

service 2½ tons and for the Berthon 1½ tons. He also considered that cuts or openings were much more easily effected in the Berthon bridge. As to durability, he held that canvas saturated with flexible waterproof paint is stronger for floating bodies and more durable than wood, while the boats are insubmersible, owing to the large quantity of air inhaled into the air cells in the act of opening. Should a hole be torn in the outer skin, the water only enters the wounded compartment. The second application to similar purposes, that is, the use of the light boat with cavalry as was described by Mr. Berthon himself, is for swimming horses and ferrying guns and wagons over rivers.

"This, I have already observed, has been introduced into the armies of Prussia. During the last three years they have been using my tripartite boats for these purposes with perfect success, and the perfection they have reached, not only on the part of the men, but, what is more, of the horses, is really surprising. I was told by an officer of the Imperial Pioneer Guard that he had seen a division of cavalry, 1,800 strong, cross a river in less than three hours by means of six of these pontoon boats. The operation was performed in this way:

"Eight troopers, in two lines, rode into the river—the bottom of which was shelving gradually to the bank—four on each side of one of the boats; they all dismounted on board, with their saddles, arms, etc. Two men at the stern then shoved the boat into the stream; the horses walked till they could no longer touch the bottom, and then by swimming they crossed the river, and the pontoon—now become literally an 8 horse power boat—traveled, without rowing, at a very good speed. Arrived at the other side, the men resaddled, mounted again and rode up the bank. The boat was then rowed back for another trip. Of course, it will be understood that all these horses had been practiced in this maneuver, and, possibly, German horses are more tractable than ours; but I feel convinced that a very little practice would be enough to induce English horses to take to the water as readily as those of Germany; and I submit that this exercise should be included in the training of horses for our cavalry and horse artillery.

"In the Prussian service these pontoon boats are carried on wagons; but such carriages are evidently unfit to follow the rapid evolutions of cavalry and horse artillery. I have, therefore, made a new arrangement for this special purpose, and it has been tried with great success at various places. I cannot say what was done at Aldershot with the light cart and boats, but I know the trials under Colonel Lord Errol at Windsor were considered perfectly satisfactory; and I am happy to say that General Keith Fraser was kind enough to express his entire approbation of what was done under his command at Churn. This modification consists of a 24 foot boat in four sections, each 6 feet long. These are carried on a light spring cart, side by side. When all are opened and united—the work of two or three minutes—a boat is formed 24 feet by 5 feet by 2 feet 6 inches for swimming horses. For ferrying guns, etc., a raft is made by dividing the boat in two 12 foot lengths, and skids 8 feet long are made to rest on saddles on each half boat; two other such skids connect the raft with the shore, over which the gun and limber are wheeled on board; the shore ends are then embarked, and the raft rowed across by men in the bows and steered by others in the sterns. This raft will carry any weight up to three tons. It may be used very conveniently as a 'pont volant' or flying bridge, and it has buoyancy for forty men or more. The weights are as follows

	Lb.
Boat in four parts.....	500
Four skids.....	200
Two saddles.....	40
Over scotches, etc.....	36
Cart.....	560

1,336

Total cart and load, under 12 cwt.

"With two horses this cart can accompany horse artillery anywhere at any speed; and should one horse be disabled, it would be an easy load for the other."

Mr. Berthon afterward suggested that should the ground not allow the passage of wheels, the boat could be placed on the horse's back, and the other left for the empty cart. He then describes a boat 10 feet long, 3 feet 6 inches wide, collapsing to 7 inches, weighing less than 80 lb. The boat is made in two halves, which can be launched in one minute. Including saddle, it makes a 100 lb. load for a horse.

In the discussion that followed, Colonel Hale, R.E., strongly advocated the boats, but urged that for cavalry it was essential to supply a boat that could be carried on a horse's back, ground especially near the rivers to be crossed being often impracticable for wheels.

Admiral Saumarez testified to the success of the Berthon boats as now used in the navy.

