THE TREATMENT OF PAPER FOR SPECIAL PURPOSES

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TREATMENT OF PAPER

FOR SPECIAL PURPOSES

A PRACTICAL INTRODUCTION TO THE PREPARATION OF PAPER PRODUCTS FOR A GREAT VARIETY OF PURPOSES

SUCH AS

PARCHMENT PAPER, TRANSFER PAPERS, PRESERVATIVE PAPERS, GRAINED TRANSFER PAPERS, FIREPROOF AND ANTIFALSIFICATION PAPERS, POLISHING PAPERS, TRACING AND COPYING PAPERS, CHALK AND LITHO TRANSFER PAPERS, LEATHER PAPERS, LUMINOUS PAPERS, TORTOISESHELL AND IVORY PAPERS, METAL PAPERS, COLOURED PAPERS, ETC. ETC., AND PAPER ARTICLES

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WITH FORTY-EIGHT ILLUSTRATIONS

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PREFACE

Of all the materials now in extensive use, paper is probably the one attracting the greatest attention, by reason of its manifold application to the production of useful articles. Thin sheets of paper are now made up, not merely into articles that retain the characteristics of the material, in some cases coated or coloured, but also into others in which the original material has disappeared, homogeneous solid substances being formed that are capable of competing with wood or iron in point of durability and elasticity. Instructions for working paper up into a great variety of articles are to be found in a large number of books and periodicals; and the author has undertaken the task of collecting and sifting them, in the hope that the result will prove beneficial to all trades in which paper is used as a raw material.

LOUIS EDGAR ANDÉS.

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THE TREATMENT OF PAPER FOR SPECIAL PURPOSES

CHAPTER I.

Parchment Paper, Vegetable Parchment.

PARCHMENT paper is the name given to paper that has undergone such modification by treatment with sulphuric acid that it no longer softens or separates into its constituent fibres on being immersed, or even boiled, in water, but retains its coherence, is impervious to water and air, and preserves its newly acquired properties when re-dried. The parchmenting process by which this change is effected is based on the power of sulphuric acid to convert the superficial strata of pure cellulose into a gelatinous mass, which forms a protective coating for the rest. This gelatinous mass is a substance, amyloid, similar to starch, and when subjected to the continued action of sulphuric acid undergoes further conversion into a gummy substance, wood dextrin. Amyloid therefore appears to be that conversion-product which unites the fibres so firmly and intimately as to convert them into a coherent mass which has entirely lost the property of solubility in water, and at the same time has considerably modified the longitudinal and transverse extensibility of the fibres, whereby their strength is greatly increased. If a strip of unsized paper be dipped in sulphuric acid the fibres swell up and become coated with the aforesaid gelatinous envelope, which extends throughout the entire mass if the exposure to the acid be sufficiently prolonged. According to Hoffmann, amyloid is still imperfectly known, being regarded by some chemists as a kind of cellulose, and by others as an intermediate stage between starch and cellulose. Any one desiring to prepare amyloid as a matter of scientific interest can do so by treating 1 part of pure cotton with 30 parts of dilute sulphuric acid (4 parts of acid to 1 of water). The cotton speedily dissolves, and at the end of about half a minute forms a stiff gelatinous mass, which gradually becomes more fluid, so that in 15 minutes it attains the consistency of syrup. On treating this with water, amyloid separates out as a white, flocculent, gelatinous substance in which no fibrous structure can be detected. If the acid mass be left alone for some time longer, it gradually changes into dextrin and sugar; and if the addition of water be delayed until 7–8 hours have elapsed, only a very small quantity of flocculent matter will be precipitated. In presence of acids and alkalis, amyloid behaves just the same as vegetable fibres, differing from these merely in its lack of structure, and from starch inasmuch as the blue coloration imparted by iodine can be removed by washing with water. When mixed with a sufficiency of water, amyloid has a glutinous appearance, and if spread out on a sheet of glass will dry to a thin, tough, transparent film. If dried on paper it does not adhere to the latter, but can be readily detached, though when deposited direct on paper from its solutions, as is done in the preparation of vegetable parchment, it remains unalterably combined with the fibres. Under the microscope the fibres of vegetable parchment can be plainly seen to be enveloped in a thin, transparent skin, and it is perfectly certain that, through the action of the acid, the fibres have received a coating of amyloid, from the fact that the superficial layer is stained blue by iodine, whilst the interior retains its shape unaltered, even in the case of the finest flax fibres. Unsized paper dipped in dilute sulphuric acid at ordinary temperature immediately becomes coated with a gelatinous film, and in the same way the surface of the individual fibres will suffer alteration if time be given for the acid to penetrate. On removing the paper from the acid bath and dipping it in water containing ammonia or caustic soda, the influence of the acid is stopped, and the acid mass separates into amyloid, which unites the fibres to a dense mass, and sulphuric acid which is eliminated by washing. The gelatinous film covering the surface of the paper facilitates the setting of the fibres together in drying, by permitting the escape of the water vapour expelled from the interior, but retarding the penetration of the air by which the water would otherwise be replaced. This behaviour explains the dried, transparent appearance of many kinds of such parchment.

Filter paper that has been washed with hydrochloric acid and hydrofluoric acid may be regarded as almost perfectly pure cellulose. If this, when dried, be impregnated with 50 per cent. sulphuric acid it furnishes a transparent, gelatinous mass, which will retain its appearance unchanged for any length of time. At 100° C., or even below that temperature, conversion into dextrin occurs very rapidly. When thoroughly washed this colloidal cellulose, for so the mass may be termed, will dissolve in pure water. The removal of the final traces of acid is facilitated by washing with ordinary alcohol, and drying at a gentle heat. When the mass is taken up with water it forms a rather milky fluid, which filters readily, and thereafter will not deposit any sediment, even during several days, but readily undergoes alteration on boiling. By the aid of a new Laurent compensator, it was ascertained that a 4-inch stratum of the solution of colloidal cellulose deviates the plane of polarisation $\frac{3}{4}°$ to the right. In contrast to the achroö-dextrins this colloidal cellulose is thrown down from solution by very small quantities of extraneous substances: sulphuric acid, nitric acid, common salt, sodium sulphate, etc., as well as by a sufficiency of alcohol. When dried on marble coated with vaseline, the colloidal cellulose gives a lustrous, semi-transparent film, which dissolves completely in cold water. A very short immersion in sulphuric acid of 69° B. density (or a little longer if the density be 55°), renders the colloidal cellulose insoluble in that acid, a small quantity of dextrin being formed at the same time. The substance may also be nitrated under the same conditions as ordinary cellulose. The properties of colloidal cellulose afford an explanation of many circumstances noticed in making parchment. Certain very thin vegetable parchments will cede colloidal cellulose to boiling water, which is not the case with the thicker kinds, owing undoubtedly to the fact that a stronger acid is used in making the latter, the colloidal cellulose, which is also formed in this case, becoming insoluble. To some extent vegetable parchment forms a tissue of ordinary cellulose, the pores of which are filled with colloidal cellulose. That this is so can be demonstrated by applying colloidal cellulose to ordinary filter paper on both sides, allowing it to dry slowly, and then passing it through a calendering machine between two sheets of polished zinc. The resulting product exactly resembles vegetable parchment that has been satinised in the same way. Colloidal cellulose differs from any natural product that has hitherto been examined.

The alterations sustained by vegetable parchment, in comparison with the paper from which it is made are somewhat extensive. For instance, the strength is increased three- or four-fold, whilst at the same time the sp. gr. increases by 32–42 per cent., and the thickness shrinks 34–37 per cent., a certain proof that the individual particles of the paper move closer together during the process. This increases the homogeneity and transparency, and consequently the resemblance to animal membrane and true parchment, a circumstance to which the product owes its distinctive name.

It is an essential preliminary to the production of parchment paper that the paper forming the raw material should be perfectly free from any substances capable of retarding the process or jeopardising the formation of a uniform product. For this reason the paper used must neither be sized nor contain any mineral substances whatsoever. Long staple paper, made from rags, is the best material, though wood pulp and straw pulp are not precluded. Sulphuric acid is generally used as the parchmenting reagent, though solutions of ammoniacal copper oxide or zinc chloride are employed as being capable of effecting the same transformation.

To ensure success it is necessary that the parchmenting solution should be of a certain concentration, and used at a certain temperature; and it may be conveniently mentioned here that these conditions are fulfilled by the use of 9–9½ parts of English concentrated sulphuric acid, or the undiluted chamber acid (60° B.), at a temperature not exceeding 10° C. The acid-free zinc chloride solution, obtained by dissolving zinc in hydrochloric acid, should be concentrated to the consistency of syrup, and employed at a temperature which may range from 50–100° C. according to the actual concentration.

The time allowed for the action of the parchmenting reagent is an important factor, and depends—apart from the nature of the liquid—on the thickness and composition (material) of the paper; pure, thin paper for instance requiring only 3–5 seconds, whilst thicker paper will take longer (up to 12 seconds). The action of the acid must be stopped immediately the proper exposure has been given, by a thorough washing, supplemented by neutralisation with alkaline lyes, or the like, the paper being dried after a final washing with pure water. The necessary precautions to adopt in order to prevent the paper from wrinkling will be referred to later on.

To obtain a dense, strong parchment, care must be taken to see that the alteration is confined to the surface of the fibres, and that the paper employed is not porous, as this would furnish a weak, though dense product. A thin, firmly twisted cotton thread, for example, will receive a greater accession of strength by treatment with sulphuric acid, than a loosely twisted one of twice the thickness. Thin, dense cotton material, the fibres of which have been forced closely together by pressing before putting them through the acid treatment, will yield an article of such strength that in many cases it can be used as a substitute for leather, and when made supple by greasing is capable of numerous applications.

At the present time paper in sheets is rarely used for making parchment paper on a manufacturing scale; and the operation of dipping the paper in the acid bath is almost invariably performed by machinery. A sufficient length of unsized paper, mounted on rollers, is introduced into a lead or glass tank, and is passed round a lead or glass roller, through the acid bath. Before leaving the tank the dipped paper traverses a pair of squeezing rollers, to express the surplus liquid, and is afterwards led through a series of washing tanks supplied with a constant flow of fresh water. To eliminate the last traces of acid, the paper is finally passed through a washing tank, the water in which receives an addition of alkali at intervals, and the operation is completed by rinsing in pure water. The more effective the washing before the paper reaches the neutralising tank, the smaller the consumption of ammonia; and it is therefore to the interest of the manufacturer to wash the paper so completely as to render the use of ammonia a supplementary, rather than a necessary, precaution. After the final rinsing the paper is passed through a pair of felt rollers, to remove as much of the water as possible, and is then stretched between layers of dry felt on a drying cylinder, from which it is removed before it becomes quite dry, and is smoothed between rollers heated by steam. During the drying process it is essential that the parchment paper should be kept well stretched transversely, since it shrinks much more than ordinary paper, and would otherwise become uneven. Very thick parchment paper is made by passing two separate layers of paper through the acid bath, then uniting them in front of the first pair of rollers before entering the washing tanks, and passing them together through the pressure rollers. In this way the two layers will adhere so firmly together that they cannot afterwards be separated.

