to lift it, and costs about £7. Prints from transfers to a zinc plate are as satisfactory as prints from transfers to stone, and there is no liability of the plate being fractured in the press, which not unfre­quently happens to the stone. The surface of the plate is prepared by scraping it evenly all over with a razor blade in parallel lines, until all irregularities are removed ; the plate is then bent so as to present a slightly convex surface, which is ground with pumice- stone and water, and smoothed with a piece of steatite, and then given a grained surface with sand. It is flattened by being passed through a press, after which it is ready to receive the transfer. The subsequent procedure depends, as in lithography, on the circum­stance that greasy substances do not mix with water and are repelled by gummy substances. The greasy ink lines of the transfer are readily absorbed by the surface of the plate ; then a preparation of gum and decoction of gall nuts (to which a little phosphoric acid is added), applied to the entire surface of the plate, serves to etch the blank ground without affecting the lines of the transfer ; but it prevents the ink from spreading, and also fills up the pores of the blank parts of the plate with a gummy substance, which repels a greasy ink. Printing ink, therefore, applied as usual with a roller to the entire surface of the plate adheres to the inked lines only and can be readily washed off the blank spaces, and then a print taken will show the inked lines only. The tracing for transfer is drawn on paper thinly coated with starch to prevent the graphic writing-ink from soaking into it ; the ink is a mixture of Paris black, Castile soap, white wax, tallow or sweet oil, and shellac, which being greasy is readily absorbed by the zinc. The tracing is laid face downwards on the plate and passed several times under the pressure of the roller of the printing press. It is then wetted and peeled off, the ink remaining on the zinc. The surface of the plate is again washed with the etching liquid, which removes stains from the blank spaces and renders them more susceptible of being equably wetted with water, and also—after a few drops of turpen­tine have been added—removes the unabsorbed writing-ink and helps to fix the lines. The plate is then ready to be printed from. The printing-ink is composed of lamp-black—with a little Prussian blue added—and linseed oil varnish of a thickness depending on the temperature and the subject. Small corrections on the plate can be made by removing the surface with a strong solution of hydrate of potash, and then preparing a new surface to be drawn on by applying dilute nitric acid and afterwards washing off the nitrate of zinc.

Anastatic printing produces facsimiles of any inked print by transfer to a zinc plate, the inked lines on it being absorbed in a greater or less degree by the plate. The print is laid face down­wards on blotting-paper, and brushed with a solution of nitric acid diluted with five times its bulk of water until thoroughly and evenly saturated ; it is then placed face downwards on a zinc plate with a well-grained surface, and passed under the roller of a power­ful copper-plate printing press. The grease of the ink, being set free by the acid, adheres to the surface of the plate ; but, as the amount of ink absorbed is much less than in the case of an ordinary transfer, it is strengthened by working up with lithographic ink, oil, and gum water until the surface is sufficiently strong to bear etching with the usual preparation of gum, nut galls, and phosphoric acid. The plate is now ready to be printed from in the usual manner. If the original print is an old one, it must first have its ink softened by immersion in hot water containing half an ounce of caustic strontia for every pint of water, the time of immersion varying, with the condition of the print, from a few minutes to an hour. A print well worked up is often superior to the original.

Photography having already been described in detail (see vol. xviii. p. 821 ), its application to mapping and map-printing need only be noticed here. The action of light can be employed either by placing the map in contact with a sheet of sensitized paper and against a glass plate in a printing frame, when the light will pass through the map and produce a picture of it on the paper, or by using a camera furnished with an object-glass, through which rays of light from the map are transmitted so as to produce a picture on a sensitized glass plate, which can afterwards be printed from. The best known of the processes in which the camera is not used is the “cyanotype”; the paper is sensitized with a mixture containing nearly equal proportions of solutions of ammonio-citrate of iron and the ferrid-cyanide of potassium ; the prints give white lines on a dark-blue ground, and are very inexpensive. There are other processes of printing with the salts of iron, uranium, &c., which give an exact transcript of the original drawing with dark lines on a white ground. But they are only suitable for maps drawn in pen and ink not larger than the glass plate of the printing frame ; being therefore only serviceable in special cases when few copies are wanted, they are little employed and may be regarded more as curiosities than as ordinary methods of map-printing. Photo­graphy is generally effected with the aid of a camera, and em­ployed to obtain a negative of a map on glass, from which prints may be taken either for use *per* *se* or for transfer to a flat surface of zinc, stone, or other suitable material to print from. The map is usually attached to a board suspended vertically in an adjust­

