

## COMPOSITE PORTRAITURE.

By FRANCIS GALTON, F.R.S.

I PROPOSE to draw attention to-night to the results of recent experiments and considerable improvements in a process of which I published the principles three years ago, and which I have subsequently exhibited more than once.\*

I have shown that, if we have the portraits of two or more different persons, taken in the same aspect and under the same conditions of light and shade, and that if we put them into different optical lanterns converging on the same screen and carefully adjust them—first, so as to bring them to the same scale, and, secondly, so as to superpose them as accurately as the conditions admit—then the different faces will blend surprisingly well into a single countenance. If they are not very dissimilar, the blended result will always have a curious air of individuality, and will be unexpectedly well defined; it will exactly resemble none of its components, but it will have a sort of family likeness to all of them, and it will be an ideal and an averaged portrait. I have also shown that the image on the screen might be photographed then and there, or that the same result may be much more easily obtained by a method of successive photography, and I have exhibited many specimens made on this principle. Photographs of some of these will be found in the Proceedings of the Royal Institution, as illustrations of a lecture I gave there "On Generic Images" in 1879.

It will be convenient that I should again explain the best of the many processes that I have already published. It is simple enough in idea, but difficult to carry out with the scrupulous accuracy of adjustment that is needed for really good results. I have, therefore, little doubt that some photographers may have tried it, or some other of my plans, and failed, and that they consequently have abandoned what I believe is likely to become a new and not unimportant branch of their art. My old plan was this:—I reduced the photographs by a copying-camera to a uniform scale, so that in each case the distance between the line that intersected the pupils of the eyes and that which lay between the lips was the same. Then I took each paper portrait in turn, and laid it face downwards on a glass illuminated by a mirror below as in a retouching-frame, and I adjusted the portrait to certain cross lines drawn on the glass. Suppose the aspect of the portraits to be full face, then the fiducial lines that I used were two horizontal ones, at the standard distance apart between pupils and lips, and a vertical line that intersected them. I adjusted the portrait until it was correctly placed as regards the two horizontal lines, and then I slid it horizontally until the vertical line was exactly half way between the two pupils. Holding it firmly in this position, I pressed a bar that carried two needle points down on the portrait; they pricked two holes, which afterwards served as "register-marks." After all the portraits had been similarly treated in turn, I strung them together like leaves in a book, by threads passing through the two holes; then they were ready to be operated on. Suppose I had six portraits, and that, under the given conditions of light, lens, and scale of reduction, it would require 60 seconds of exposure to make a good copy of any one of the six, then I allotted only 10 seconds to each separate portrait, thus dividing the 60 seconds equally among them. I fixed the book of portraits against the wall in front of the camera, and when all was ready I uncapped the lens for 10 seconds; then I turned down the first portrait and exposed the second, and uncapped the lens again for 10 seconds, and so on until the six portraits had been gone through.

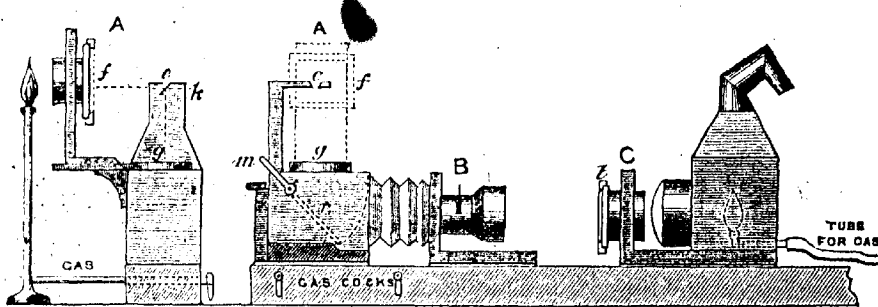
The method I now use is much better; it leads to more accurate results, and is easier to manage. I will exhibit and explain the apparatus as it stands, and will indicate some improvements as I go on. The apparatus is here. I use it by gaslight, and employ rapid plates, which, however, under the conditions of a particularly small aperture and the character of the light, require 60 seconds of total exposure. The apparatus is 4 feet long and 6½ inches broad; it lies with its side along the edge of

\* "Composite Portraits," Journal of the Anthropological Institute, 1878, reprinted in *Nature* and in the *Photographic News*, and translated in the *Revue Scientifique*. Also "Generic Images," Proceedings of the Royal Institution, 1879.

the table at which I sit, and it is sloped towards me, so that, by bending my neck slightly, I can bring my eye to an eyehole, where I watch the effect of the adjustments which my hands are free to make. The entire management of the whole of these is within an easy arm's length, and I complete the process without shifting my seat.

