulon and La Grasse. Both versions agree closely with the Greek original as to the course of the events, although the myth had been accepted as a true account of a contemporaneous occurrence in the latter place many years before it received its modern names of persons and places from the Toulonais.—In a note on the history of anthropology in 1788, M. Topinard has collected together various interesting details as to the precise meaning attached at that and earlier periods of the last century to the terms anthropology and ethnology. A doubt exists, however, as to the latter term, which is generally believed to have originated in its present sense with W. Edwards, when in 1839 he founded his so-called Ethnological Society. Dr. Topinard derives many curious facts from the manuscript work of Chavannes, Professor of Theology at Lausanne, whose speculative views as given in his writings he believes to have largely influenced the Encyclopædists no less than the author of "Emile."—Report by Dr. P. Topinard on the Neolithic skull, found at Feigneux (Oise) in 1887, which presents undoubted traces of having been trepanned both during life and after death.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 31.—"Colour Photometry. Part II. The Measurement of Reflected Colours." By Captain W. de W. Abney, R.E., F.R.S., and Major-General Festing, R.E., F.R.S.

In a previous paper we showed how the luminosity of different spectrum colours might be measured, and in the present paper we give a method of measuring the light of the spectrum reflected from coloured bodies such as pigments in terms of the light of the spectrum reflected from a white surface. To effect this the first named of us devised a modification of our previous apparatus. Nearly in contact with the collimating lens was placed a double image prism of Iceland spar, by which means two spectra were thrown on the focussing screen of the camera (which was arranged as described in the Bakerian lecture for 1886), each formed of the light which enters the slit. The light was thus identical in both spectra. The two spectra were separated by about ¼ of an inch when the adjustments were complete. A slit cut in a card was passed through this spectrum to isolate any particular portion which might be required. The rays coming from the uppermost spectrum were reflected by means of a small right-angled prism in a direction nearly at right angles to the original direction on to another right-angled prism. Both prisms were attached to the card. From this last prism the rays fell on a lens, and formed on a white screen an image ofthe face of the spectroscope prism in monochromatic light. The ray of the same wave-length as that reflected from the upper spectrum passed through the lower half of the slit, and falling on another lens formed another image of the face of the prism, superposed over the first image. A rod placed in front of the screen thus cast two shadows, one illuminated by monochromatic rays from the top spectrum, and the other by those from the bottom spectrum. The illumination of the two shadows was equalized by means of rotating sectors which could be closed and opened at pleasure during the time of rotation. The angle to which the sector required to be opened to establish equality of illumination of the two shadows gave the ratio of the brightness of the two spectra. When proper adjustment had been made, the relative brightness was the same throughout the entire spectrum.

To measure the intensity of any ray reflected from a pigment, a paper was coated with it and placed adjacent to a white surface, and it was so arranged that one shadow of the rod fell on the coloured surface and the other on the white surface. The illuminations were then equalized by the sectors, and the relative intensities of the two reflected rays calculated. This was repeated throughout the spectrum. Vermilion, emerald-green, French ultramarine were first measured by the above method, and then sectors of these colours prepared, which when rotated gave a gray matching a gray obtained by rotation of black and white. The luminosity curves of these three colours were then calculated and reduced proportionally to the angle that each sector occupied in the disk. The luminosity curve of the white was then reduced in a similar manner, and it was found that the sum of the luminosities of the three colours almost exactly equalled that of the white. The same measurements were gone through with pale-yellow chrome and a French blue, which formed a gray on rotation, with like results. It was further found that *the sum of the intensities* of vermilion, blue, and green varied at different parts of the spectrum, and the line joining them was not parallel to the straight line which represented white for all colours of the spectrum and which itself was parallel to the base. Since a straight line parallel to the base indicated degraded white, it followed that if the intensity of the rays of the spectrum were reduced proportionally to the height of the ordinates above a line tangential to the curved line (which represented the sum of the intensities of the three colours at the different parts of the spectrum) and were recombined, a gray should result. A method was devised of trying this, and the experiment proved that such was the case. The same plan enabled the colour of any pigment to be reproduced from the spectrum on the screen. The combination of colours to form a gray on rotation by a colour-blind person was also tried, and after the curve of luminosity of the colours had been calculated and reduced according to the amount required in the disk, it was found that the sum of the areas of the curves was approximately equal to the white necessary to be added to a black disk to form a gray of equal intensity as perceived by him. The spectrum intensity of gas-light in comparison with the electric light was also measured, and the amount of the different colours necessary to form a gray in this light was ascertained by experiment.