Captain Ferguson, Second Life Guards, spoke of the success that had been achieved with the Berthon boat lent to the cavalry, and experimented on last summer. After a little trouble it had been completely successful. The only accident that occurred was that a very violent horse had kicked through both skins in one place, but had only made a hole that was efficiently stopped by cramming in a pocket handkerchief. He thought, however, that a tripartite boat with greater length would be advantageous, because it would be easier to steer it—that is, there would be more power and less liability to be deflected by a horse.

The chairman insisted on the utility of expecting cavalry generally to swim rivers en masse, unassisted. A few exceptional men and horses only would succeed in this, while with the assistance of the Berthon boat, cavalry could depend on crossing easily. He had first heard of this boat from a German colonel, who had congratulated General Fraser on England's having had the start in this matter, and then learned to his surprise that it had escaped trial in this country, and was actually unknown to General Fraser, then inspector-general of cavalry.

THE value of the Vatican, and its treasures, in money would exceed £30,000,000.

THE DUOGRAPH.

THE blind have always excited compassion, and during the last twenty years several inventors have succeeded in constructing writing machines designed specially for their use. We think that we shall interest our readers in presenting them with a figure and description of a new apparatus that is useful not only to the blind, but to all those who are devoted to them and who desire to converse with them by letters about matters of business or friendship.

The object of the duograph, a movable dial with double alphabet, is to permit the blind to write to those who can see, and reciprocally, without any intermediary and without rendering it necessary for either party to study any other alphabet than the one with which each is acquainted.

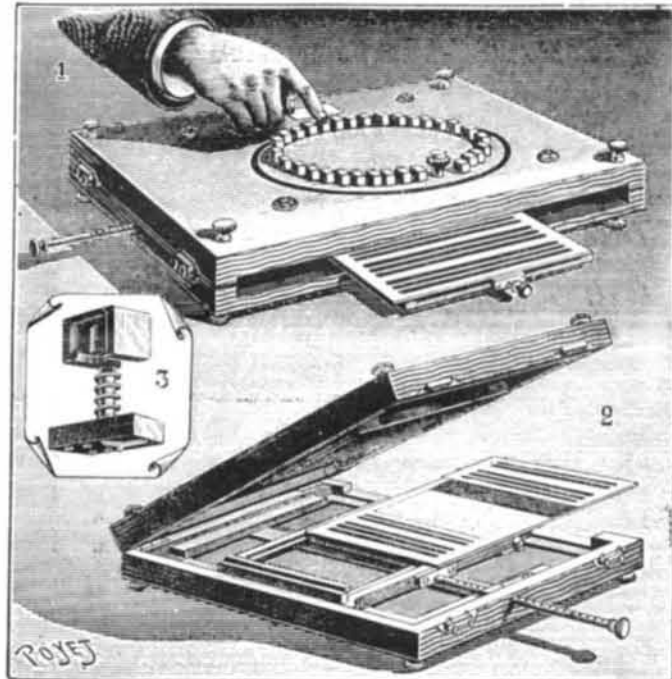
The duograph employs the characters in relief of Louis Braille and the characters in use among those who are able to see.

This ingenious apparatus was devised by Abbot J. Stiltz, almoner of the blind sisters of St. Paul.

The two characters, which are separated upon a dial, are united at the lower part of each type. The maneuvering of the apparatus is very simple and easy. In order to operate it, it suffices to press with the finger one of the rectangular keys that carry the points in relief and to revolve the dial. Each double letter, in passing over a small opening formed in the upper part of the plate that supports the disk descends under the pressure of the finger and prints itself in relief and in color.

At each revolution of the dial a spring acts upon a rack and causes the regular advance, to the distance necessary for each letter, of a tablet upon which is fixed the sheet of paper that is to receive the impression. When the line is finished, it suffices to move the tablet back to its starting point and to cause it to rise by one notch in order to begin another line. This is easily done by means of a rack and a spring placed beneath the tablet. The double character employed requires no more space than the single Braille character. The letter in color, in fact, is placed in the interline.