The apparatus consists of three parts, A, B, and C. A is rigidly fixed; it contains the dark slide and the contrivances by which the position of the image can be viewed; the eyehole, *e*, already mentioned, being part of A. B is a travelling carriage that holds the lens, and is connected by bellows-work with A. In my apparatus it is pushed out and in, and clamped where desired, but it ought to be moved altogether by pinion and rack-work. The lens I use is a I B Dallmeyer. Its focal length is

DIAGRAM SHOWING THE ESSENTIAL PARTS.



- A The body of the camera, which is fixed.  
 B Lens on a carriage, which can be moved to and fro.  
 C Frame for the transparency, on a carriage that also supports the lantern; the whole can be moved to and fro.  
 r The reflector inside the camera.  
 m The arm outside the camera attached to the axis of the reflector; by moving it, the reflector can be moved up or down.  
 g A ground-glass screen on the roof, which receives the image when the reflector is turned down, as in the diagram.  
 e The eyehole through which the image is viewed on *g*; a thin piece of glass immediately below *e*, reflects the illuminated fiducial lines in the transparency at *f*, and gives them the appearance of lying upon *g*,—the distances *f k* and *g k* being made equal, the angle *f k g* being made a right angle, and the plane of the thin piece of glass being made to bisect *f k g*.  
 f Framework, adjustable, holding the transparency with the fiducial lines on it.  
 t Framework, adjustable, holding the transparency of the portrait.

appropriate to the size of the instrument, and I find great convenience in a lens of wide aperture when making the adjustments, as I then require plenty of light; but, as to the photography, the smaller the aperture the better. The hole in my stop is only two-tenths of an inch in diameter, and I believe one-tenth would be better.\*

C is a travelling carriage that supports the portraits in turn, from which the composite has to be made. I work directly from the original negatives with transmitted light; but prints could be used with light falling on their face. For convenience

\* A small aperture helps to remove a cause of fog, due to the source of illumination not lying in the same plane as the transparency, but behind it. Suppose an isolated black dot, *p*, in the transparency call its image on the focussing-screen *m*; let the point in the illuminated surface that lies in the prolongation of *m p* be called *p'*. Then to produce an image free from fog, every ray proceeding from *p* towards the lens ought to be intercepted by *p*. This, however, can never be the case under the above conditions. Since *m* is in focus for rays proceeding from *p*, the focus for rays proceeding from the more distant point *p'* will be somewhere in front of *m*. Consequently those rays from *p'* that skirt *p*, and that fall upon the outer portions of the lens, will be brought to a focus in front of *m*; they will diverge as they proceed further, and will form a blur of light that will overspread *m*,—in short they will cause fog. Owing to this cause, we cannot have perfect sharpness in any contour line in the image of a transparency that is illuminated by a mirror reflecting the light of the sky, or by a distant sheet of white paper. The remedy is two-fold; one part consists in bringing the source of illumination as near as possible to the transparency, and the other is to use a very small aperture. I rest the transparency against a ground-glass plate not too strongly illuminated from behind, and which itself becomes the source of illumination. I do not like to put the face of the transparency against the face of the ground glass without introducing certain other difficulties; thus the image somewhat loses its definition, and the grain of the ground glass, or any dust on its surface, is photographed with unwelcome precision. As for the aperture, I use a stop the hole in which is too small to admit an ordinary lead pencil.

of description I will confine myself to the first instance only, and will therefore speak of C as the carriage that supports the frame that holds the negative transparencies. C can be pushed along the board and be clamped anywhere, and it has a rack and pinion adjustment; but it should have been made movable by rack and pinion along the whole length of the board. The frame for the transparencies has the same movements of adjustment as those in the stage of a microscope. It rotates round a hollow axis, through which a beam of light is thrown, and independent movements in the plane, at right angles to the axis, can be given to it in two directions, at right angles to one another, by turning two separate screws. The beam of light is furnished by three gas-burners, and it passes through a condenser. The gas is supplied through a flexible tube that does not interfere with the movements of C, and it is governed by a stop-cock in front of the operator.