As before, it was found that the calculated luminosity of the colours was equal to the white which, combined with black, formed a gray of equal luminosity.

The question of the coloured light reflected from different metals was next considered, and the method of measuring it devised, as was also the method of measuring absorption spectra. The luminosity curves obtained by the old method were compared with those obtained by the present method, and so close an agreement between them was found to exist as to give a further confirmation that our former plan was accurate. A number of pigments that can be used for forming grays by rotation were measured, and the results tabulated in percentages of the spectrum of white light and on a wave-length scale.

Physical Society, June 9.—Prof. Reinold, President, in the chair.—The following papers were read:—On the analogy between dilute solutions and gases as regards Gay-Lussac's and Boyle's and Avogadro's laws, by Prof. van 't Hoff, presented by Prof. Ramsay, F.R.S. If a dilute aqueous solution of sugar (say 1 per cent.) be placed in a vessel, A (the walls of which are permeable to water, but not to sugar molecules), and immersed in a large quantity of water, B, water will pass from B to A until a certain difference of pressure exists between the inside and outside of A, that difference depending on the temperature and concentration of the solution. The pressure is called *osmotic pressure*, and the walls of A are said to be *semi-permeable*. Such a vessel may be artificially produced by depositing ferrocyanide of copper on unglazed porcelain; but many of the experiments dealt with in the paper have been made with the cells of plants, the walls of which form good *semi-permeable membranes*. At constant temperature the osmotic pressure is found to be proportional to the concentration of the solution, and for a given concentration the pressure is proportional to the absolute temperature. Similar results have been obtained with solutions of KNO_3, K_2SO_4, NaCl, &c., and Soret has found that if a solution be heated unequally at different parts, the warmer parts are less concentrated, just as in gases under similar conditions the warmer parts are more rarefied. The numerical results are in fair accordance with those deduced from the laws above stated. Theoretical proofs of the laws are given, in which reversible cycles and the second law of thermodynamics are made use of. By similar reasoning the author concludes that "under equal osmotic pressure, and at the same temperature, equal volumes of all solutions contain the same number of molecules, and moreover the same number of molecules which would be contained in a gas under the same conditions of temperature and pressure." These results are confirmed by Pfeffer's direct determinations of osmotic pressure, and Raoult's experiments on the "molecular lowering of vapour-pressure," and the "molecular depression of the freezing-point of the solvent." The latter part of the paper contains applications to chemical phenomena. Prof. Rücker regretted that the names Boyle's law and Gay-Lussac's law had been so persistently made use of in the paper, as he thought a wrong impression would be spread as to the nature of the phenomena. He also considered it probable that the proportionality observed was merely the result of the smallness of the ranges over which the experiments had been made. Mr. H. Crompton took exception to the imaginative character of the reasoning, and thought much more experimental proof was required before the results could be accepted for any but very small ranges of concentration. In answer to Prof. Reinold, Prof. Ramsay said the experimental data were not obtained by van 't Hoff himself, but were taken chiefly from Raoult's determinations.—On a method of comparing very unequal capacities, by Dr. A. H. Fison. One coating of each condenser is joined to earth, and to one end, A, of a high resistance (20,000 or 30,000 ohms), through which a current is flowing. The small condenser is charged to the P.D. existing between the ends A, B, of the resistance, and discharged into the large one. This is repeated a great number of times. If C be a point between A and B, the resistance between A and C may be varied until the P.D. between them is equal to that between the coatings of the condensers after *n* operations. If the insulated coatings be now joined to C through a galvanometer, no deflection will result. The relation between the capacities C_1 and C_2 of the large and small condensers is given by