The peculiar properties of parchment paper render it suitable for numerous applications, such as legal and other documents, insurance certificates, banknotes, drafts, important records, and in fact all documents whose preservation is a matter of importance. One method sometimes adopted for preserving these documents against fire is to pack them in strong boxes, which are then allowed to become encrusted with crystals of alum or some other salt. In the event of fire, the water of crystallisation is converted into steam, which protects the parchment paper documents more effectually from destruction than if ordinary paper had been used. Parchment paper is also far better able to withstand insect ravages than ordinary paper; and this power may be still further increased by incorporating certain compounds (mercury salts, for example) with the paper before it is treated with acid. It can also be recommended for making banknotes, since the lettering on paper that has been parchmented after printing can no longer be scratched out without entirely destroying the substance of the paper itself. Another advantage of parchment paper is, that writing on such paper is very difficult to remove and replace by fresh text, so that a considerable degree of security is afforded against falsification. Owing to its strength and durability, parchment paper is adapted for plans, especially those made for building purposes and exposed to wet weather and careless handling. The thin, transparent sheets make very good tracing paper. Parchment paper can also be largely used for binding books, being durable and of excellent appearance. This latter quality also characterises books, cards, etc., made of the same material, the paper being printed after being parchmented, since it shrinks under the acid treatment. Parchment paper readily absorbs printer's ink, as well as ordinary writing ink, and it will fix dyestuffs in general more readily than calico does, for instance. There is no need to expatiate on its usefulness for covering glasses and other vessels containing substances liable to deterioration, such as preserves, extracts, etc., for wrapping fatty products or the like, for capsuling corked bottles, and so forth. Furthermore, it serves for wrapping tobacco and other substances, to prevent the escape of contained moisture or the absorption of moisture from the air. Still further applications are for luting the joints of stills and other apparatus, making small bags, the edges of which are cemented with gelatine, for cooking and steaming food, etc.

The properties of parchment paper are detailed by Kletzinsky as follows:

"Vegetable parchment is unaffected by caustic potash, and will also resist the action of cold acid better than animal membrane. Experiments have shown that parchment paper forms just as good a covering for receptacles as the best animal bladder. Hot, concentrated hydrochloric acid will dissolve phyto-parchment to glucose, apart from a small fibrous residue."

When vegetable parchment is soaked in water, which is then heated to boiling and treated with sulphuric acid, a somewhat violent reaction ensues, and if the resulting dark brown acid pulp be at once diluted with water, a slightly coloured solution of sugar is obtained that can be freed from sulphuric acid by adding milk of lime. The precipitated gypsum carries down with it the undecomposed particles of paper, and clarifies the liquid, which can then be treated for the production of alcohol. If the manufacture of parchment paper should ever attain the degree of importance it deserves, the waste products will easily find a more suitable application than conversion into spirit.

Given careful preparation and sufficient washing, no increase occurs in the weight of the paper, the amount of sulphuric acid retained being imponderable; and consequently the remarkable and technically valuable alteration sustained by the paper in the acid treatment is purely molecular. Equally surprising are the shrinkage and contraction set up in the process. The paper becomes slightly thicker, but its superficial area diminishes by 10–30 per cent. according as the exposure to the acid bath ranges between 10 and 15 seconds; this shrinkage being in no way compensated by the slight increase in thickness, the augmented strength is at once explained on a physical basis.

With regard to the use of parchment paper for closing glasses containing alcoholic liquids, the following statement is made: A wide sugar-glass was filled half full of strong spirit, and then tied up with moistened parchment paper. When dried, it set as firm and hard as pig's bladder. After the vessel had stood in a warm place for three weeks, only a very small quantity of the alcohol had evaporated: in fact, the strength of the spirit had increased to a small extent (about $\frac{1}{2}$ a degree). This is not difficult to understand when it is remembered that both paper and bladder are more permeable to water vapour than to that of spirit.

The behaviour of parchment toward white or fuming nitric acid, of sp. gr. 1·4–1·6, is important. If a sulphuric parchment be dipped in such acid for 10 minutes at least, and then washed thoroughly with water, it will be found to have increased 10–20 per cent. in thickness, and to a considerable degree in strength, the shrinkage of superficial area being much smaller. When washed and dried under moderate pressure it exhibits a perfect resemblance to parchment, with greatly increased powers of resistance to mechanical abrasion and atmospheric influences. When dried and re-dipped in dilute sulphuric acid this nitro-parchment becomes glass-clear and transparent, besides being more resistant to acids. On the other hand, it dissolves to a golden yellow solution in boiling caustic potash, and like all other nitro-compounds it burns readily like touch-paper.

Experiments have been made to determine the comparative strength of parchment paper, ordinary paper, and animal parchment. With this object, test strips of parchment paper and parchment were cut to a length of 22·2 mm., the ends being then clamped to horizontal cylinders, so as to form a loop of the material in each case. Through each loop was passed a small wooden cylinder, fitted at the ends with small cords supporting a pan for the reception of weights, and the pans were weighted until the test strips broke. A series of these trials showed that parchment paper has about five times the strength of the paper from which it is made, and that parchment paper is about three-fourths as strong as ordinary parchment of equal thickness. It was also found that the strips of parchment paper are very unequal in thickness, considerable differences in this respect being observable even in strips cut from one and the same piece.

Although parchment paper may be inferior to the real article in point of strength, it is far superior in its power of resisting the influence of chemical reagents, water in particular, for whilst it absorbs an equal quantity of that liquid and becomes perfectly soft and flexible, it can be left in contact therewith for several days, and even boiled, without suffering in the least.

When dried again it regains its original appearance and strength. Ordinary animal parchment on the other hand is soon attacked by boiling water, and is gradually changed into gelatine. Even at the ordinary temperature it is very prone to putrefy in presence of moisture, whereas the non-nitrogenous vegetable parchment can be exposed to moisture without suffering the slightest alteration.

From experiments made by A. Sudicke with parchment paper from the Helfenberg Works, near Dresden, it appears that paper in the course of transformation into vegetable parchment increases in thickness by about 34–44 per cent., and by 32–42 per cent. in specific gravity. The strength of the crude paper was $2\frac{3}{4}$–3 lb. per sq. yd., and that of the finished parchment paper $10\frac{1}{4}$–$12\frac{1}{4}$ lb.

For many purposes it is necessary that parchment paper should be sized; and tubes of this paper intended to replace sausage skins, require to be fastened with some adhesive, the provision of which was found somewhat difficult at first, until Jacobsen succeeded in devising a suitable preparation. The reliability of this preparation was tested in a large sausage factory in Berlin, some two million tubes being tried.

When several sheets of parchment paper are gummed together, they form an extremely strong material, greatly resembling real parchment, and valuable to the bookbinder. Again, parchment paper gummed on to packing cloth makes a waterproof wrapping that should find extensive application.

Since sealing wax will not stick on the smooth surface of parchment paper, Eckstein recommends that circular holes should be punched in the paper intended for wrappering, and the spaces thus formed filled with ordinary paper pulp before drying, thus producing a surface to which the wax will adhere. This is the method used in making durable envelopes for sending articles of value through the post.

The close texture of parchment paper renders it suitable for photographic purposes, since it will yield pictures with clearer detail and economise the consumption of gold and silver salts.

White opaque parchment paper closely resembles real parchment that has been coated with lead oxide. In both cases any writing on the surface can be easily removed.

Sheets suitable for inlaying can be prepared by parchmenting paper that has been printed with lines and veins, in imitation of ivory, from a copper plate. It has also been proposed to make playing cards of parchment paper, and to cut the same material into thin strips for the production of light, plaited hats.

According to Neumann, the calcium or magnesium chloride, formerly used for making parchment paper flexible, can be replaced by potassium, sodium, and aluminium acetate, phosphorus salts, common salt, or a mixture of soft and glycerine soaps.

To distinguish between real parchment paper and imitations, E. Muth recommends that strips about half an inch wide should be dipped for a short time in hot water. The real article remains almost as strong as it was when dry, and when torn the edges are as smooth as though cut, showing a zigzag appearance under a magnifier. The imitation paper softens and weakens, and the torn edges clearly show the fibres embedded as in ordinary paper.

Another test is by dipping the papers in saturated lime water, sized papers being first washed with hot water. Under this test, white parchment paper made from cotton fibre retains its original colour, whilst pergamyn, or paper made from sulphite (wood) pulp, takes on a brownish yellow colour, and remains so when washed. Wood pulp paper can be recognised by the red coloration it gives when tested with a solution of phloroglucin in hydrochloric acid.

The presence of lead in parchment papers is sometimes revealed by the black colour imparted to cheese that has been wrapped in paper of this kind. F. J. Herz found lead in five specimens of parchment paper, containing respectively 32, 50, 66, 282, and 2700 mgrms. of lead per kilo. The last specimen discoloured cheese in 1–2 days, whilst No. 4 turned black in a few days, and after 8–10 days imparted some of this coloration to the cheese. In the other three specimens no blackening was observed. Since the lead was traced to the sulphuric acid used in parchmenting the paper, it is evident that makers should be very careful to use none but lead-free acid when making papers intended for use as a wrappering for foodstuffs.

MAKING PARCHMENT PAPER.

According to Jacobsen, the sulphuric acid used should have a concentration of 59–60° B., since weaker acid will not effect the transformation, whilst stronger acid acts too quickly and makes the parchment brittle. The proper strength is obtained by mixing 1 part by volume of water with two parts of English sulphuric acid, of density 66° B. It is advisable to test the density of the mixture after cooling it down to near the freezing point of water. It should be noted that cotton and linen fibres are not transformed with equal rapidity. In a paper containing both it can be readily observed that the linen fibres remain unaltered after the cotton fibres have united to a transparent, uniformly coherent mass. Paper from pure cotton will therefore have more the appearance of a skin, but becomes more brittle and fragile when dry. By suitably blending the paper-stock the maker has it in his power to vary the properties of the vegetable parchment, so as to make it harder or more supple. The admixture of mineral substances should be avoided as injurious. Papers made of unbleached material do not parchment well, the vegetable fibres being protected from the action of the acid by the encrusting envelope; and wood pulp is imperfectly transformed for the same reason, but cellulose paper behaves better. If the paper is to be completely parchmented it must, in certain cases, be so thin that the acid can penetrate through it while floating on the surface of the bath, otherwise the paper would consist of two parchmented layers separated by a core of unaltered fibre. Highly satinised paper behaves like paper that is too thick. The paper is drawn perfectly straight through the acid, at such a rate that it remains 5, 10 to 15 seconds in the bath. On leaving the bath it is transferred to a washing tank, where the bulk of the adherent acid is removed, the remainder being neutralised in a second tank charged with an alkaline solution (ammonia, ammonium carbonate, sodium carbonate, etc.). In a third tank the neutral products are washed out with pure water, and the paper is finally dried. Paper made in rolls in the continuous machine is run off the roll into the acid bath, where it is held down by a heavy glass rod, and is then squeezed between rubber rollers. It next passes through a series of washers charged with pure water, afterwards through pressure rollers, and is dried over uniformly heated copper tubes and calendered.