The apparatus, so far as it has been described with any detail, and, ignoring what was said about an eye-hole, is little else than a modified copying-camera, by which an image of the transparency could be thrown on the ordinary focussing-screen, and be altered in scale and position until it was adjusted to fiducial lines drawn on the screen. It is conceivable that this should be done, and that the screen should be replaced by the dark slide, and a brief exposure given to the plate; then, that a fresh transparency should be inserted, a fresh focussing adjustment made, and a second exposure given, and so on. This, I say, is conceivable, but it would be very inconvenient. The adjusting screws would be out of reach; the head of the operator would be in an awkward position; and though these two difficulties might be overcome in some degree, a serious risk of an occasional shift of the plate during the frequent replacement of the dark slide would remain. I avoid all this by making my adjustments while the plate continues in position with its front open. I do so through the help of a reflector temporarily interposed between it and the lens. I do not use the ordinary focussing-screen at all in making my adjustments, but one that is flush, or nearly so, with the roof of the camera. When the reflector is interposed, the image is wholly cut off from the sensitized plate, and is thrown upwards against this focussing-screen, *g*. When the reflector is withdrawn, the image falls on the plate. It is upon this focussing-screen in the roof that I see the fiducial lines by which I make all the adjustments. Nothing can be more convenient than the position of this focussing-screen for working purposes. I look down on the image as I do upon a book resting on a sloping desk, and all the parts of the apparatus are within an easy arm's length.

My reflector in my present instrument is, I am a little ashamed to confess, nothing better than a piece of looking-glass fixed to an axle within the camera, near its top left-hand edge. One end of the axle protrudes, and has a short arm; when I push the arm back, the mirror is raised; when I push it forward, it drops down. I used looking-glass because the swing action is very true, and as my apparatus was merely a provisional working model, made of soft wood, I did not like to use sliding arrangements which might not have acted truly, or I should certainly have employed a slide with a rectangular glass prism, on account of the perfect reflection it affords. And let me say, that a prism of 2 inches square in the side is quite large enough for adjustment purposes, for it is only the face of the portrait that is wanted to be seen. I chose my looking-glass carefully and selected a piece that was plane and parallel. It has not too high a polish, and therefore does not give troublesome double reflections. In fact, it answers very respectably, especially when we consider that perfection of definition is thrown away on composites. I thought of a mirror silvered on the front of the glass, but this would soon tarnish in the gas-light, so I did not try it. For safety against the admission of light unintentionally, I have a cap to the focussing-screen in the roof, and a slide in the fixed body of the instrument, immediately behind the reflector and before the dark slide. Neither of these will be wanted when the reflector is replaced by a prism, set into one end of a sliding block that had a large horizontal hole at the other end, and a sufficient length of solid wood between the two to block out the passage of light both upwards and downwards, whenever the block is passing through the half-way position.

As regards the fiducial lines, they might be drawn on the glass screen; but black lines are not, I find, the best. It is far easier to work with illuminated lines; and it is important to be able to control their brightness. I produce these lines by means of a

vertical transparency, set in an adjustable frame, connected with A, and having a gas-light behind it. Below the eye-hole *e*, through which I view the glass screen *g*, is a thin piece of glass set at an angle of 45°, which reflects the fiducial lines and gives them the appearance of lying on the screen, the frame being so adjusted that the distance from the thin piece of glass to the transparency and to the glass screen *g* is the same. I thus obtain beautiful fiducial lines, which I can vary from extreme faintness to extreme brilliancy, by turning the gas lower or higher, according to the brightness of the image of the portrait, which itself depends on the density of the transparency that I am engaged upon. This arrangement seems as good as can be. It affords a gauge of the density of the negative, and enables me to regulate the burners behind it, until the image of the portrait on *g* is adjusted to a standard degree of brightness.