$$\left(1 + \frac{C_2}{C_1}\right)^n = \frac{R_{AB}}{R_{BC}},$$

where R_{AB}, R_{BC} are the resistances between AB and BC respectively. Since time is required to perform the operation, the instantaneous capacities cannot be compared, and accordingly the measurements are taken after a definite time of electrification. A special rotating key was shown for performing ten operations per revolution, in which a trigger arrangement was provided for stopping the rotation after a predetermined integral number of revolutions. The method has been used for comparing a small air-condenser with a microfarad. The capacity of the former was also calculated electro-statically (correction being made for the edges), and that of the latter measured electro-magnetically by a ballistic galvanometer. The results give a value for v equal to $2{\cdot}965 \times 10^{10}$. In these experiments the capacity of the rotating key was allowed for. Under favourable conditions, capacities in the ratio of 1 to 1000 or 1 to 10,000 can be compared with an accuracy of $\frac{1}{4}$ per cent. Prof. Ayrton thought the novelty of the arrangement was in the rotating key, as the method of comparing unequal capacities by charging the smaller and discharging it into the larger a considerable number of times had been described and used by himself and Prof. Perry in their experiments on the specific inductive capacity of gases.—Mr. W. Lant Carpenter exhibited a new form of lantern, recently constructed by Mr. Hughes, of Dalston. The mahogany body is hexagonal, and each of the three front sides is provided with condensers and projecting arrangements. The back side opens to give access to the radiant, which in this case is a Brockie-Pell arc lamp, but if necessary a lime-light can be readily substituted. The lamp is fixed to the base-board, and the body can be rotated through 60° on either side of the central position, thus allowing any of the three nozzles to be directed towards the screen. The three sets of condensers are placed so that their axes intersect at a point about which the radiant is placed. The centre nozzle is fitted as a lantern microscope, with alum cell and various sets of condensing lenses and objectives, and a space in front of the main condensers is provided for polarizing apparatus. The focussing arrangement consists of a skew rack and pinion and a fine screw adjustment, and the whole microscope can be easily removed and a table polariscope substituted. The right-hand nozzle is arranged for the projection of ordinary lantern-slides, and the left-hand one is provided with an adjustable slit for spectrum work. A small table sliding on rails serves to carry the prisms, and the same rails support projecting lenses. Prof. S. P. Thompson congratulated Mr. Lant Carpenter on his selection of the Brockie-Pell lamp as the radiant, for, in addition to its being a focussing-lamp, it is unique in the fact that it works satisfactorily on either constant current or constant potential circuits.—Note on some additions to the Kew magnetometer, by Prof. Thorpe, F.R.S., and Prof. Rücker, F.R.S. In their magnetic survey of Great Britain and Ireland the authors have experienced considerable difficulty in making the necessary adjustments of the small transit-mirror used for determining the geographical N. point from observations on the sun. To make the required adjustments it is necessary to obtain an image of the cross-wires reflected from the mirror; and owing to the large amount of extraneous light, and the insufficient illumination of the cross-wire, the image is difficult to see. To exclude extraneous light, a tube is placed between the transit-mirror and the telescope, and a small screen placed behind the mirror. The cross-wires are illuminated by light reflected from a small platinum mirror introduced between the eye-piece and the cross-wires, which are viewed through a hole in its centre. The mirror is placed at 45° to the axis, and reflects a considerable quantity of light on the cross-wires when directed towards a bright part of the sky. In some cases it is advisable to take observations of the sun without first adjusting the transit-mirror, and afterwards correct the error introduced thereby. To do this a finely-divided scale is placed in the plane of the cross-wires, and from the position of the image, as indicated on the scale, the correction can be made. Observations taken with the mirror in adjustment and others taken when out of adjustment, and subsequently corrected, give very concordant results. The Rev. Father Perry said the improvements described were of great importance, for difficulties similar to those experienced by the authors had caused him to abandon the Kew magnetometer for field work, and to use a theodolite instead.