The accompanying engraving shows the arrangement of the mechanism. Fig. 1 gives a general view



THE DUOGRAPH.

of the apparatus. Fig. 2 represents the corrugated tablet having a double motion, and upon which is placed the paper designed to receive the characters of the double alphabet—one in relief (Braille system) and the other in color (typographical characters) for those who can see. The dotted white portion represents the sheet that is to receive the double impression and the black portion the chemical or tinted paper. Fig. 3 shows the movable double character carrying at the upper part the points in relief and at the lower part both the points in relief and the typographical characters.

The principle of the duograph is applicable in all countries. As it is, the apparatus may be employed everywhere where the Roman character and the Braille system of writing are used.

The apparatus, which is relatively light, of moderate dimensions, and but about an inch and a half in thickness, is easily transportable. Its inventor has endeavored to create a practical system, and the serious testimonials of competent judges permit of the hope that the work will not prove without real utility for the future.—La Nature.

MODERN PHOTOGRAVURE METHODS.*

By HORACE WILMER.

If I take a piece of polished metal, such as I have in my hand—copper for instance—and draw a design upon it, and then remove all the metal round and about the design, so as to leave the latter standing up above the general level of the copper, we shall have in its simplest form a typographic block. Such a block, when mounted on a piece of wood so as to bring it what is called type high, can be inserted among type; can be printed simultaneously with letterpress, and constitutes the basis of the illustrations which we see in books and newspapers. The various methods by which such blocks are made may be described as relief processes, because in them the design or picture is in relief.

If, on the other hand, I take this same piece of cop-

* A paper recently read before the Society of Arts, London. From the Journal of the Society.

per and, instead of drawing and designing upon it as before, I scratch with a sharp instrument, such as a graver, a series of lines, I have in its simplest and most elementary form an engraved plate. Such a plate is no longer capable of being inserted among, and printed simultaneously with, type. It requires a different class of ink, different paper, and a different press in which to take off the impressions.

From the earliest days of photography it has been the constant endeavor of experimentalists to utilize the photographic image for the production of printing blocks, and during the last half century many important inventions having this end in view have been made.

It is not too much to say that at the present time, in regard to book and newspaper illustration, photography is almost exclusively used in the construction of the printing blocks, while in its more pictorial and artistic aspect, i. e., in the manufacture of etched plates, it is now largely doing work which at one time was exclusively the province of the etcher or engraver.

The title of my paper, which is that of modern photogravure processes, will not allow me to linger any further over the subject of modern relief processes, fascinating as it is. The field covered by these processes, the enormous advance which has been made in them during the last few years, and the influence which they will have on the future of journalism, are subjects of the very deepest interest.

I have already pointed out that the method of printing a photogravure, or engraved plate, differs essentially from that of a relief block; and it would be well, before describing how such plates are made, to familiarize you with the appearance of a photogravure plate, and to describe to you the method in which it is printed.

In printing an engraved or etched plate, such as a photogravure plate, the plate is slightly warmed. It is then dabbed over very thoroughly with a stiff ink, known as copper plate ink, until the plate is completely covered, and exhibits nothing but a uniform black surface. The printer then proceeds, with the assistance of a large roll of muslin, and working with a circular motion, to remove all the ink from the surface of the plate; he finishes it by working it with the palm of his hand, and having carefully cleaned the margins

with chalk, it is ready to print. It is now placed face upward on the plate of the press, a piece of paper of special quality—which has been damped and kept under pressure for a time, so as to make it moist throughout—is laid upon it, and the plate and paper are passed through the rolls of a press. The pressure of the roller, which is very considerable, is distributed over the back of the paper, by the interposition of several thicknesses of fine and coarse blanketing. The paper is lifted gently off, and we have now an impression in ink, in thickness corresponding with the actual depths of the various parts of the picture. The picture is really a cast in stiff ink, showing in varying thicknesses of ink the varying tones of the picture.

Briefly speaking, this is the method in which an intaglio or photogravure plate is printed, and the method applies to every form of engraved plate, whether produced by photography or otherwise.