For convenience in enlarging or reducing, I take care that the intersection of the vertical fiducial line with that which passes through the pupils of the eyes shall correspond to the optical axis of the camera. Then, as I enlarge or reduce, that point in the image remains fixed. The uppermost horizontal fiducial line continues to intersect the pupils, and the vertical one continues to divide the face symmetrically. The mouth has alone to be watched. When the mouth is adjusted to the lower fiducial line, the scale is exact. It is a great help having to attend to no more than one varying element. The only inconvenience is that the image does not lie in the best position on the plate when the point between the eyes occupies its centre. This is easily remedied by using a larger back with a suitable inner frame. I have a more elaborate contrivance in my apparatus to produce the same result, which I need not stop to explain.

For success and speed in making composites, the apparatus should be solidly made, chiefly of metal, and all the adjustments ought to work smoothly and accurately. Good composites cannot be made without very careful adjustment in scale and position. An off-hand way of working produces nothing but failures.

I will first exhibit a very simple but instructive composite effect. I drew on a square card a circle of about 2½ inches in diameter, and two cross lines through its centre, cutting one another at right angles. Round each of the four points, 90° apart, where the cross cuts the circle, I drew small circles of the size of wafers and gummed upon each a disc of different tint. Finally I made a single black dot half-way between two of the arms of the cross. I then made a composite of the four positions of the card, as it was placed successively with each of its sides downwards. The result is a photograph having a sharply defined cross surrounded by four discs of precisely uniform tint, and between each pair of arms of the cross there is a very faint dot. This photograph shows many things. The fact of its being a composite is shown by the four faint dots. The equality of the successive periods of exposure is shown by the equal tint of the four dots. The accuracy of adjustment is shown by the sharpness of the cross being as great in the composite as in the original card. We see the smallness of the effect produced by any trait, such as the dot, when it appears in the same place in only one of the components: if this effect be so small in a series of only four components, it would certainly be imperceptible in a much larger series. Thirdly, the uniformity of resulting tint in the composite wafer is quite irrespective of the order of exposure. Let us call the four component wafers A, B, C, D, respectively, and the four composite wafers, 1, 2, 3, 4; then we see, by the diagram, that the order of exposure has differed in each case.

Composite:		Successive places of the Components.							
1	2	A	B	D	A	C	D	B	C
4	3	D	C	C	B	B	A	A	D

In 1 it has been A, D, C, B,  
 " 2 " " B, A, D, C,  
 " 3 " " C, B, A, D,  
 " 4 " " D, C, B, A;

yet the result is identical. Therefore the order of exposure has no effect on the result.

I will next show a series consisting of two portraits considerably unlike to one another, and yet not so very discordant as to refuse to conform, and of two intermediate composites. In making one of the composites I gave two-thirds of the total time of exposure to the first portrait, and one-third to the second portrait. In making the other composite, I did the converse. It will be seen how good is the result in both cases, and how the likeness of the longest exposed portrait always predominates.

The next is a series of four composites. The first consists of 57 hospital patients suffering under one or other of the many forms of consumption. I may say that, with the aid of Dr. Mahomed, I am endeavouring to utilize this process to elicit the physiognomy of disease. The composite I now show is what I call a hotch-potch composite; its use is to form a standard whence deviations towards any particular sub-type may be conveniently gauged. It will be observed that the face is strongly marked, and that it is quite idealised. I claim for composite portraiture, that it affords a method of obtaining *pictorial averages*, which effects simultaneously for every point in a picture what a method of numerical averages would do for each point in the picture separately. It gives, in short, the average tint of every unit of area in the picture, measured from the fiducial lines as co-ordinates. Now every statistician knows, by experience, that numerical averages usually begin to agree pretty fairly when we deal with even twenty or thirty cases. Therefore we should expect to find that any groups of twenty or thirty men of the same class would yield composites bearing a considerable likeness to one another. In proof that this is the case, I exhibit three other composites: the one is made from the first 28 portraits of the 57, the second from the last 27, and the third is made from 36 portraits taken indiscriminately out of the 57. It will be observed that all the four composites are closely alike.