Linnean Society, June 21.—Mr. F. Crisp in the chair.—Mr. F. W. Oliver exhibited the aquatic and terrestrial forms of *Trapella sinensis*, of which he gave a detailed account, illustrated by diagrams.—Dr. R. C. A. Prior exhibited a branch of the so-called "Cornish elm," and described its peculiar mode of growth, which suggested its recognition as a distinct species. In the opinion of botanists present, however, it was regarded as merely a well-marked variety of the common elm.—On behalf of Mr. R. Newstead, of the Grosvenor Museum, Chester, photographs and drawings of the little grebe, *Podiceps minor*, were exhibited to illustrate a peculiarity observed in the mechanism of the leg-bones.—Mr. A. W. Bennett exhibited under the microscope, and made remarks upon, filaments of *Sphæroplea annulina* (from Kew), containing fertilized oospores.—Mr. Thomas Christy exhibited specimens of natural and manufactured Kola nuts, and explained how the latter might always be detected.—The following papers were then read:—Dr. P. H. Carpenter, on the *Comatulæ* of the Mergui Archipelago.—Prof. P. Martin Duncan and W. P. Sladen on the *Echinoidea* of the Mergui Archipelago.—Mr. W. P. Sladen, on the *Asteroidea* of the Mergui Archipelago.—Mr. W. Bolus, on South African *Orchideæ*.—Mr. R. A. Rolfe, a morphological and systematic revision of *Apostasiæ*.

Geological Society, June 7.—Dr. W. T. Blanford, F.R.S. President, in the chair.—The following communications were read:—A letter from H.M. Secretary of State for India, accompanying some specimens of rubies in the matrix from Burma.—On the Sudbury copper deposits (Canada), by J. H. Collins.—Notes on some of the auriferous tracts of Mysore Province, Southern India, by George Attwood.—On the Durham salt-district, by E. Wilson. In this paper the author described the new salt-field in the North of England, occupying the low-lying country bordering the estuary of the Tees, and situated partly in Yorkshire and partly in Durham. The history of the rise and progress of the salt-industry in South Durham was given, since the first discovery of salt by Messrs. Bolckow, Vaughan, and Co., at Middlesborough, in the year 1859. The stratigraphical position of the saliferous rocks of the Durham salt-district was considered in some detail. The diverse views which have been previously expressed on this head were referred to, and reasons given for concluding that all the beds of rock-salt which have been hitherto proved in this field, and the red rocks with which they are associated, belong to the upper portion of the Trias, viz. to the Upper Keuper series (Waterstones subdivision). The probable area of this salt-field, the limits of the distribution, and varying depths of the chief bed of rock-salt were indicated, and the extent of its supplies pointed out. In conclusion, the author called attention to the waste, as well as to certain other disadvantages resulting from the process of winning the salt now in operation.—On the occurrence of *Calcisphæra*, Williamson, in the Carboniferous Limestone of Gloucestershire, by E. Wethered.—Second note on the movement of scree-material, by C. Davison; communicated by Prof. T. G. Bonney, F.R.S.

Anthropological Institute, May 29.—Francis Galton, F.R.S., President, in the chair.—A paper by Mr. G. H. Kinahan was read, on rubbings from ancient inscribed stone monuments in Ireland.—Dr. Stewart gave an account of the inhabitants of Paraguay.

June 12.—The Rev. H. G. Tomkins read a paper on Mr. Flinders Petrie's collection of ethnographic types from the monuments of Egypt. The author classified the collection under the four heads of Westerns, Southerns, Asiatics, and Egyptians; and examined, in order, the races mentioned under each of these heads. Among the Westerns are the Tahennu, or fair people, who, as Egyptian mercenary troops, founded, by a prætorian revolt, the famous twenty-second dynasty, to which Shishak, the invader of Palestine, belonged. The Lebu, or Libyans, fall under this head; and the author identifies with them the light-complexioned, fair-haired, and blue-eyed brickmakers of the celebrated tomb of Rekhmara. The want of the long side-locks is not surprising, since they were slaves employed in the lowest drudgery. The Shardina furnished highly-trained soldiers to the Egyptian army of Rameses II. They wore helmets with two horns, crested with a disk, and seem to have been Sardinians. Under the head of Southerns we have very various and interesting types. It is curious to find, in the paintings, blacks with red hair; but it seems probable that the colour was produced by the use of dye. Mr. Tomkins gave a full description of the race of Pûn, and dwelt particularly upon the terraced mountains covered with incense-trees that caused so much astonishment to the officers of Queen Hatasu. He also gave a probable explanation of the origin of the remarkable features of Amenhotep IV., the celebrated Khu-en-aten, whose mother, Queen Tua, was distinguished for her beauty.