You will no doubt have imagined to yourselves, from what has been described, that the surface of a photo-etched plate consists in a number of depressions, deep where the heavy shadows are, less deep in the half tones, until we reach the level of the original copper, which represents the high lights.

To a certain extent, this is correct; but were it absolutely true, the making of a photogravure plate would be a much simpler matter than it really is. Such a plate, however, would be useless, because it would not yield a print at all, and for this reason: the surfaces etched are large; the depths of etching are extremely small, and so also the difference between the depth of the tones. The consequence is that although it would be easy enough to cover such a plate with ink, the roll of muslin would inevitably wipe out all the ink again from these shallow depressions. It is therefore necessary to break up, by some means or another, the whole surface of the plate; so as to form not only large areas of shallow depressions, but to cover these portions with a series of honeycombs, or cells, which shall imprison the ink and resist the tendency of the muslin to sweep it out.

The means by which these cells or honeycombs are formed are called the grain, and the matter is one of the deepest importance, because the success of the resulting picture, the superiority of one process of

photogravure over another, depends very largely indeed on the question of grain.

There are many methods by which a grain is imparted to a plate. Its action consists in protecting the copper, wherever it exists, from the action of the etching fluid. The etching goes on among and around the grain, but wherever the small particles of grain exist, a small pinnacle reaching to the original level of the copper is maintained, and thus forms the honeycombs or cells described.

No half tone intaglio plate can be printed at all unless it possesses a grain of this sort. An artist's etching, with which you are all familiar, is composed of lines entirely, and these lines being deep and narrow there is no tendency of the muslin to wipe out the ink. In the case of a mezzotint plate, however, a grain is given by means of a rocker. The plate is, previously to its being worked, pitted all over and in all directions with a toothed instrument known as a rocker, so that, if inked up, it gives one uniform black impression; the half tones and high lights of the picture are afterward put in by means of a burnisher and scraper.

You will see, in the diagram which I now show on the screen, the appearance of a photogravure plate if it were prepared without a grain. The second picture shows a plate which has been grained with the picture over it, and the third a typical section of an etched photogravure plate.

I also show on the screen a slide exhibiting the actual grain itself. In the process which I am about to demonstrate to you, the grain is given by allowing a very fine dust of bitumen to settle all over the plate. The plate is then treated sufficiently to attach these tiny particles to the plate, and they protect the copper wherever they exist from the action of the etching fluids.

In order to get the finest results from photogravure it is obvious that we ought to have the means of etching as deeply as we can in our deepest shadows, but in doing so a practical difficulty comes in. In proportion as we etch deeply so we etch laterally, and if the etching is carried beyond a certain point a danger arises of carving away the summits of these important little pinnacles of grain on which the whole success of the printing depends. The coarser the grain is in the first instance the less is the danger, but inasmuch as the beauty and delicacy of a proof depends on the grain being as fine as possible—because each of these little pointsprint as a white speck—it is clear that the ideal grain is one which shall be graduated in coarseness, in proportion exactly to the depth of etching which it is to represent. That is to say, we require to produce the finest results a discriminating grain coarser in the deepest shadows, finest in the highest lights, and graduated throughout the picture, and I shall presently refer to certain methods in which a discriminating grain forms part. This question of discriminating grain is one to which a great deal of experimental work has been devoted.

The question of grain, generally, is of so much importance that it dominates all other considerations. Every advance and improvement that has been made in connection with the methods of intaglio work have depended upon this special factor. In the editorial article of the British Journal Almanack of 1893, Mr. Traill Taylor puts the matter very clearly. He says:

"In truth the subject is of great importance, for whereas it is by no means difficult to convert a negative having lights and shades into a surface having such lights and shades converted into reliefs and hollows, it is not always easy to impart to a printing surface of this nature such a degree of granularity as on the one hand will hold enough ink as to enable a good impression to be obtained therefrom, or on the other hand to give it so pronounced and coarse a grain as just stops short of destroying all the fine details. Large industries and vested interests depend upon this matter of grain, to the successful selection or application of which several firms are indebted for their eminence."