The points to be observed throughout the process are as follows: The concentration of the acid must be kept at a uniform level. Owing to the large surface exposed to air, which is laden with water vapour from the washing tanks, the acid soon absorbs a large quantity of moisture, and becomes too weak to act. Water is also introduced into the acid by the paper itself.

Care must be taken that the temperature of the acid does not exceed 57° F., for though it will act up to 68°, it makes the paper too soft, and the paper cannot be drawn through quickly enough. The temperature of the bath rises through the absorption of water, and also from the heat of the room. For instance, the heat of the sun shining through a window may spoil the whole operation. The proper concentration of the bath can be restored by adding acid until the specific gravity instrument again registers 59° B., whilst the temperature can be lowered by means of cold water. Eckstein was the first to observe that two sheets of still damp parchmented paper can be united by contact so as to be afterwards inseparable by means of water or any other liquid. This is so far important, inasmuch as thin sheets of paper alone can be parchmented right through, and thick sheets cannot be produced without doubling.

Dullo states that the successful preparation of parchment paper entails the use of sulphuric acid of a certain strength. If the acid be too strong it will ruin the paper in 2–3 seconds, whilst if too weak the paper is not parchmented, and its coherence is so loosened by the water that it tears in the finishing processes. It is true that parchment will still be formed when the acid is slightly diluted below the proper strength, but it curls up in the acid, and still more in the washing water, to such an extent as to become quite useless. The proper degree of dilution is obtained by taking 125 parts by weight of water to each 1000 parts of concentrated sulphuric acid. When the mixture has thoroughly cooled, unsized paper is passed through the bath in such a manner as to be uniformly wetted on both sides by the acid. The paper should be as perfectly dry as possible, since damp paper would be destroyed at once. The time of exposure to the acid varies, increasing with the thickness and strength of the paper. With one and the same paper a brief sojourn in the acid bath furnishes a thicker, but less transparent parchment, a longer exposure a very clear product. Formerly it was thought that paper containing cotton could not be made into good parchment paper, if at all, but it is now recognised that pure cotton rags furnish the very best product. When the action has been sufficiently prolonged, the paper is transferred to pure cold water, thence into a solution of ammonia, and afterwards into pure water again, in order to remove the last traces of the acid. The paper hardens in the first water, probably because the gelatinous mass formed by the brief reaction of the acid before the fibres begin to dissolve is suddenly removed from the action of the acid by the water. The main point essential to the manufacture of a good article is to take a very uniform paper, and to ascertain the best concentration of the acid bath, and the number of seconds the paper may remain in the bath, so as to obtain complete conversion into parchment without risk of loss by solution in the acid. This latter is important, as it involves a waste of material, and loss of weight in the finished parchment. A little care, however, will enable this loss to be detected with ease.

When parchment paper is left to dry spontaneously, it curls to such a degree that the appearance is spoiled. This may be prevented as follows: After the endless strip of paper has been drawn through the acid bath and the washing, neutralising and rinsing tanks, it is passed over cloth rollers, to remove a portion of the water, and finally over very warm, polished rollers, which press and smooth the paper. In the rear of the rollers it is cut into sheets.

According to the kind of paper used, the duration of the acid reaction will vary, and in order to render this possible, the acid tank can be mounted so as to be movable to various distances from the first washing tank. In this way the paper impregnated with acid can be made to traverse a longer or shorter distance before the action of the acid is suspended by the water. Zinc chloride can also be used for parchmenting paper, but as its action on the fibre is not so violent as that of sulphuric acid, the solution must be very strong and applied in the warm.

Taylor employs zinc chloride instead of sulphuric acid, the solution of that salt being neutralised by the addition of zinc oxide or zinc carbonate, and concentrated by evaporation until it is of the consistency of syrup in the cold. In this condition it has a sp. gr. of about 2·100. The dry paper is dipped in or floated on this solution until it is steeped right through, which done it is taken out, freed from surplus solution by a flat squeegee or squeezing rollers, and immediately dipped in water, in order to remove all soluble matter. If any zinc oxide is left in the paper, it is immersed, after partial washing, in a weak solution of soda, and then thoroughly washed. The paper is next pressed, dried, and smoothed in the ordinary way, or else sized and stained. This treatment causes it to contract, but makes it closer in texture, less porous, and stronger. In order to make this transformation as complete as possible, the solution of zinc chloride must be used warm, or else the paper must be exposed to gentle heat after it has been taken out of the bath and squeezed. The most suitable temperature varies, according to the effect desired, from 80°–90° F., or even to a little below the boiling point of water. In deciding which to employ, it is necessary to take into account the nature, thickness, and texture of the paper, the concentration of the zinc chloride, and the duration of exposure. As a rule, when ordinary filter-paper is used, and the same is heated on a metallic surface, a temperature of 120°–140° F. is sufficient. The completion of the reaction is indicated by the slightly swollen and dry appearance of the paper, and its transformation from a stiff, semi-transparent condition into a more opaque and flexible state. The heat may be allowed to act, either by suitably warming the zinc chloride, or by passing the impregnated paper over a heated surface, or again by ironing. When a continuous strip of paper is used, it is passed between warm rollers or through a heated chamber, the entire operation, from immersion to the final rinsing, being then carried on continuously. In some cases Taylor dissolves cotton, starch, dextrin, or gum in the concentrated solution of zinc chloride by the aid of heat. Sheets of paper that have been steeped in zinc chloride, laid and pressed together and ironed over with a hot iron, will adhere firmly and form thick sheets.

According to Kletzinsky, English sulphuric acid is diluted with half its own volume of water, cooled to 66° F., and employed for dipping unsized paper. At the end of 10–15 seconds, the paper is taken out, left to drain, and at once thrown into a large tank of water, where it is washed like fabric, the water being renewed until it is neutral to test paper. Finger stalls or clamps of vulcanised rubber or sheet lead should be used to protect the fingers from the corrosive action of the acid bath.

In drying the neutralised paper, it is liable to shrink and curl irregularly, like dried bladder. If the parchment is intended to be used in place of bladder, this does not matter, since the folds will disappear when the paper is wetted, and the sheet can be stretched out smooth; but in order to produce flat sheets fit for sale, the drying must be conducted under pressure or tension. Thick, unsized paper is not thoroughly permeated by the parchmenting solution, and consequently a layer of crude paper fibres is left between two films of parchment.

If several sheets of paper are to be immersed in the parchmenting bath at one time, care must be taken that all are thoroughly wetted before they are allowed to come into mutual contact in the slightest degree, otherwise they will stick together, and tear if an attempt be made to separate them.

Gaine gives the following as the method of making parchment paper: Unsized cotton paper is dipped in a mixture of 2 parts of concentrated sulphuric acid and 1 of water, immediately withdrawn, and then washed in ordinary water. Unless the foregoing relative proportions of the mixture be accurately maintained, the product will not possess the desired properties, since it is only when a proper mixture is employed that the full action of the sulphuric acid is secured, and a parchment paper is obtained that can be written on with ink without the latter spreading. When properly made the parchment paper will be so strong that a strip a little less than an inch wide will, when made into a loop, carry a weight of 65–88 lb. without breaking, whereas an inferior grade of the same paper will break under a load of 55 lb. or less. Parchment paper absorbs a certain quantity of moisture, though water will not penetrate or filter through the mass, and therefore does not destroy its coherence. It is unchanged by heat and moisture. No increase in weight occurs during the transformation of paper into vegetable parchment, and the latter, therefore, does not retain any of the sulphuric acid.

According to Wright, a kind of parchment paper can be manufactured by utilising the property of ammoniacal copper oxide (a solution of metallic copper in ammonia, in presence of air) of dissolving cellulose.

Paper or millboard is dipped into the concentrated solution until the external fibres are gelatinised, and is then dried on cylinders heated by steam. The method can also be applied to string, canvas, etc. With careful drying, the copper combines with the fibre to form a green compound, which protects the material from insects and fungi.

Reinsch states that the commonest grades of printing paper, old newspapers, etc., are made into parchment paper by dipping in English sulphuric acid diluted with half its volume of water, whereby the paper is converted into a tough substance resembling parchment. The paper must then be thoroughly washed, and dried by winding it on rollers. To obtain a thick product two sheets or continuous bands of the paper must be laid together and subjected to the pressure of a straight glass rod mounted over them; when washed and dried, the sheets will be found to have firmly united.

According to Campbell, the concentration of the parchmenting acid and the duration of the immersion need not be so scrupulously exact if the paper has previously been dipped in a strong solution of alum, dried thoroughly, and then passed through concentrated sulphuric acid, the alum protecting the paper from excessive attack by the acid. The treated paper is finally dried slowly.

THE PARCHMENT PAPER MACHINE.

In the usual process of making parchment paper, the several operations are carried on independently, so that the parchmenting, repeated washing, drying, and calendering (if required) are performed in separate apparatus. Working in this way, however, the parchment can only be made in sheets or strips of moderate length; there is a good deal of extra work entailed by carrying the paper from one apparatus to another, a large percentage of loss through torn paper, wasted acid, and excessive water consumption, and a large space is required for a relatively small output. Furthermore, the product usually lacks uniformity, owing to the paper jerking whilst travelling the comparatively long distance between the paper roller and the parchment roller, so that irregular immersion in the acid ensues, and the paper becomes more transparent in some places than in others, *i.e.* is unequally parchmented.

The machine now about to be described is designed to obviate these drawbacks, and to enable even the largest rolls of paper to be uniformly parchmented, washed, and dried continuously, with a minimum consumption of sulphuric acid—the bulk of this being recovered—and water, diminished percentage of spoiled paper, and an increase in the output amounting to 25-50 per cent.

The paper to be treated is wound on the roll *A*, and passes first of all over the roller *B* into the bath *K* charged with sulphuric acid prepared in the usual way. Here it passes under the glass roller C and is parchmented; and on issuing from the bath traverses the glass rollers DD', to enter the roller press E', which squeezes out the surplus acid, and is mounted in such a way that this acid is obliged to return to the bath, which it reaches in the requisite state of concentration for use over again. Owing to the short distance between the squeezing rollers E' and the paper roll A, the unwinding of the latter can be regulated by the brake a, so that a uniform tension is maintained, whether the paper be thick or thin. Consequently the acid acts in a regular manner, and a uniform product is obtained.

The paper is next passed through a relatively small, separate trough k, in which the greater part of the residual acid is absorbed by water, until the acid liquor has a density of 20°, whereupon the machine is stopped for the trough k to be emptied and re-filled with water. This acid liquor is utilised for the recovery of the contained acid.