Mathematical Society, June 14.—Sir J. Cockle, F.R.S., President, in the chair.—The Vice-Chancellor of Cambridge University (Dr. C. Taylor), read a paper on the determination of the circular points at infinity.—Prof. M. J. M. Hill followed with a paper on the c- and p-discriminants of integrable differential equations of the first order.—Mr. Tucker (Hon. Sec.), communicated papers by Lord Rayleigh, Sec. R.S., on point-, line-, and plane-sources of sound.—Note on rationalization, by H. Fortey.—Applications of elliptic functions to the theory of twisted quartics, by Prof. G. B. Mathews.—Prof. Greenhill, F.R.S., communicated remarks on coefficients of induction and capacity and allied problems, in continuation of a former paper (January 1879).—The following were taken as read: electrical oscillations, by Prof. J. J. Thomson, F.R.S.; and demonstration of the theorem "that the equation $x^3 + y^3 + z^3 = 0$ cannot be solved in integers," by J. R. Holt.

Zoological Society, June 5.—Dr. Edward Hamilton, Vice-President, in the chair.—The Secretary read a report on the additions that had been made to the Society's Menagerie during the month of May.—Mr. H. E. Dresser exhibited a specimen of a new Shrike from the Transcaspian district of Central Asia, which he proposed to name *Lanius raddei*, after Dr. Radde, of Tiflis, its discoverer.—Mr. Sclater, on the part of Mr. F. M. Campbell, exhibited a pair of Pallas's Sand-Grouse (*Syrrhaptes paradoxus*), shot in Hertfordshire in May last, and made remarks on the recent immigration of this Central Asiatic bird into Western Europe.—The Secretary exhibited, on behalf of Prof. R. Collett, a nest, eggs, and two young ones in down of the Ivory Gull (*Larus eburneus*), belonging to the Tromsö Museum, which had been obtained in Spitzbergen in August 1887.—Mr. Warren communicated a paper on Lepidoptera collected by Major Yerbury in Western India in 1886–87, forming a continuation and completion of two previous papers by Mr. A. G. Butler on Lepidoptera collected by the same gentleman in similar localities. The present collection contained examples of over 200 species of Heterocera, of which about one-fourth were described as new. Mr. Warren remarked upon the abnormal development of separate organs, such as the antennæ and palpi, in tropical insects, as being rather specific aberrations from a generic type, than as warranting the erection of new genera.—A communication was read from Mr. Martin Jacoby, containing descriptions of some new species of Phytophagous Coleoptera from Kiukiang, China.—Mr. F. E. Beddard read some notes on the structure of a peculiar sternal gland found in *Didelphys dimidiata*.—Mr. G. A. Boulenger read a paper on the scaling of the reproduced tail in Lizards, and pointed out that the scaling of the renewed tails of Lizards may, in some cases, afford a clue to the affinities of genera or species to one another.—Mr. F. E. Beddard gave a preliminary notice of an apparently new form of Gregarine, found parasitic on an earthworm o the genus *Perichæta* from New Zealand.

CAMBRIDGE.