The possibility of utilizing the methods now in vogue for the production of screen negatives appears to be of special interest in this matter, and indications are not wanting that perhaps in the near future transparencies broken up by means of a screen might be used and an artificial grain obtained by these means.

There are many methods by means of which photogravure plates can be made. The Klic process, of which I propose to give a practical demonstration later on, is, owing to its simplicity and the results which it gives, very largely used both in England and all over the Continent. You will see round the walls examples of work by several English as well as Continental firms, and I have no doubt that many of these are done by the process in question. Briefly speaking, in the Klic process a transparency is employed, and a print from this is made on carbon tissue. For the information of those who do not know what is meant by carbon tissue, I will explain that it is paper coated with a solution of gelatine containing bichromate of potassium. This salt invests the gelatine with the extraordinary property of insolubility after exposure to light. If, therefore, paper so coated is exposed under a negative or transparency, the gelatinous film is rendered insoluble, in proportion to the intensity of light action, and when it is soaked in warm water, owing to the dissolving away of the portions unaffected or less affected, a picture in relief is obtained in which the shadows are either depressed or elevated, according to whether a transparency or a negative has been used.

In the Klic process, the copper plate is grained, the carbon-exposed picture is mounted on its surface, and, after development and drying, the picture is etched by means of perchloride of iron. There is no means in this instance of giving a discriminating grain.

A method described by Bonnet in his book, "Manuel d'Héliogravure," published by Gauthiers-Villars & Company, of Paris, and which, with some modification, I have worked myself, consists in the following: A copper plate is coated with the bichromatized gelatine solution and dried over a heated surface by means of a whirler. It is then exposed under a transparency, and, after exposure, is developed in warm water. When it is considered to be sufficiently developed, because no image is visible, I soak it in a solution of Judson's violet dye, and this will bring out the picture. It is then grained over the film, after it

is dry, and, in the first instance, a somewhat coarse grain can be given. The picture is then etched, the shadows will be first attacked, and, after a certain time, the etching is arrested, and the film is cleaned off. The whole operation is repeated, and a finer grain given, when the etching is carried somewhat further, and, for the third time, the grain given is very fine, and the etching carried to conclusion. Careful methods of registration are required. You will see that in this case a discriminating grain is rendered possible. The process, however, is much more tedious than the Klic process, but it contains the germs of success.

The methods to which I have referred consist in the etching direct of a copper plate, through a photographic picture previously mounted on its surface. There is, however, another class of methods, which consist in building up a plate upon a relief by deposition of copper in a battery. Colonel Waterhouse published some years ago a method of doing this. A gelatinous film, which has been exposed under a negative, and in which, therefore, the portions representing the shadows are raised, while the high lights are depressed, is sifted over, while still wet, with sand. The sand is prepared previously, by heating it with wax, and stirring it until cold, so that each grain of sand is enveloped in a coating of wax. The grains of sand sink more deeply into the thick parts of the gelatine picture, and less deeply into the thin parts, so that when the film is dry and the sand is brushed out, the picture, as represented by the film in relief, is pitted all over with a grain coarse in the shadows, and getting finer as it approaches the high lights. The film is then rendered conductive, by brushing over with plumbago, and a copper cast is formed by it in a battery. The cast forms the photogravure plate.

There are many processes other than those I have mentioned for the production of photogravure plates, and I would refer any one interested in the subject to the editorial article of the British Journal of Photography for 1893. I am indebted to the excellent description, given there by Mr. Traill Taylor, for such information as I do not possess from practical knowledge.

I should like to take this opportunity for congratulating this society on their action in offering certain prizes for the encouragement of photogravure in this country. The world has been largely indebted to the efforts of an Englishman, Mr. Fox Talbot, for the advance in the methods of producing photogravure plates; and it seems strange that at the present moment the English market should be supplied almost entirely by Continental productions. The works of Messrs. Goupil, the Berlin Photographic Company, M. Dujardin, of Paris; Dr. E. Albert, of Munich; Paulsen, of Vienna, and others, are to be seen everywhere, but, up to the present, English firms have hardly entered into the arena, in spite of the magnificent paintings in our national collections waiting to be reproduced.