able frame, while the camera is placed on an adjustable stand set at right angles to the map frame on a tramway, along which it can be moved to any desired distance from the map. The camera is furnished with a ground-glass focusing screen, on which is pencilled a rectangle whose dimensions are proportional to those of a corre­sponding rectangle on the map, in the ratio of the scale of the required photograph to that of the map. The map and the focusing screen are brought into parallelism at such a distance that the image of the rectangle on the map exactly coincides with the rect­angle on the focusing screen. A sensitized collodion plate is then substituted for the screen and a negative taken, which is afterwards “fixed” and “intensified” so as to produce the greatest trans­parence in the lines and an almost opaque density of the ground. Printing from a negative is usually performed by the action of light when only a few copies are wanted, and mechanically when many are wanted ; the prints are taken directly from the negative in the one instance, and from a transfer of the negative to the surface of a stone or metal plate in the other. Of the processes of printing directly from the negative, silver printing, the oldest, is as yet unsurpassed for the delicacy of its results, but it is expensive and perishable ; the prints are taken on paper coated with albumen containing an alkaline chloride, such as common salt, floated on a bath of nitrate of silver, and allowed to dry in the dark. After exposure to light in a printing frame, the prints are washed, toned with a solution of gold, and then fixed in a bath of hyposulphate of soda, which dissolves all the remaining unaltered chloride of silver. At the Ordnance Survey office platinum printing is now (1887) largely used instead of silver printing for all purposes where only a few copies of a map are required. It is more expensive, but the prints are absolutely permanent and are produced more quickly than silver prints. Their rich velvety black colour and freedom from glaze render them peculiarly suitable. The paper is sensitized with a preparation of platinum and ferric oxalate. After exposure to light, the image is developed almost instantaneously by laying the print on a hot solution of potassic oxalate ; it is then washed in successive baths of dilute acid to remove the soluble iron salts, and after that in a few changes of water. Various processes of “collo-chromate” printing are also most usefully employed in map­printing ; they depend on the reaction of the salts of chromium— particularly the alkaline bichromates—on gelatin, gum, albumen, or other colloid substances, which, in proportion to the amount of the action of light upon them, become more or less insoluble in and unabsorbent of water, and acquire the property of taking up greasy ink and not attracting plumbago or other fine dry pigment in powder. When the subject is in line the print is taken on paper that is usually coated with a mixture of gelatin and bichromate of potash, coloured with Indian ink or any other suitable pigment; after a few minutes’ exposure in the copying frame the paper is plunged into tepid water, which dissolves the unaltered gelatin in the blank parts of the print—they have been protected from the light under the dark parts of the negative—leaving a clear image in pigment on a white ground. When the subject is in half-tone, the gelatin film has to be detached from the paper that it may be developed by being washed on the unexposed side, a temporary support being employed to preserve the image from injury during the washing ; the most delicate shades in the half-tones are thus perfectly preserved.

In the processes noticed above it is necessary to repeat the opera­tion by exposure to light for every print produced; the rate of printing will therefore be more or less dependent on the sensitiveness of the paper, the strength of the light, and the condition of the atmosphere. In the processes about to be described these dis­advantages are obviated by transferring the photographic image to a surface of stone or metal, from which prints may be made mechani­cally in any numbers independently of light or weather. The photo-mechanical processes are broadly divisible into two classes,— one comprising photo-lithography, photo-zincography, and photo- typography, for the reproduction of subjects in line only; the other, photo-collotype and photo-gravure, for subjects in mezzo­tint or half-tone as well as line.

Photo-lithography and the analogous photo-zincography are the processes which have hitherto been most extensively employed for map printing. They are the simplest to carry out ; they allow the photographs of several sections of a map which may be too large to be reproduced as a whole to be combined ; and additions and corrections may be readily made by hand on the stone or zinc plate. The prints for transfer from the negatives are taken on paper coated with a mixture of gelatin and potassium bichromate, as in the pigment printing process, except that the greasy ink or colour­ing matter is not mixed with the gelatin, but applied evenly over the surface of the prints after exposure to the light. The inked print is immersed for a few minutes in tepid water to soften the gelatin still remaining soluble in the parts not acted upon by light, and is then laid on a sloping plate and washed with a soft sponge until all the unaltered soluble gelatin and the ink overlying it are removed. The lines on which the light has acted remain insoluble and retain the ink, forming a clear image of the subject in a greasy