Philosophical Society, May 21.—Mr. J. W. Clark, President, in the chair.—On solution and crystallization, by Prof. Liveing. When a substance passes from a state of solution into the solid state, the new arrangement of the matter must be such that the entropy of the system is a maximum; and, other things being the same, the surface energy of the newly formed solid must be a minimum. If the surface tension be positive, that is tend to contract the surface, the surface energy will be a minimum when the approximation of the molecules of the surface is a maximum. The essential difference between a solid and a fluid is that the molecules of the former maintain approximately the same relative places, whereas the molecules of a fluid are subject to diffusion. Further, crystalloids in assuming the solid form assume a regular arrangement of their molecules throughout their mass, which we can usually recognize by the optical properties of the crystal, and by the cleavage. If we suppose space to be divided into equal cubes by three sets of parallel planes, each set at right angles to the other two, and suppose a molecule to be placed in every point where three planes intersect, we shall have an arrangement which corresponds with the isotropic character of a crystal of the cubic system. But of all the surfaces which can be drawn through the system the planes bounding the cubes meet the greatest number of molecules, those parallel to the faces of the dodecahedron meet the next greatest number of molecules, and those parallel to the faces of the octahedron meet the next greatest number. Also if we take an angular point of one of the cubes as origin, and three edges of the cube as axes, and the length of an edge of the cube as the unit of length, every plane which cuts the three axes at distances p, q, r respectively from the origin, where p, q and r are whole numbers, will be a surface of maximum concentration of molecules, but the concentration will be less as p, q and r are greater. Hence forms which are bounded by these planes, which follow the law of indices of crystals, will be forms of minimum surface energy and therefore of equilibrium. The tendency in general will be for substances with such a structure as is here supposed to take the form of cubes, since the cube will have the greatest concentration of molecules per unit of surface. But the total surface energy will depend on the total surface as well as on the energy per unit of surface, and for a given volume the surface will be diminished if the edges and angles of the cube are truncated by faces of the dodecahedron and octahedron, or by more complicated forms. When a solid is broken, two new surfaces are formed each with its own surface energy, and the solid must be more easily fractured when the new surfaces have the minimum energy. Hence substances with the structure supposed must break most easily in directions parallel to the sides of the cube, dodecahedron and octahedron; and these are the cleavages observed in this system. If we suppose the molecules placed at the centres of the faces of the cubes, instead of at the angles, the arrangement will still be isotropic, but the octahedron will be bounded by the surfaces of greatest condensation, and the cube will come next to it. It is probable that substances which cleave most readily into cubes, such as rock-salt and galena, have the former structure, while those which have the octahedral cleavage may have the latter arrangement of their molecules. For the pyramidal and prismatic systems we may suppose space divided not into cubes but into rectangular parallelopipeds with edges equal severally to the axes of the crystals, and molecules placed as before. For the rhombohedral system we may suppose space divided into rhombohedra, or in crystals of the hexagonal type into right prisms with triangular bases, and for the other systems into parallelopipeds with edges parallel and equal to the axes. In each case if the molecules be disposed at points of intersection of three dividing planes we shall have such an arrangement as satifies the optical conditions, and planes which follow the law of indices are surfaces of maximum condensation. Calculations show that whenever a crystal has an easily obtained cleavage the direction of cleavage corresponds to the surface of greatest condensation, and that the most common forms of crystals correspond in general to forms of minimum surface energy. The surface tension of a plane surface will have no resultant out of that plane, but where two plane surfaces meet in an edge, or angle, the tensions will have a resultant of sensible magnitude in some direction falling within the angle. Whenever all the faces of a crystallographic form are developed, every such resultant will be met by an equal and opposite resultant, and the form will be one of equilibrium. If one edge, or angle, be modified, the opposite edge, or angle, must either be similarly modified, or the resultant arising from the modification must be equilibrated by some internal forces produced by displacement of the molecules. In general, equilibrium is attained by similar modifications of similar edges and angles, but when only some of the edges or angles of a crystal are modified, while other similar edges or angles are not modified, we usually have evidence of the consequent internal strain. Thus cubes of sodium chlorate, which have half the angles truncated by faces of a tetrahedron, rotate the plane of polarized light, hemihedral tourmalines are pyro-electric, and so on. This theory therefore accounts for the plane faces of crystals, the law of indices, the most common combinations, and the cleavages. The same theory accounts for the development of plane faces when a crystalline solid of any shape is slowly acted on by a solvent. Solution will proceed so long as the entropy of the system is increased by the change, but when the solution is nearly saturated there will be an increase of entropy from the solution of a surface which has more than the minimum surface energy, while there will be no increase from the solution of a surface which has only the minimum energy.—On the effect of an electric current on saturated solutions, by Mr. C. Chree, M.A. This paper contains an account of experiments whose aim was to determine what effect, if any, an electric current may have on the quantity of salt required to form a saturated solution. Strong currents and a rapidly reversing commutator were employed. Certain chlorides were dealt with, and in no case did the existence of a current produce any sensible immediate effect. When heating was allowed to take place, the action of the current appeared to check the solution that would naturally have followed. This view was further supported by experiments on the effects of simple heating. These experiments showed, however, that an originally saturated solution when slowly heated can dissolve salt only with extreme slowness.