I propose now to proceed with the demonstration of the Klic process of photogravure.

The negative selected for reproduction should be as perfect as possible; but, inasmuch as a reversal transparency is required, it is usual to make this by means of the carbon process. The tissue known as transparency tissue, and sold by the Autotype Company, either in a sensitive or unsensitive condition, is the best to employ.

I prefer to purchase the tissue in its unsensitive condition, and sensitize it myself as required. This is done in a 3 per cent. bath of bichromate of potassium, and the tissue is then dried on plate glass in a drying box. The ventilation of the box should be such that the tissue will dry in about five or six hours. The negative is masked, and the tissue exposed and printed. The exposure depends, of course, on the density of the negative, but it is generally somewhat long, owing to the large quantity of pigment contained in the gelatine. The tissue is mounted on glass and developed, and, when dry, is masked in the same way as the negative.

The picture, which is to be mounted on copper, and which is to form the resist through which the etching takes place, is also printed on carbon tissue, but in this case we use either one of the ordinary brands of carbon tissue, such as the standard brown or the purple, or, in preference, a special tissue made by the Autotype Company, and known as autogravure tissue. This is printed under the transparency, and, in order to insure as correct an exposure as possible, a trial print is made and mounted on matt opal glass. An inspection of this after development will show if the correct exposure has been given. The picture is of course negative in character, having been produced from a transparency.

The copper to be used should be manufactured out of specially good metal, be highly polished, without flaw or scratch, and should be beveled. Such plates can be obtained already prepared, and cost about 1d. per square inch.

The plate is cleaned by means of a soft pad of prepared cotton wool, moistened with a cream of double washed whiting made into a paste with water containing a little dilute ammonia. The solution should not exceed 5 per cent. in strength. The plate is cleaned by circular rubbing. The whiting is either washed off or wiped off with cotton wool, and it is well to put the plate into water containing a few drops of sulphuric acid, say one drachm of acid to one pint of water. Wash and dry the plate, and it is ready for graining.

The grain commonly used is powdered bitumen, although any gum which can be reduced to a very fine powder and which will resist the acid is suitable. Powdered resin can be used, and it has been recommended to use a mixture of resin and bitumen, but since the plate has to be heated and these gums melt at different temperatures there is a difficulty in fixing them both on the plate, at least by heat.

A box containing the grain, such as you see here, is revolved slowly in order to set all the dust in motion. The sides and top are well struck to detach any particles which may adhere, and which would cause trouble by dropping on the plate while in the act of graining. The box, after 15 to 20 revolts, is brought to rest, and allowed to rest for a time before the plate is inserted. The period of rest determines very much the character and coarseness of the grain. The heaviest particles fall first, and if the box is allowed to rest for say one

minute before the plate is inserted, the grain will probably be pretty fine, but a few experiments will soon show. It is allowed to remain in for some three or four minutes, and is then removed. The plate, it should be said, should be inserted in the box resting on a glass plate larger than itself, and be supported a little above the bottom of the box.

Probably one graining will be insufficient, and it will be necessary to repeat the process perhaps twice before enough grain is on the plate. It is well, when first starting the process, to put on a fairly large quantity of grain, so as to be sure of not running a risk of biting away the grain. The plate is now nipped in a hand vise or pliers, and heated over a gas flame until the grain is heated, and has tacked itself on to the plate. This occurs when the plate appears when looked down upon to have lost all its grain, and when examined by reflected light with the eye low down appears a steely gray. The plate is allowed to cool, and the negative carbon resist previously described is then mounted upon it in the ordinary way. When mounting the tissue, allow it to soak very thoroughly before squeezing it on to the plate.

After it has been squeezed, put a few sheets of blotting paper over it and a heavy weight and allow it to rest for a quarter of an hour or twenty minutes, more won't hurt.