I will now show a few typical portraits I selected out of 82 male portraits of a different series of consumptive male patients; they were those that had more or less of a particular wan look, that I wished to elicit. The selected cases were about 18 in number, and from these I took 12, rejecting about 6 as having some marked peculiarity that did not conform well with the remaining 12. The result is a very striking face, thoroughly ideal and artistic, and singularly beautiful. It is, indeed, most notable how beautiful all composites are. Individual peculiarities are all irregularities, and the composite is always regular.

I show a composite of 15 female faces, also of consumptive patients, that gives somewhat the same aspect of the disease; also two others of only 6 in each, that have in consequence less of an ideal look, but which are still typical. I have here several other typical faces in my collection of composites; they are all serviceable as illustrations of this memoir, but, medically speaking, they are only provisional results.

I am indebted to Lieut. Leonard Darwin, R.E., for an interesting series of negatives of officers and privates of the Royal Engineers. Here is a composite of 12 officers; here is one of 30 privates. I then thought it better to select from the latter the men that came from the southern counties, and to again make a further selection of 11 from these, on the principle already explained. Here is the result. It is very interesting to note the stamp of culture and refinement on the composite officer, and the honest and vigorous but more homely features of the privates. The combination of these two, officers and privates together, gives a very effective physiognomy.

Let it be borne in mind that existing cartes-de-visite are almost certain to be useless. Among dozens of them it is hard to find three that fulfil the conditions of similarity of aspect and of shade. The negatives have to be made on purpose. I use a repeating back and a carte-de-visite plate, and get two good-sized heads on each plate, and of a scale that never gives less than four-tenths of an inch between the pupils of the eyes and the mouth. It is only the head that can be used, as more distant parts, even the ears, become blurred hopelessly.

It will be asked, of what use can all this be to ordinary photographers, even granting that it may be of scientific value in ethnological research, in inquiries into the physiognomy of disease, and for other special purposes? I think it can be turned to most interesting account in the production of family likenesses. The most unartistic

productions of amateur photography do quite as well for making composites as those of the best professional workers, because their blemishes vanish in the blended result. All that amateurs have to do is to take negatives of the various members of their families in precisely the same aspect (I recommend either perfect full-face or perfect profile), and under precisely the same conditions of light and shade, and to send them to a firm provided with proper instrumental appliances to make composites from them. The result is sure to be artistic in expression and flatteringly handsome, and would be very interesting to the members of the family. Young and old and persons of both sexes can be combined into one ideal face. I can well imagine a fashion setting in to have these pictures.

Professional skill might be exercised very effectively in retouching composites. It would be easy to obliterate the ghosts of stray features that are always present when the composite is made from only a few portraits, and it would not be difficult to tone down any irregularity in the features themselves, due to some obtrusive peculiarity in one of the components. A higher order of artistic skill might be well bestowed upon the composites that have been made out of a large number of components. Here the irregularities disappear, the features are perfectly regular and idealised, but the result is dim. It is like a pencil drawing where many attempts have been made to obtain the desired effect: such a drawing is smudged and ineffective; but the artist, under its guidance, draws his final work with clear bold touches, and then he rubs out the smudge. On precisely the same principle the faint but beautifully idealised features of these composites are, I believe, capable of forming the basis of a very high order of artistic work.

Mr. WARNERKE said that when Mr. Galton published the first description of his process, five or six years ago, he tried it, and was much pleased with the result of his experiments, which were attended with considerable success. At that time the system was by no means so perfect as it was now, and did not permit of the use of separate negatives in the manner described that evening. The system he (Mr. Warnerke) used, as described by Mr. Galton at that time, was simply to put several sitters in exactly the same position, and expose one after the other on the same plate. He obtained very fine results, and many present at the meeting may have seen the example in his possession. After this he tried the plan of taking transparencies, and, by superimposing them, obtaining a composite portrait. He quite agreed with Mr. Galton's suggestion that composite portraiture might be adapted to the use of professional photographers, and might even be made very remunerative.