PARIS.

Academy of Sciences, June 18.—M. Janssen, President, in the chair.—Lagrange's hypothesis on the origin of comets and meteorites, by M. H. Faye. According to the author's calculations, this hypothesis, first submitted to the Bureau of Longitudes in 1812, does not hold good for the comets whose orbits do not quite approach any of the planetary orbits. But it would seem capable of being applied to the meteorites, whose fragmentary character, minute size, chemical and mineralogical identity with the constituent elements of the earth, combined with their great abundance, would seem to be absolutely incompatible with an extra-planetary origin. The earth alone with its satellite best satisfies all the conditions of the problem, while its orbit is continually intersected by millions of these bodies, as required by the hypothesis in question. Hence their origin is to be sought in the earth itself and in the moon, whence they were ejected under conditions which have long ceased to exist.—Fluorescence of ferruginous lime, by M. Lecoq de Boisbaudran. These experiments show that a small quantity of the sesquioxide of iron added to the carbonate of lime produces a green fluorescence after high calcination in the air. This fluorescence, which is occasionally somewhat intense, is very sensitive to the action of heat; hence it soon fades away in the presence of the electrode, retaining its brilliancy only in the parts of the tube furthest removed from the centre of action.—Experimental researches on the diseases of the vine, by MM. Pierre Viala and L. Ravaz. Having already shown that the different reproductive organs found on the parts affected by black rot belong to the fungus, cause of this disease, the authors here demonstrate the true parasitic character of the fungus itself. They once for all establish the filiation which exists between its various forms of reproduction, and thus make it evident that the blight on the leaves has the same origin as that of the grapes.—Researches on the accidental errors occurring in the observations of transits made by the method of eye and ear, by M. G. Rayet. In supplement to the studies of Struve, Robinson, Dunkin, Finlay, and others, the author here describes the results of special observations made on about seventy stars, or constellations, comprised between 20° of austral declination and the North Pole. He has thus determined the numerical value of the accidental errors relative to some dozen stars between 80° and 89° 22'·3 of declination.—On the rings of Saturn, by M. Perrotin. During the opposition of Saturn in the present year the author has made a series of micrometric measurements of the rings by means of the great equatorial of the Observatory of Nice. The results of these observations, made for the purpose of determining the dimensions of the system, are here fully tabulated for the whole period from February 2 to May 8.—On the planet Mars, by M. Perrotin. On presenting the already promised sketches of recent appearances in this planet, the author remarked that since his last communication the region of Libya has undergone fresh modifications. The sea which covered the surface of this insular mass has mostly receded, its present appearance being intermediate between that of 1886 and its condition a few weeks ago. The existence has also been determined of canals or channels, partly double, running from near the equator to the neighbourhood of the North Pole. They mainly follow the meridian, and merge in the seas encircling the white snow-cap of the Pole, and, strange to say, their course may be followed across the seas themselves right up to the snow-cap.—Heat of combination of the primary, secondary, and tertiary aromatic monamines with the acids, by M. Léo Vignon. In continuation of M. Louguinine's study of the primary monamines, the author here investigates the reactions of several acids on a series of primary, secondary, and tertiary monamines. He deals more especially with aniline, monomethyl aniline, and dimethylaniline in the presence of the hydrochloric, sulphuric, and acetic acids.—On the decomposition of the ferrate of baryta at high temperatures, by MM. G. Rousseau and J. Bernheim. In his researches on ferric acid, Fremy has indicated the analogy existing between the ferrates and the manganates, as established by the wet process. Here the authors endeavour to ascertain whether the parallelism is maintained in the reactions of the dry process and in their mode of decomposition under the action of heat.—On some new double phosphates in the magnesian series, by M. L. Ouvrard. The products here described have been obtained by the method already referred to in a previous note on the action of the alkaline phosphates on the alkaline earthy oxides. All the metals investigated are allied in their composition to the substances obtained with the pyro- and ortho-phosphates of potassa and soda.—On the poison of the Hymenoptera with smooth sting, and on the existence of a poison-cell in the honey-producing insects, by M. G. Carlet. In continuation of his researches on the barbed sting of bees, wasps, &c., the author here studies the smooth sting of Philanthus, Pompilus, &c. He describes the nature of the poison, which has merely a soporiferous effect, and clearly determines the presence of a poison-cell in bees and allied insects.—On a new bacterial disease of the duck, by MM. Cornil and Toupet. An examination of the bacteria of this disease ("duck cholera") shows that it is quite distinct from chicken cholera. The virus is fatal to the duck alone, sparing hens and pigeons, and killing rabbits only when an excessive dose is administered.—M. A. d'Arsonval contributes an elaborate paper on the relation between animal electricity and surface tension.