The paper is then led over the wooden rollers bbb, between the spraying pipes sss, and under the tension block e', to the second roller press E^2, whereby the parchment is further purified and freed from still adhering acid and the dextrin formed during the treatment. The next step is to pass the paper through a lye bath K', to make sure that it is thoroughly freed from acid, and after traversing the other washing tanks, will reach the drying cylinder in a pure state. From the lye bath the paper is led over the roller F into the second washing tank K^2, and through the second series of spraying pipes ttt. To ensure uniform tension and movement of the paper, a set of carrier rollers R, R', R^2, R^3, is arranged here, together with a tension bar e^2. After passing this latter the paper enters the third washing tank K^3, passes through a third series of spraying pipes uuu, and reaches the third roller press E^3, which has not only to force out the water, but also to press the paper to the desired thickness. This equalising process is important, in order to ensure uniform winding on the drying cylinder and even drying, as well as saving steam and time in that operation. Another tension bar e^3, is arranged in front of the last pressure rollers; and this bar, like the others, is fluted or ribbed on its under surface, in order to smooth out any inequalities in the paper and prevent folds.

The pressure rollers E', E^2, and E^3, which are on Schürmann's patent, anti-deflection principle, are covered with rubber, and are adjustably mounted, so that they can be set at varying distances and exert a correspondingly greater or smaller pull and pressure as required. The belt pulleys (not shown in the drawing) actuating these rollers and the driving rollers R to R^2, are fitted with expansion devices, to enable the suitable peripheral velocity to be rapidly and conveniently imparted to each pair of rollers while the machine is in work.

The parchment paper is conducted from the press E^3 to the drying cylinder T, which is of the usual construction. Here the paper is pressed by a heavy roller G, and by an endless, adjustable band of drying felt d, which extends most of the way round the cylinder, and facilitates drying and the production of a smooth paper. The finished parchment is wound into a roll at J. The roller H' is heated by steam to prevent sweating and the formation of rust marks. From this point the paper can also be led to a calendering machine and cutter.

OPAQUE, SUPPLE PARCHMENT PAPER.

The paper to be parchmented may be treated with a compound, such as barium hydrate, barium chloride, slaked lime, etc., which is thrown down by the sulphuric acid as an opaque precipitate adhering firmly to the parchmented fibres. These adjuncts can be incorporated with the paper pulp, or applied to the finished crude paper, or finally to the parchmented paper itself before washing.

Parchment paper, and paper in general, can be made supple by adding a hygroscopic substance, such as calcium chloride, magnesium chloride, etc., to the paper pulp or to the sizing.

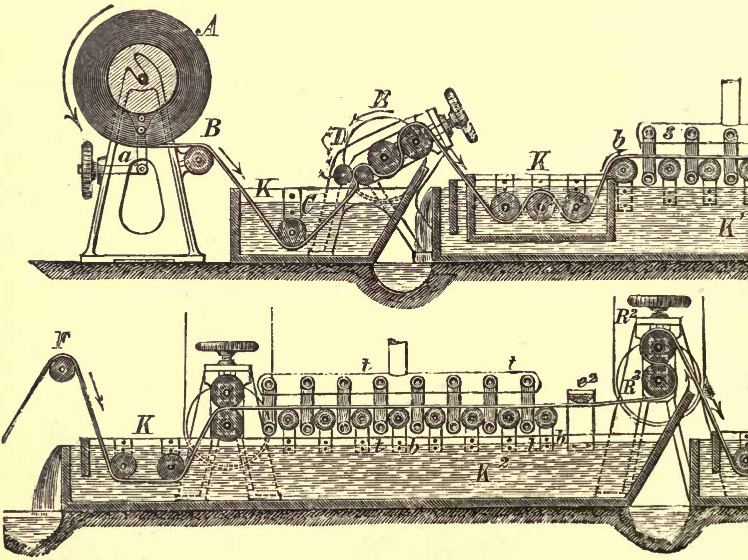
THICK PARCHMENT.

For making thick parchment paper, suitable for bearing cups, driving belts, etc., Morrow conducts an endless band of paper through a bath of nitric acid or a nitrate, until the surface assumes a gummy appearance. The damp paper is immediately wound on a warm cylinder, whereupon the individual layers coalesce, this being facilitated by acting on the coiled paper with a heated pressure roller. The resulting paper tube is cut open and washed in water or dilute alkali, according to the degree of flexibility desired. The plates, slowly dried and pressed, are then ready for use, and can be employed for producing articles that are now made of rubber, etc.

KUGLER'S PARCHMENT PAPER AND PARCHMENT SLATES.

Kugler prepares artificial parchment paper by coating durable paper fabrics or thin cotton stuffs (like bookbinders' cloth) with albumin or blood serum, which is then coagulated by heat. This product is primarily intended for covering satchels, purses, papers, and books, and is claimed to possess the advantages of being waterproof, more easily cleaned with water, and more durable than other products of the same nature. The material to be converted into imitation parchment paper can be stained any desired colour, and is then treated with milk of starch, which makes it supple and completely insulates the substratum from the subsequent coating. The albumin or blood serum is next applied, and coagulated by steam superheated to about 150° C.

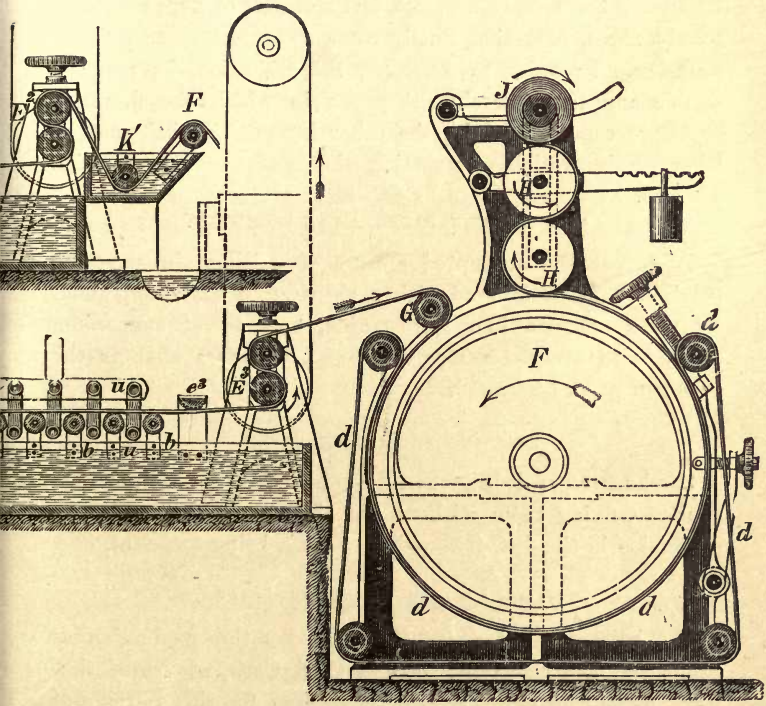
This operation is performed in a long, rectangular stove, with a pitched cover, and closed in front by a tight-fitting door, the whole being surrounded by a jacket casing. Hot steam is admitted, and the water of condensation is drained off through suitable valves, the articles to be stoved being protected from drops of moisture, so that the hot dry steam alone takes part in producing coagulation. The hot steam is also allowed to pass through into the jacket, so as to prevent the deposition of



FIGS. 1 and 2.—Machine for

moisture on the walls and maintain a higher temperature in the stove itself.

Kugler also makes parchment slates, or writing tablets, in the following manner. Fine emery (for ensuring the necessary abrasion of the writing pencil) is mixed with mineral black, logwood extract and ultramarine, to produce a black stain, and then incorporated with blood serum and ground very fine in a special mill, since it would abrade the grinding surface if treated like ordinary colours. In this mill three rollers of different sizes are run at suitable speeds, in combination with a



rchment paper (*see* pp. 20–22).

device that keeps the material constantly returning to the rollers, so that it can be ground over and over again. The resulting mass is applied as three or four coatings to the substratum, each being smoothed with a roller, and finally steamed in the aforesaid stove, and finished by passing it between rollers.

DOUBLE AND TRIPLE OSMOTIC PARCHMENT.

As the result of experiment, A. Eckstein found that ordinary parchment paper is unsuitable for osmotic purposes, because it contains thin places, and splinters of iron, coal dust, woody fibres, etc., that finally come away and cause unequal diffusion. In order to overcome this objection, he prepares double and triple parchment paper, in which the defective spots are compensated by the other layers. No information, however, is available respecting the method of preparation adopted.

ANTI-ERASURE PAPER AND PARCHMENT.

To reveal the attempted erasure of writing, the paper or parchment paper is sized with a preparation containing about 40 parts of potassium ferricyanide, and 40 of ammonium sulphide to every 1000 parts of size. Erasure changes the colour of paper so treated.

STAINING PARCHMENT PAPER.

Parchment paper behaves like animal fibre towards coal tar dyestuffs, fixing them without the aid of mordants, a simple immersion in the dye, followed by drying, being sufficient.

UTILISING WASTE PARCHMENT PAPER.

The utilisation of waste materials for the production of oxalic acid has been described by C. E. Cech, who states that waste parchment paper is now being used for this purpose in one of the largest oxalic acid works (that of D. Kunheim, Berlin), producing about 200 tons of this acid per annum from sawdust.

Cech states that the chief point to be observed in making oxalic acid from waste parchment paper is the thorough lixiviation of the material. According to the process introduced in 1857, by Roberts, Dale & Co., of Warrington, for making oxalic acid from sawdust by treating that material with caustic potash, waste parchment paper should not only give a sufficiently high yield of the acid, but is free from the colouring matters that have to be extracted when hard-wood sawdust is used. Upman, however, states that Cech's proposal is not new, successful attempts to prepare oxalic acid by treating cellulose with caustic potash having been made on a small scale, prior to the sawdust process; but on the other hand it cannot be disputed that the idea had not hitherto been made public. Upman further states that the question whether parchment paper waste is really suitable to replace sawdust cannot be decided at present, since apart from the circumstance that the material, if available in sufficient quantity, must be pressed for carriage to a distance, the thorough lixiviation of the waste may be attended with greater difficulties than are at first apparent, and the paper would have to be dried afterwards. All these operations entail expenses that are absent in the case of sawdust, though, on the other hand, they might be compensated by the higher yield obtainable.

PARCHMENTED LINEN, WOOLLEN, AND COTTON FABRICS.

Linen, woollen, cotton, or other vegetable textiles to be parchmented are first of all washed in warm water, to eliminate all traces of dextrin, starch, or other agglutinant dressings. The fabric is next immersed in a thin pulp made from linen or cotton waste or unsized paper.

Linen and woollen fabrics intended for osmotic purposes, after leaving this first bath, from which they take up fibrous particles that fill the pores of the material, must be subjected to gentle pressure between rollers; but this operation is unnecessary when other purposes are in view. The next stage consists in immersing the material in a bath of sulphuric acid (density 66° B.), diluted with 10–15 per cent. of water, and maintained at the same temperature as the air of the workroom.