Captain ABNEY: The paper just read is one of great scientific value, and must have required much careful study: few people, perhaps, would have the time to give to the subject, which is one that Mr. Galton has made specially his own. In regard to the experiments of the composite of the four wafers, it was not superfluous in any case to mention the results obtained, as I should certainly have thought there might have been a difference according to the order of exposure. I presume Mr. Galton uses gelatine plates?

Mr. GALTON: Yes.

Captain ABNEY: If you give exposure enough to bring out of the transparency one-fourth of the shades in the dark parts, the exposure might prove to be too much for the light parts; and when all the negative had been exposed, these light parts might begin to show a reverse action. However, this does not seem to have been the case, and apparently Mr. Galton has settled the point satisfactorily. There is one other point also in reference to his method of illuminating his negatives. It is sometimes very awkward if you get a bright spot behind a dark line, or *vice versa*, for you get the image of the bright spot as well as the dark line. I will give an instance of this. The other day, in taking some transparencies of spectra, my assistant used a ground glass behind the negative, and he took for this purpose the focussing screen of the camera, on which were ruled lines for regulating the sizes of negatives, and he was very much annoyed to get on his negatives dark streaks in the opaque portions. I traced these streaks to the images of the ruled lines. I would like to ask Mr. Galton

if, instead of using ground glass, he has ever tried a solution of wax in ether at the back of the negative. This might, perhaps, be worth trying, as the surface given is extremely smooth and even. I am glad Mr. Galton has been so successful with the composite portrait of the officers and men of the Engineers. I was not aware the typical officer was so good looking as he appears to be, and I cannot help feeling a certain amount of satisfaction in being connected with the corps on this account alone [*laughter*].

Colonel WORTLEY: Perhaps Mr. Galton could explain how it is that in the composite portrait of officers and men combined, where the negatives of twelve officers and thirty men have been used, the expression of the features of the smaller number seem to predominate?

Mr. GALTON observed that Colonel Wortley was in error in regard to the proportions. The picture shown was made from the negatives of twelve officers, but only eleven men. Mr. Galton further observed as a curious instance of the way in which opinions differed as to likenesses, that he gave to an artist the composite portrait formed from two criminal boys to draw on the wood. The artist had never seen either of the boys, yet the picture he drew was the portrait, not of the composite, but of one of the boys whose picture formed a part of the composite. He (Mr. Galton) took this to exemplify the different opinions which people formed of likenesses, just as persons often disagree as to which member of its family a child most resembled.

The PRESIDENT, in asking the Meeting to pass a vote of thanks to Mr. Galton, spoke of the pleasure which the paper had given, and congratulated Mr. Galton upon the success which had attended his many experiments. It was very singular to see how individual peculiarities were lost and merged into the type of persons upon whom the experiments had been made. Pictures of ethnological types, even of those belonging to our own country, would be very valuable, as indicating the characteristics of different races. He (the President) could only regret that the Photographic Society's contract with the Water Colour Society prevented Mr. Galton from exhibiting his experiments by means of the lantern, as that would have shown the results in a more striking way. However, as it was, Mr. Galton had given the Meeting a great treat, and he had no doubt a hearty vote of thanks would be passed. A vote of thanks was then passed to Mr. Galton by acclamation.

The following paper by Captain Abney, owing to the lateness of the hour, was taken as read:—

### UTILIZATION OF THIN GELATINE PLATES.

BY CAPTAIN ABNEY, R.E., F.R.S.

WHAT I am about to describe is not new, but it has scarcely been given sufficient prominence, I think, and it may be that it may aid in the utilization of thin gelatine plates, which otherwise would not be wasted. I have by me some gelatine plates which are very thinly coated,—so thin, indeed, that when the image is developed right through to the back of the plate the density is far less than it should be. It struck me that it was a pity to waste these plates, since they were exquisitely sensitive and bright, so long as the image was not forced in order to obtain density. The question arose as to whether sufficient density could be given before fixing, and the plates were so transparent that the density could be easily judged by transmitted light. Plates were exposed and developed with ferrous oxalate till an image full of detail was seen by reflected light.