AMSTERDAM.

Royal Academy of Sciences, May 26.—M. Franchimont, communicating the results of experiments on nitro-ureides and nitramines, said that internal ureides, by their behaviour with nitric acid, may be distinguished into at least three sorts.—M. Sahols treated of the calculation of the moments of flexion and the shearing-forces in railway-bridges, in connection with the irregular distribution of the pressures exercised by the axles of locomotive-engines. He pointed out what elements of the engine are of especial influence on these, and arrived at very simple approximative formulæ for the calculation of the said moments and forces on bridges of not too insignificant length.—M. Pekelharing read a paper on the proliferation of endothelium-cells in arteries, stating, as the result of his experiments made upon them, that this proliferation is most probably caused by a diminution of the pressure upon the inner wall of the arteries.—M. van der Waals treated of the connection between the change in the density of the limiting layer between fluid and vapour, and the mode of action of the molecular forces.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Proceedings of the Royal Society of Edinburgh, Sessions 1883 to 1887 (Edinburgh).—Transactions of the Royal Society of Edinburgh, vol. xxx. Part 4, vol. xxxii. Parts 2, 3, 4, vol. xxxiii. Parts 1, 2 (Williams and Norgate).—Transactions of the Royal Society of Edinburgh, vol. xxxi. Botany of Socotra: Prof. I. B. Balfour (Williams and Norgate).—British Reptiles and Batrachians: C. C. Hopley (Sonnenschein).—Anleitung zu Wissenschaftlichen Beobachtungen auf Reisen, Bands 1 and 2: Dr. G. Neumayer (Oppenheim, Berlin).—Mathematical Drawing Instruments, sixth edition: W. F. Stanley (Spon).—Proceedings of the American Association for the Advancement of Science, New York Meeting, 1887 (Salem).—British Dogs, Parts 17 to 20: H. Dalziel (U. Gill).—Observations made at the Hong Kong Observatory in the year 1887: W. Doberck (Hong Kong).—Synopsis of the Aphididæ of Minnesota: O. W. Oestlund (St. Paul).—Report on Botanical Work in Minnesota for the year 1886: J. C. Arthur (St. Paul).—Preliminary Description of the Peridotytes, Gabbros, Diabases, and Andesytes of Minnesota: M. E. Wadsworth (St. Paul).—Palæolithic Man in Eastern and Central North America (Cambridge, Mass.).—Journal of the Royal Microscopical Society, June (Williams and Norgate).—Proceedings of the Society for Psychical Research, June (Trübner).—Sulla Forza Elettromotrice del Selenio, Memoria del Prof. A. Righi (Padova).

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GEOLOGISTS' ASSOCIATION, at 8.—On the Rhætics and Lias of Glamorganshire : H. B. Woodward.—On the Geology of the Forest of Dean : E. Wethered.—On the Clays of Bedfordshire : A. C. G. Cameron.

EDINBURGH.

THURSDAY, JUNE 28.

MINERALOGICAL SOCIETY, at 7.—A Mangano-Magnesian Magnetite : Prof. Albert H. Chester.—The Distribution and Origin of the Mineral Albertite in Ross-shire : Hugh Miller. (Communicated by the Local Secretary.)—The Rock-forming Feldspars and their Determination : Alex. Johnstone, and Dr. A. B. Griffiths (Communicated by the Local Secretary.)—A Scottish Locality for Bornite : Rev. W. W. Peyton.—With several Papers by Prof. W. I. Macadam.

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