The insertion and removal of the fabric must be so regulated that the time of exposure to the action of the acid varies between 6 and 36 seconds, according to the weight of the fabric. The excess of acid is then removed by squeezing between a pair of leaden or glass rollers, and run back into the bath. The final traces of the acid are eliminated by washing with cold water in one or more tanks, and finally by a bath of weak ammonia.

The ammonia having been washed out in turn, the fabric is subjected to heavy pressure on a steel smoothing plate, in order to press the absorbed particles of fibre firmly into the pores. Drying is effected between two cylinders which are covered with felt, flannel, or merely with millboard, and are placed in contact with hollow copper or iron cylinders heated by steam. The process concludes with a careful smoothing by heavy pressure between a pair of finely polished hollow copper, steel, or iron cylinders heated by steam.

Fabrics treated in this way are perfectly waterproof and very strong, and in addition to other purposes can be used for wagon tilts and packing sheets. They are also preferable to parchment paper for dialysing chemical solutions, on account of their greater durability.

PARCHMENT MILLBOARD.

Instead of making parchment millboard by uniting a number of bands of paper between rollers after issuing from the acid bath, and leaving the resulting board in water for a considerable time in order to remove the excess of acid, a method has now been introduced, in which the several bands or sheets of paper are passed through a series of parchmenting baths of diminishing strength, and are then united by pressing them together between hot plates, preferably after having removed part of the moisture by the aid of dry felt or cloths. The layers will unite still more firmly if 3–6 per cent. of sodium nitrate or potassium nitrate has been added to the acid bath. In parchmenting hard or thick paper by the ordinary method, it has been found that the parchmenting bath does not sufficiently penetrate the paper, but acts merely on the surface, so that when the paper is placed in water, it splits into two layers, each of which is parchmented on one side only. This defect, however, can be remedied by first entering the paper in a bath of very weak acid, which penetrates right through the paper, several other acid baths of gradually increasing strength being afterwards used.

WOOD'S ARTIFICAL PARCHMENT.

Fibrous material of any kind, such as cotton, paper, or cellulose, is first dipped in a bath of resin soap dissolved in water. This is the ordinary commercial resin soap, consisting of resin, oil or tallow, and soda or potash. When the stuff is thoroughly soaked, it is hung up in a warm room until nearly dry, and is then, in a still damp state, entered in a bath of zinc chloride, that has been concentrated to 65–70° B., the working temperature being about 30° C. On leaving this bath the stuff is passed over or through hot rollers, and then cooled and washed with pure water to remove all traces of resin soap or zinc chloride. After being hung up to dry in a hot room, the stuff is coated with oil, preferably vaseline oil, and is run through a calender. As it contains no colouring matter, it is not liable to crack, and can be washed and smoothed, furnishing a strong, tough, and flexible product.

IMITATION HORN AND IVORY FROM PARCHMENT PAPER.

If paper be allowed to drain after passing through the acid bath, and then carefully spread on a sheet of glass and covered with another similar layer—taking care that no air bubbles are left between them—the two will unite on being pressed together by means of a straight glass rod. The double sheet is taken off the glass and dipped in water, where it is left for several days in order to remove the whole of the acid. When dried, the double sheet can no longer be separated into its components. In this way it is evident that sheets of parchment paper can be made of any desired thickness, and these can be used for imitation ivory or horn, since they possess the toughness of the latter substance, and will also take a polish. In a moistened condition this mass can also be used for the production of bas-reliefs.

PERGAMYN (GREASE-PROOF IMITATION PARCHMENT PAPER).

Prime sulphite cellulose is placed in a pulping machine along with twice as much size as would be used for writing paper, and a little glycerine and grape sugar, the whole being ground very fine for 12–15 hours until it gets warm in the machine. Pergamyn is not at all easy to work in the paper machine. Above all, the aspirators must be in good working order, and it is advisable to have two Kaufmann aspirators and one actuated by a plunger pump at disposal; owing to the difficulty experienced in getting the water out of the wet band, the upper squeezing roller should exert merely a slight pressure, and the felt cover should be somewhat worn, or short in the hair, so that the paper does not stick. The first pressing must be gentle, but the second pressing should be thorough. To enable the paper to dry slowly, the first drying cylinder should not be too hot, and, in addition, before rolling up the paper it should be damped and stored for several days in such a manner as to keep the edges from drying. Should they do so, however, they must be damped from time to time with a wet sponge. When the parchment has lain for a few days, and the moisture has penetrated right through, it is damped again on a special damping roller, left for several days longer, and then smoothed. It is advisable to run the paper as quickly as possible, and only once, through a 10–12 roller calender, under heavy pressure. If it does not come out well with a single calendering, it had better be damped again rather than that a good deal of waste should be caused by a double rolling.

IMPERMEABLE PARCHMENT PAPER.

An oil- and grease-proof paper is prepared by dipping in a hot solution of gelatine containing $2\frac{1}{2}$–3 per cent. of glycerine, the paper being then dried. This paper may be waterproofed by immersing it in carbon disulphide, containing 1 per cent. of linseed oil and 4 per cent. of caoutchouc in solution.

PARCHMENTED MILLBOARD.

According to an American patent, strong commercial sulphuric acid is diluted with about its own volume of water, the mixture being treated to an addition of 10–25 parts by weight of hydrochloric acid, as much zinc as will dissolve, and, after cooling, about one-sixth to one-fourth, by weight, of dextrin. Paper is run off from a roll, through this bath, and wound on another roller, until the desired thickness of millboard is obtained, whereupon the roll is cut open, as in making ordinary millboard, and spread out flat. The resulting sheets are steeped in water or a neutralising bath, to eliminate the surplus acid. The zinc may also be dissolved in the hydrochloric acid, before adding it to the bath, and the dextrin may be replaced by waste from similar millboard, paper, blood, or albumin.

PARCHMENT PAPER FILTERS.

G. W. Warren, in the *Chemical News,* described a method of making filters of parchment paper. For this purpose, filter paper is treated with hydrofluoric acid, well dried, and then dipped for 5 hours in a mixture of equal volumes of English sulphuric acid and nitric acid (sp. gr. 1·5), thoroughly washed and redried. Filters prepared in this way are slightly hygroscopic, burn quickly without more than a slight residue, retain the finest precipitates, and also filter much more rapidly than ordinary filter paper.

ELASTIC MASS FROM VEGETABLE PARCHMENT.

A large number of thin paper strips (16–20) are laid one on another, and passed in that condition through a bath of concentrated sulphuric acid, on issuing from which they are squeezed between rollers. This makes the surfaces adhere very intimately, whilst at the same time the total thickness is lessened. Parchment prepared in this way is cut into strips of suitable breadth for the purpose in view, and will be so compact that no trace of the individual layers is visible on the cut surfaces.

This parchment is claimed to form a good substitute for whalebone, for ladies' dresses and corsets, chiefly on account of its ability to stand the warmth of the body, and also for its durability and low price. Another important feature from an industrial point of view is that the cut lengths neither crack, split, nor tear; at the same time they can be easily mounted, inserted into folds, and do not injure lining or corset material in the least.

IMITATION PARCHMENT PAPER.

The following recipes can be recommended:—

1. Sulphite cullulose 60 per cent., soda cellulose 25 per cent., wood wool 15 per cent., the whole being dressed with 5 per cent. of size and 5 per cent. of aluminium sulphate, calculated on the dried material. The paper is good, but not of best quality.

2. Sulphite cellulose dressed with 5 per cent. of size and 5 per cent. of aluminium sulphate, calculated on the dried product. This is ordinary imitation parchment paper.

3. Sulphite cellulose (IIA quality) is treated with 2 per

cent. of dilute sulphuric acid in a papermaking machine. The resulting paper is coarse, but very similar to parchment.

4. Sulphite cellulose 60 per cent., straw 40 per cent. sized with 4 per cent. of size and 4 per cent. of aluminium sulphate. This is a very light-coloured, transparent paper.

5. Sulphite cellulose 60 per cent., straw 40 per cent. Dressing: 4 per cent. of size and 3 per cent. of aluminium sulphate. Paper like No. 4.

6. Sulphite cellulose 60 per cent., straw 40 per cent., dressed with size and aluminium sulphate, 3 per cent. of each. Like Nos. 4 and 5.

7. Sulphite cellulose 70 per cent., straw 30 per cent. Dressing: size 3½ per cent., aluminium sulphate 3 per cent.

8. Sulphate cellulose, sized with 5 per cent. of size, 5 per cent. of aluminium sulphate, and 2 per cent. of stearine. The paper is good and has a more shiny appearance than the other sorts. The stearine is chopped into small pieces, stirred up with warm water and added to the rest of the mass in the paper machine.

In the production of imitation parchment sheets the grinding of the mass is an important factor; it should be ground for a long time until soft, and beaten for ¼–½ an hour in the trough after the roller has been lifted out. In the paper machine it should be agitated to a moderate extent and well pressed. Worn-out felt must not be used, and the drying felt must be tightly stretched, in order to prevent the formation of bubbles in the paper; at the same time the paper should be dried gradually, since otherwise it is liable to wrinkle. It is advisable to lap strips of paper, about 1½ inches wide, round each end of the first cylinder, or, better still, the first and second, so that the edges of the moist band of paper rest thereon. This prevents the edges drying too quickly, and obviates cockling; and the paper must be kept well stretched in passing through the machine.

ARTIFICIAL PARCHMENT.

An artificial parchment, which can be written on with pencil or ink, and from which the writing can be removed by the aid of water, is obtained in various ways.

1. White lead, gypsum, and slaked lime are mixed to a very fine powder, the mixture being stirred up with parchment size and applied as a coating on strong writing paper. The dried coating is rubbed with pumice or glass paper, and finally impregnated with clear boiled linseed oil.

2. Single or doubled sheets of paper are rubbed with pumice and primed with white pipeclay, followed by two coatings of white lead thinned with size (13 parts of glue and 250 of water). After drying and pressing, three coatings are given with the following paint, the paper being then wiped over with a linen cloth: To prepare the paint, 500 parts of linseed oil are boiled with 100 parts of litharge and 6 of sugar of lead, until a thick varnish is formed; 200 parts of this are then mixed with 300 parts of copal varnish, clarified, and mixed with 200 parts of oil of turpentine. This varnish is mixed with white lead in a paint mill, a yellow tinge being imparted with a little yellow ochre or other suitable pigment.

3. Strong and very smooth paper is coated on both sides with a varnish made from 16 parts of copal varnish, 16 of boiled oil, and 19 of oil of turpentine. When perfectly dry, each side is coated two or three times with a thick paint prepared by grinding together 96 parts of white lead, 4 of sugar of lead, and 5 of levigated pumice powder, with good, pure boiled oil, and coloured with any suitable red or yellow pigment. Finally, the paper is pounced with pumice, polished with a linen rag, and dried.

TESTING THE SULPHURIC ACID.