It is then developed in water at about 100° Fahr., the temperature of the water being raised to 110° Fahr. while the back is stripped off. Develop thoroughly, so as to get rid of all insoluble gelatine, and then allow it to dry spontaneously, or else dry off by methylated spirit.

When it is thoroughly dry, and this is an important point, it is ready for the margins. The marginal lines are ruled with an ordinary engineer's pen, charged with stopping out varnish, and the edges and back carefully painted.

The plate is now ready for etching. The mordant consists of perchloride of iron. It is used in solutions of varying strength determined by means of a Baumé hydrometer. The solutions generally used range from 43° Baumé, being the strongest, to about 30° Baumé, being the weakest, and some five solutions of strength, say 43, 40, 38, 34, 30, may be used. When first made up, the solutions act too energetically, and the older they are the better probably will they work. Anyhow, when you get a set of solutions that are working well you may look upon them as valuable. It is well to add say 5 per cent. of methylated spirit to each solution. It works then with greater regularity. The action of the etching is as follows: The negative resist, which is on the copper plate, consists of varying thicknesses of gelatine. In the shadows the film is extremely attenuated, in the high lights it is at its thickest.

A solution of perchloride of iron, graduated to 43° Baumé, can only penetrate the very thinnest solution of gelatine. If we start, therefore, with this, it will, provided the film in the deepest shadows be sufficiently thin, commence to penetrate and attack the copper underneath. It is left for say one minute after the etching is commenced, when it is poured off and the next weaker solution used. This having greater penetrating power, will attack the next tones, while at the same time it cumulates the etching in the deepest shadows—and so on each solution as it is put on, bringing out fresh detail and at the same time increasing the work done by the previous ones. The total time of etching will vary from ten minutes onward, but the exact time which each solution is allowed to act depends on a variety of considerations, and the exact knowledge can only be acquired by practice. It is a good rule to allow each solution to act so long only as it finds out and brings out fresh detail. So soon as its action appears to cease, and it appears to be only etching downward instead of onward, it is time to go on to the next; the last solution will bring out the sky, and the picture will apparently blacken all over. It is then time to take it out and plunge it into a bath of potassium carbonate and water. This converts the perchloride into carbonate, and the film can be well rubbed off with the finger. The plate is then well washed, dried and cleaned off with benzole, which will remove the bitumen. Follow this with turpentine on cotton wool, then a little methylated spirits applied in the same way; and, lastly, clean with the weak ammonia solution and a little of the whiting cream. Use it very thin, so as not to rub down any of the fine detail, wash the plate and immerse again in the weak acid, as at first, and your plate should be then ready for printing.

A little dry whiting rubbed over the plate with the finger will adhere wherever ink will, and will give you some idea of the printing value of your plate.

SOME MODERN METHODS OF LIGHTING COMPARED.

THIS was the title of a paper contributed to the last meeting of the Carlisle Architectural, Engineering, and Surveying Society by Mr. Thomas Glover, who has just received the appointment of engineer and manager of the West Bromwich Corporation Gas Works. Starting with a brief history of the origin and extent of gas lighting, Mr. Glover defined the necessary qualities of artificial light to be steadiness, reliability, convenience, safety, and freedom from all injurious properties likely to cause air pollution or injury to health. A table exhibited demonstrated that all illuminants, with the exception of the electric light, caused air pollution; but contrary to ideas prevalent in many people's minds, gas caused the formation of less carbonic acid, light for light, than either oil or any description of candles. Apart from the question as to the method adopted for lighting an apartment, in order to secure a sweet atmosphere, it was necessary to have some method of ventilation; and a simple plan was described which might be used for ordinary living rooms. The propriety of enriching a poor gas of say 15 candle power to 19 candles by means of canal costing 1½d. per candle per 1,000 cubic feet was held to be questionable; but there could be no doubt as to the wisdom of enrichment by means of oil gas at ½d. per candle per 1,000 cubic feet. The importance of good fittings was shown in a striking way experimentally; and the desiderata for a good burner were enumerated. Attention was bestowed upon the use and advantages of governors, fixing these on the