Sulphuric acid is made by exposing sulphur dioxide to the action of air, water vapour, and nitrous acid, in large chambers lined with sheet lead (the so-called "leaden chambers"). The nitrous acid acts as a carrier of oxygen from the air to the sulphur dioxide, and the nitric oxide resulting from this reaction is recovered for use over again. The acid prepared in this way has the density 50°–53° B., and contains about 62–67 per cent. of H_2SO_4. It is usually concentrated, the first step being by evaporation to 60° B. (78 per cent. H_2SO_4) in leaden pans or Glover towers; for certain purposes it is further concentrated to 66° B. (93–96 per cent. H_2SO_4) in glass or platinum vessels. By congelation, it can be obtained in the state of sulphuric monohydrate, or absolute (100 per cent.) sulphuric acid, and in that condition is a water-white, oily liquid with the density 1·837–1·838 at 15° C., solidifying at lower temperature into crystals that melt at 10·5° C. It fumes slightly at the ordinary temperature, and more strongly when warmed, owing to the liberation of a small quantity of sulphuric anhydride. Distillation commences at 290° C., a mixture of arseniferous acid and anhydride coming off. At 338° C. the boiling point is constant, an acid about 98·5 per cent. pure then passing over. This is the highest degree of concentration that is obtainable by heating dilute acid.

The concentrated "English" acid (density 66° B.) from the platinum or glass retorts is also an oily liquid, with the density 1·84 at 15° C.; it rarely contains more than 96 per cent. of H_2SO_4 (sometimes barely 94 per cent.), and does not solidify on cooling. On the other hand, the second hydrate $H_2SO_4H_2O$, crystallises at 8·5° C.

The percentage of pure acid in the aqueous acid, up to 90 per cent., can be determined with sufficient accuracy from the density, provided the test be made at the temperature given in the tables, the influence of the impurities present in the commercial acid being inappreciable. This influence, however, is markedly felt above 90 per cent., a very small variation in the density then corresponding to a considerable difference in the strength; and the method fails when the highest degrees of concentration are reached, the density then receding. On this account the tables can only be used for acids up to 65° B.; and it must also be remembered that the tables for converting degrees Beaumé into specific gravity (density), differ considerably among themselves. Furthermore, the tables merely apply to pure acids, such as do not occur in commerce, so that it is necessary to determine the exact content of acid by volumetric titration in addition to the sp. gr. test. This is sufficient for all practical purposes, since sulphuric acid is never adulterated with other acids, and the acid impurities (*e.g.* sulphurous acid) make very little difference to the results.

Of the impurities of sulphuric acid, the following must be taken into consideration: Nitrogen compounds, generally nitrous acid, or occasionally nitric acid, can be detected by various qualitative reactions, such as the formation of a brown layer round a crystal of ferrous sulphate immersed in the acid, whilst very minute traces are revealed by the beautiful blue coloration imparted to a solution of diphenylamine in sulphuric acid. Nitrous acid can be determined quantitatively by a standardised solution of potassium permanganate, the acid being allowed to run from a glass tap burette into a measured volume of the test solution, diluted with water at 30°–40° C., until the decoloration point is reached. With half-normal permanganate solution, *i.e.* containing 15·82 grms. of $KMnO_4$ per litre, and therefore capable of ceding 0·004 grm. of oxygen per cubic centimetre, each c.c. of the solution corresponds to 0·0095 grm. of N_2O_3. The total nitrogen compounds in sulphuric acid, including any nitric acid present, can best be determined by means of Lunge's nitrometer.

Sulphurous acid can be most readily detected in sulphuric acid by the smell, the nose being the most sensitive reagent in this case, more especially since the other methods of detecting SO_2 by its reducing action or by transformation of the sulphuric acid, fail to act in this case. A quantitative determination will rarely be required, but can be performed by titration with iodine solution.

Chlorine or hydrochloric acid are rarely met with in appreciable quantities in commercial sulphuric acid, and can readily be detected and estimated by means of silver nitrate.

Selenium is often present in small quantities in sulphuric acid, and being free and in a state of very fine suspension is usually recognisable by its reddish tint. When present as SeO_2, it can be thrown down as a red precipitate of metallic selenium by sulphur dioxide.

Solid impurities are found by evaporating the acid in a platinum dish. Lead and iron are the chief impurities of this class. Lead is detected by the brown coloration formed with sulphuretted hydrogen, or simply by the white precipitate of lead sulphate formed on diluting the acid with water, the dilute acid being mixed with at least an equal volume of alcohol when a quantitative determination is required. Iron is detected by boiling the acid with one drop of nitric acid to convert the iron into sesquioxide, and treating the cold solution with potassium thiocyanate, a red precipitate indicating iron. The quantitative estimation is performed volumetrically by reduction with zinc and titration with permanganate solution, or gravimetrically (in the absence of alumina) by precipitating the ferric oxide with ammonia.

Arsenic is found, after freeing the acid from lead (by dilution, subsidence, and filtration), by treatment with sulphuretted hydrogen, which gives a yellow precipitate. For the quantitative determination this precipitate is washed and oxidised with nitro-hydrochloric acid, and then precipitated with magnesia mixture as ammonio-magnesium arsenate. Of course the other quantitative test for arsenic can be employed, such as the Marsh test, the Reinsch copper-plate test, or the German Pharmacopœia test. This latter test consists in adding zinc, whereupon the liberated gas will blacken a piece of filter paper moistened with silver nitrate. If a highly concentrated solution of silver nitrate be used, the moistened paper will turn yellow at first, and then black.

CHAPTER II.

Paper for Transfer Pictures (*Metachromotypes*).

THE paper used for transfer pictures is a good, smooth paper, only slightly sized, if at all, capable of readily taking up the adhesive solution, and as readily softening when the picture is transferred. Starch paste, gum arabic, and flour paste are used, and careful preparation is essential to the production of a good article, it being evident that defective coating of the paper with adhesive will result in the picture being imperfectly released, because the printing colour will be absorbed by the paper in such places, and will no longer separate therefrom.

The paper must therefore be uniformly coated with the adhesive, and must also be capable of taking up the adhesive evenly. The best method of applying the adhesive is by means of a broad flat brush, the paper being spread on a large table, and the solution laid on smoothly by drawing the brush to and fro. If necessary, successive coatings are given, alternately lengthwise and across the paper. Many attempts have been made to apply the adhesive by machinery, but hitherto without complete success.

After this preparatory treatment the paper is hung up on lines in a warm room to dry, preferably in a state of tension to prevent curling, after which it is cut into sheets and packed. It may also be run through a satining machine, to produce a smooth, even surface.

RECIPES FOR PREPARING THE PAPER.

1. The adhesive is compounded from:

Starch	400 parts
Gum tragacanth	100 ,,
Fine pale glue	200 ,,
Ground chalk	100 ,,
Gamboge	5 ,,

The glue, tragacanth, and gamboge are steeped separately in water for two days to dissolve. The starch is moistened with cold water and then made into paste by pouring boiling water over the mass with continued stirring, followed by boiling with a further quantity of hot water. During this boiling the dissolved glue and tragacanth are added, followed by the chalk, the whole being left on the fire until homogeneous, whereupon the gamboge mixture is stirred in. The paste is strained through a cloth, and applied to the paper with a sponge, two coatings being given.

2.	Starch paste	10 parts
	Gelatine	4 ,,
	Kremnitz white	4 ,,
3.	Starch	3000 ,,
	Alum	200 ,,
	Gamboge	5 ,,

4. One hundred and twenty-three parts of starch are mixed to stiff bookbinders' paste, and boiled with 66 parts of finest glue, that has been left to swell up in water, the whole being mixed with 50 parts of Kremnitz white ground in water.

5.	Dextrin	20 parts
	Water	90 ,,
	Glycerine	8 ,,

the solution being filtered before use.

6. Uniform, unsized paper, not too thick, is coated with the following preparations:—

(*a*) A warm solution is made of 10 parts of gelatine in 300 of water, and is applied evenly to the paper by means of a sponge or wide brush, the paper being laid flat on an inclined surface to dry.

(*b*) A second solution is prepared from—

Starch	50 parts	
Gum tragacanth	10 ,,	in
Water	600 ,,	

by softening the tragacanth in one-half the water, the starch being made into a stiff paste with the remainder, and the whole strained through muslin. The dried paper is next evenly and somewhat thickly coated with the tragacanth mucilage by the aid of a wide brush and again left to dry. A third coating is applied in a similar manner, this time, however, of dissolved albumin, prepared by mixing 1 part of blood albumin with 3 of water. By frequent shaking this dissolves in 24 hours to a cloudy liquid, which can be clarified by the addition of a little ammonia. The solution may be used with or without dilution, according to requirements. When dried the third time, the paper should have a perfectly even appearance. If the sheets curl too much, the first gelatine solution may be treated with a little glycerine, which will soften it down.

7. According to Miller, the paper used for transfer pictures should be fairly strong, should not stretch, either in printing or in taking off the transfers, and when moistened should slip off sideways at the end of one or two minutes, without any of the impression sticking to its surface. Before printing, the paper must be wiped over with a damp sponge; if it does not stretch it is suitable, but if it cockles it must

be discarded. To impart the necessary properties the paper must be treated in the following manner: It is first coated with a strained paste made of wheaten starch, and applied with a goat or badger-hair brush. After being dried on the flat the sheets are well pressed between sheets in a smoothing press. A second coating is applied, this time using a mixture of gum arabic mucilage and starch paste in equal parts; and the paper is then left to dry for at least 6–8 hours, so that it will not undergo any distortion in printing.

TRANSFER PAPERS FOR DECORATING GLASS (*Miller*).

8. The paper is drawn lengthwise through a solution of—

Common salt	100 parts.	
Powdered alum	150 ,,	in
Water	4000 ,,	

contained in a flat dish, and after draining is laid on a rack to dry.

Next, 250 parts of cabinetmaker's glue are softened, boiled in 1000 parts of water, and mixed with 100 parts of glycerine, 25 parts of common salt, and enough coal tar dye to give a recognisable tinge to the prepared surface of the paper, the pan containing the mixture being then placed in water, and the contents stirred until cold. If a trial film of this coating is found to be brittle on drying, more glycerine is added and well stirred in. When cold, the whole is strained through a cloth. Two coatings are applied to the paper.

TRANSFER PAPERS FOR DECORATING GLASS.

9. One hundred parts of wheaten starch and 400 parts of soft or distilled water are stirred in a pan, and the resulting paste is coloured with a little gamboge or coal tar dye, this being used

chiefly for the purpose of showing which is the treated side of the paper.

Common salt	25 parts,
Pure glycerine	70 ,,
Softened glue	50 ,,
Molasses	25 ,,

are raised to the boil, and when all is dissolved the starch paste is added, with stirring, the whole being boiled up for a short time. On being taken off the fire the mass is stirred till cold, and strained through a linen cloth into a clean dish. The paper receives two coatings of this mucilage, and after drying is smoothed between rollers.

TRANSFER PAPERS FOR GLASS ETCHING (*Hock*).

10. The paper for making the transfers must be thin, unsized, smooth, soft, and free from lumps or other defects which would prevent it adhering properly to the rounded surface of the glasses. When obtainable cheaply, fresh albumin can be employed to prime the paper for printing the designs. As this material, however, is usually too dear, the following method must be adopted:—

The sheet of paper having been shaped to the proper form is steeped in a suitable vessel with a fairly dilute solution of ammonium sulphate. In order to keep the paper clean and ensure uniform penetration of the solution, the operator's hands must be free from grease. The paper is next hung carefully on rods to dry. When dried, it is coated with a suitable substitute for albumin, *e.g.* ordinary starch paste, prepared by the warm method, and stained a deep yellow with an aqueous solution of gamboge. This paste is laid on evenly and moderately thick with a wide brush. When dried and glazed between rollers the paper is ready for printing, and must be stored in a very dry place.

CHAPTER III.

Papers for Preserving and Packing Purposes.

THESE papers, which deserve a more extensive application than they at present receive, are used for wrapping substances that are liable to injury from the access of air, and preserve them in their original condition for a considerable time. They serve, for example, to protect fat from becoming rancid, metals from tarnishing or rusting, and tobacco from losing its moisture.

They are generally prepared by dipping suitable paper of varying thickness in preservative substances, which are either dissolved in suitable solvents, or—when their nature permits—rendered fluid by heat. The paper is then drained, passed through rollers if necessary, and finally dried, this operation being performed in a warm room when aqueous solutions have been used, otherwise at the ordinary temperature. When dry the paper is again pressed to smoothen it and remove wrinkles, and is finally packed.

BUTTER PAPER.

The preparatory composition consists of—

Common salt	10 parts.
Saltpetre	20 ,,
Egg albumin	1000 ,,

The white of egg (or albumin) is beaten to a froth in the usual way, the other ingredients being added gradually and stirred until dissolved. This solution is used for impregnating thin, well-dried filter paper, which is then suspended on lines until partially dry, each sheet being finally ironed smooth with a hot flat iron, to which a little wax is applied at intervals.

Butter wrapped in this paper will keep good for months, provided it was quite fresh at the start, and was carefully packed to exclude air. Consequently, this butter paper is a very useful article in every household, and is particularly valuable for large butter exporting firms. The sheets are packed in 10's or 100's in parchment paper, bearing a printed notice of the name and advantages of the butter paper.

NEEDLE PAPER.

This paper is made from pulp containing an admixture of graphite. It is stained with logwood extract and sized with glue and alum, and is used as an anticorrosive wrapping for small steel articles (sewing needles and the like).

According to Lake, it may be prepared by parchmenting paper, as already described, and coating the same with powdered graphite before washing.

SALICYLIC PAPER.

Any kind of absorbent paper can be used for this purpose, the quality depending entirely on the object in view.

For honey, milk, cream, or similar substances, soft English filter or blotting paper will do, but a harder grade is needed for butter, fresh meat, fruit, or vegetables. In any event, however, unsatinised paper is preferable. A sufficient quantity of salicylic acid is divided into two parts: the one being dissolved in a heated mixture of 3 parts Glauber salt, 7 parts borax, and 58 parts water. The other half of the acid is digested with a little warm glycerine (sp. gr. 1·10–1·50), one-third of the requisite quantity of the latter being stirred in by degrees, whereupon the two solutions are mixed and diluted with water to make a 3 per cent. solution for thin paper, or 5 per cent. for thicker paper. Should the acid crystallise out, more glycerine must be added by degrees, until the liquid is again perfectly clear. The liquid is placed in a wide, flat dish, and the sheets of paper dipped one at a time. When the solution is kept at a temperature of about 140–150° F., 4–5 minutes will be enough, though thick paper takes longer; and 15–20 minutes will be required when the solution is used cold. The paper is

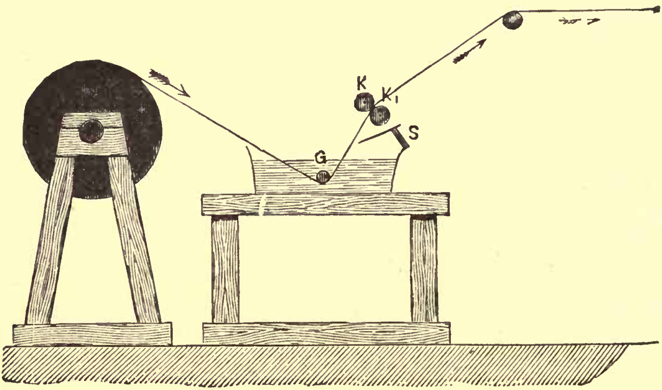


FIG. 3.—Apparatus for making wax paper.

dried in the sun, in front of the fire, or in a drying oven, and must be stored in a cool, dry place, either flat between sheets of millboard, or in rolls.

WAX PAPER.

Wax paper is largely used for wrapping products that contain a certain amount of moisture, which it is desirable to retain; such as tobacco and snuff; also as a covering for jam pots, to exclude injurious atmospheric influences, etc.

A number of sheets of unsized or slightly sized paper of firm texture are placed in a pile on a large table, and a little scraped wax is laid on the topmost sheet. On applying a hot flat iron, the wax will melt and penetrate the paper, the surplus making its way down into the second and third sheets. As soon as the iron gets cool it must be replaced by a fresh one. Another way is to hold a large lump of wax in one hand and press it against a hot iron held in the other; this will ensure a quantity of melted wax being available all the time, and enable a large number of sheets of wax paper to be prepared with little trouble.

For larger quantities it is preferable to work with a roll of paper, mounted on a roller *W* (Fig. 3). From this roller the paper is led through an enamelled iron trough, containing wax that is kept in a molten condition by a suitable heating device —gas, oil, or spirit lamp. The trough also contains a glass rod *G*, mounted in such a manner that it can be taken out when required; and on the one edge of the trough is mounted a steel scraper *S*, set at such an angle that the band of wax-impregnated paper can slide over it without being cut. Just above the scraper are two porcelain rollers KK^1, set close together so as to remove all surplus wax. The impregnated paper can be allowed to fold loosely on itself at a short distance away, and at the end of several hours will be ready for cutting up into sheets or winding on a roller.

PARAFFIN PAPER.

This paper is used for the same purposes as wax paper, and can be prepared in a similar manner, or the paraffin wax may be dissolved in benzol, oil of turpentine, or petroleum, the paper being dipped in the solution or coated with the aid of brushes, and then hung up to dry, whereupon the solvent evaporates. If a closed drying chamber be used, the solvent may be recovered.

WRAPPING PAPER FOR SILVERWARE.

The packing paper in which silverware is wrapped, to protect it from tarnishing, is prepared as follows: The paper is dipped in a solution of zinc or lead oxide in caustic alkali. For example, 6 parts of caustic soda are dissolved in hot water, to a density of 20° B., 4 parts of tin oxide being then added, and the mixture boiled for 2 hours, if possible under a pressure of 5 atmospheres. When the solution has clarified, it is diluted to a strength of 10° B., and is then ready for use. The preparation absorbs and fixes hydrocarbons and acids, and thus prevents their exerting any injurious action on the silver.

WATERPROOF PAPER.

1. To make paper waterproof, impermeable to grease, and opaque, it is dipped in a saturated solution of borax in which a quantity of shellac has been dissolved by gentle heat. The paper may be stained beforehand if desired. Borax, it may be said, is soluble to the extent of 6 parts per cent. in cold water, and 200 per cent in hot water.

2. Twenty-four parts of alum and 4 of white soap are dissolved in water, and a solution of 6 parts of gum arabic and 6 parts of glue in 32 parts of water is prepared in another vessel. These two solutions being mixed and warmed, the paper is dipped in the mixture, and is then hung out on a line in a warm room to dry.

HYGROSCOPIC PAPER.

To keep paper, parchment paper, and other fibrous substances soft, flexible, and elastic, capable of absorbing and retaining moisture, and in some cases making them transparent as well, they are treated with a solution of potassium or sodium acetate, containing grape sugar, dextrin, starch, or other mucilaginous or gelatinous substances, according to the result desired. It is also desirable to add a small quantity of antiseptic, such as carbolic acid or salicylic acid.

ANTICORROSIVE PAPER.

Articles to be protected from moisture may be packed in paper treated with mineral oils, such paper being impermeable to moisture or grease. These anticorrosive papers have been made by different methods for some years; but the new product, made in accordance with a patented process by Grebrüder Krah, of Iserlohn, differs from those hitherto known, by possessing the property of liberating hydrocarbon vapours, which will protect metallic articles from rust, even though they are in direct contact with moisture. This property is imparted to the paper by treating it with a mixture of heavy and volatile hydrocarbons. The heavy oils used for this purpose are those distilling over from petroleum, between the lamp or burning oils and the tarry matters. About 10–15 per cent. of volatile hydrocarbons, such as naphtha, petroleum, ether, etc., are dissolved in these heavy oils, and the mixture is applied to the paper in the usual way. When metallic articles are packed in this prepared paper, the aforesaid volatile hydrocarbons settle down gradually on the cold metal, thus covering it with a colourless film that prevents any formation of rust.

If volatile hydrocarbons were used alone for impregnating the paper, they would quickly evaporate, and the paper would not acquire anticorrosive properties; but the addition of the heavy oil retards the volatilisation of the lighter oils, and the paper consequently retains its properties for a considerable time.

CHAPTER IV.

Grained Transfer Papers.

THESE transfer papers are growing in popularity as a cheap and easy method of imitating the natural grain of wood on painted articles of all kinds, and as they are very largely used, the manufacture is fairly profitable. The paper, in the form of bands or sheets, is first coated with an insulating layer of starch, flour, and tragacanth, dissolved in water (either alone or together in various proportions), then dried and printed with the desired pattern. This is prepared in various ways, either by engraving from a drawing, or from a mechanically produced impression of a piece of natural wood.

The paper may be printed in oil or water colour, the latter being by far the most usual method, the oil printed paper being more difficult to manipulate, as well as dearer.

According to size, the prepared paper is printed in a hand or machine press, or by the aid of elastic plates. The water colour contains no more gum or paste as binding medium than is necessary to prevent the pigment coming off in the form of dust. When dried, the paper can be rolled up and is then ready for sale. These papers must be stored in a dry place, and must not be kept too long, since in course of time they lose their property of transferring the impression, and may then be a source of trouble between buyer and seller that would not have arisen had the papers been sold in a fresh state.

The most important of the methods adopted in making these papers, are those of Antony, Grossheim, and Tischler, which are detailed below.

1. ANTONY'S METHOD.

Well-planed and sandpapered boards are steeped in a bath of acetic acid, which causes the softer portions of the wood to shrink, leaving the harder parts standing out, whilst the finest pores are deepened and made visible. In certain woods, such as Brazilian maple for instance, the light-coloured parts shrink and the dark shadings stand out; whereas in others again, oak for example, the dark veins and pores contract. On coming out of the bath the wood is dried.

1. A board, on which the light-coloured portions have shrunk, is inked with an ink roller, and impressions are taken in a litho press for transfer to a lithographic stone, to reproduce the shadings and other colours in the wood in question. The finished reproduction consists of three printings: first the shadows, then the original taken from the board, and finally the ground colour.

2. A board on which the dark portions have shrunk is inked with thin ink, and an impression taken in the press for transfer to a litho stone. The entire drawing is gone over with Indian ink, and the transfer ink is removed from the stone, leaving the rest of the surface covered with the Indian ink to represent the depressions of the wood. These grain designs are transferred to other litho stones, and then the shadings and other tints of the wood are drawn, as mentioned under 1.

2. GROSSHEIM'S METHOD.

Grossheim invented a special process for preparing original plates or rollers for printing any desired pattern, which plates or rollers can be re-ground several times without needing to be re-engraved.

In the usual method of imitating marble, the grain of wood, etc., the design, after being etched on the stone, is reproduced by transferring it, by means of an elastic roller and various intermediate operations, on to the original to be printed. If the original has been too deeply etched, so that it retains too much colour, a good deal of ink remains on the elastic roller, and the pattern thickens and is transferred unevenly. Conversely, the lighter the etching in the stone, the finer and more delicate is the transfer, the correct degree being gauged by the intelligence and practical experience of the operator. His attention, therefore, is concentrated on making the etching uniform in depth, and seeing that the same is neither too deep nor too shallow. Nevertheless, both in etching and engraving, it is nearly impossible to maintain this uniformity, the variable resistance of the material in the one case affecting the decomposition, whilst in the other the requisite minute examination of the depth would render the work too expensive.

Consequently, one has to be satisfied with conditions which will furnish a plate that can be used, though not perfect, the depth of the etching being kept as close as possible to the minimum. In re-inking the plate, however, after each impression, the removal of the superfluous ink by the spatula inevitably abrades the plate itself, so that it becomes worn out by the time 1000–2000 impressions have been taken. At the same time the earlier pulls differ considerably from the latter ones, both in colour and sharpness, for the same reason, and also because the spatula removes small particles of material from the contours of the design, thereby making them "woolly." To obviate the aforesaid defects is the object of Grossheim's invention, by means of which the following advantages are secured :—

1. The original plates or rollers are obtained in which the design is engraved to the uniform and necessary depth to ensure good reproduction.

2. The resulting original will last 5–6 times as long as those produced in the ordinary way.

3. Even though it is impossible to entirely prevent the abrasion or removal of small particles of the contours of the design, their sharpness is not deteriorated to any extent.

These results are obtained by engraving or etching the original plate or cylinder very deeply, in fact so deep that it could not be used for printing. This deep design is then filled with any suitable material, such as putty, gypsum, or the like, which is softer than the material of the plate, so that the surface of the latter is made almost perfectly smooth again. A suitable spatula is then scraped over the plate, so as to remove just enough of the soft filling to make the design of the proper depth for yielding copies. This proper depth is thus kept constant, or can easily be made so. Since the total depth of the engraving is 5–6 times that of ordinary plates or cylinders, these latter do not require to be re-engraved on account of wear until a corresponding number of impressions have been taken. The deep engraving or etching being almost at right angles to the surface of the plate, the abrasion of small particles of the edges of the design cannot cause any spreading of the contours. Moreover, even when the plate has become uneven and useless for the time, owing to wear, it merely needs grinding true again to restore the pristine sharpness of the design; and this grinding can be repeated as often as the original depth of the etching allows.

When the plate is worn down so far, it does not, as in the ordinary process, have to be ground down perfectly plain, and etched with a repetition of the design, since the existing design can be etched deeper by coating the raised portions with a resist, thus restoring the design to its original depth for filling as before. In fact, it is to all intents and purposes a new plate, with the difference that no new design has to be engraved.

3. TISCHLER'S METHOD.

For the production of cheap graining transfers, Tischler employs a special kind of metal positives of the designs to be reproduced, these being obtained by etching out the designs on zinc plates by the electro process. The zinc plate is coated with a resist in which the design is drawn by a graving tool, and the resulting place is used as the positive electrode of a galvanic bath. The negative electrode consists of another zinc plate of equal size with the first, and placed at a suitable distance from the latter in the bath. A battery of 8–10 Daniell cells is used, their number varying in accordance with the size of the plate to be etched. By this means the design can be etched out very sharp, clean, and deep. After the current has acted long enough on the plate, which is immersed in a solution of zinc sulphate acidified with sulphuric acid, the etched plate is taken out of the bath, and the resist is washed off with caustic potash or soda lye. All parts of the design will be found etched out to the same depth, a condition that is not very suitable for the production of flexible printing plates therefrom, inasmuch as, in addition to the fine detail in relief, portions of the ground that are not intended to be printed may be transferred to the primed surface and printed.

To obviate this defect it is necessary to wipe the zinc plate with a rag, dry it, and then fill all the recessed portions with a printer's roller composition, made of glue, glycerine, and syrup, so as to make the plate perfectly level, in order to keep the solder used in the next operation from running down into the hollows. The portions representing the grain of the wood must then be raised, more or less with tin, in order that they may appear to be sunk in the transfer paper, whilst the vacant parts in which there is no grain will not print with the rest when transferred to wood. By immersing the plate in warm water, the composition is removed, and the soldered parts are levelled with a scraping tool.

The grained papers are prepared from these plates in the following manner:—

The zinc plate is laid on the hollow bottom plate of a strong press that can be heated by steam and cooled by water. The zinc plate is oiled, and is then filled with the aforesaid printer's roller composition, or with a mass rendered suitably soft by the addition of some hygroscopic salt, like calcium chloride, zinc chloride, or aluminium chloride. The upper plate of the press is covered with a strip of linen, corresponding in size to the zinc plate, and the bottom plate—which must be perfectly even, so as to support the zinc plate at all parts—is provided with four fillets, about $\frac{1}{12}$–$\frac{1}{8}$ of an inch high, which regulates the thickness of the compo to be applied to the linen. On lowering the upper plate, any surplus compo is forced out, and, in the meantime, cold water is introduced into the cavity of the bottom plate, to facilitate the setting of the compo adhering to the linen. The latter will then come away from the plate, carrying with it the raised compo corresponding to the hollows in the zinc plate. This matrix is strengthened with a coating of rubber varnish, and is ready for printing.

For this purpose a roller covered with ink of suitable colour is passed over the face of the matrix, which is then carefully pressed on the prepared printing paper by means of a brush, and as carefully lifted off again. The resulting transfer paper is attached to the surface for which it is intended by simply moistening the back, and only requires a coating of varnish to make it adhere firmly thereto.

CHAPTER V.

Fireproof and Antifalsification Papers.

FIREPROOF PAPERS.

1. According to the process of L. Frobeer, of Berlin, fireproof papers for printed and written documents can be prepared by washing asbestos fibre of the best quality with a solution of potassium permanganate and bleaching it with sulphuric acid. Of this prepared fibre, 95 parts are mixed with 5 parts of scraped or pulped cellulose, of the kind used in paper-making. The mass is placed in a pulp mill along with glue water and borax, and manufactured into smooth paper, which is rendered suitable for writing on, by calendering. This paper, as well as the printing or writing ink to be used with it, can stand protracted exposure to a heat of 800° C.

The fireproof printing and writing ink are made of a mixture of platinum chloride and lavender oil, to which are added—for black, lampblack and boiled oil; for printing ink and Indian ink, water and gum arabic; for writing ink, when the paper printed with this ink is heated to incandescence, the platinum is reduced and remains as a blackish-brown coating. Coloured inks for the same purpose can be made by the aid of metallic under-glaze colours and aquarelle colours, *e.g.* :—

Metallic glaze colour	68 parts.
Aquarelle colour	25 ,,
Dry platinum chloride	2 ,,
Gum arabic	5 ,,

2. Gaspard Meyer's process differs from other asbestos papers, in that the pulp made of asbestos fibre and suitable adjuncts is sized with a fireproof mineral binding medium, such as water glass, before treating with animal size. This is done in order to enable the paper to retain the necessary coherence of structure when exposed to the most intense fire heat, and also to facilitate the staining of the paper right through with the usual fireproof colours.

The subsequent sizing with ordinary size, which is not fireproof, is only for the purpose of imparting gloss and flexibility to the paper. The ink is also made with an admixture of water glass, for the sole purpose of fixing the printed or written characters into the mass by fusion in the event of fire. The asbestos fibres for the paper are cleansed as usual, carded, bleached with bleaching powder and washed, before mixing with 8–10 per cent. of water glass, and 4–5 per cent. of organic paper-stock for pulping in the mill.

For white paper or cardboard, the following proportions are recommended :—

Asbestos fibre	460 parts.
Powdered mica (best) or lime . .	30 ,,
Paper-stock fibre	10 ,,

These ingredients are made into a thin pulp in the usual way, the water content being reduced by the ordinary process of skimming, pressing, and drying.

The primary mineral sizing already mentioned can be applied either to the pulp or the finished paper. In the former case the average proportions are about 4 per cent. of dissolved gelatine, and 6 per cent. of water glass. In such case no cellulose is necessary. The finished paper is sized by dipping the sheets in a bath of water glass containing about 1 per cent. of glycerine, to effect the cohesion of the fibres and maintain uniformity of colouring in the event of fire. This mineral sizing is therefore an important part of the process. It really forms the true fireproof ingredient of the mass, since without it the latter would fall to pieces at high temperatures. The second sizing with glue is of course unable to stand fire, and is employed merely to make the paper glossy and supple. The fireproof inks for this paper are made of fireclay and ultramarine, finely ground together until the desired colour is obtained—or they may also be diluted with zinc white.

For oil colours, *i.e.* those prepared with linseed oil, the following proportions are given :—

Pigment (clay, ultramarine) . . .	10 parts.
Dry water glass	10 ,,

For water colours, liquid water glass is used, with an addition of 1 per cent. of glycerine.

As already mentioned, this addition of water glass is intended for the highly important purpose of maintaining coherence between the applied colour and the paper, in the event of the latter being exposed to intensely high temperatures, the silicate of the colour then fusing with the substance of the paper; whereas, otherwise, the impression or writing on the paper would be entirely destroyed.

To prepare colour for papering and decorative purposes the aforesaid alumina - ultramarine - silicate colour merely needs grinding along with a thin flour paste.

The inventor gives the following instructions for preparing the fireproof writing ink for use with his fireproof asbestos paper: The alumina or ultramarine is ground with water, 2 per cent. of glycerine being then added, and the mixture incorporated with a dilute solution of water glass, the average proportions being—

Colour preparation	20 parts.
Water glass solution	80 ,,

ANTIFALSIFICATION PAPER.

This paper is prepared by treating the paper pulp or finished paper with ferric salts, together with ferrocyanides, *e.g.* lead ferrocyanide, that are soluble in acids but insoluble in water. Chromates, possessing similar properties, may also be used, as well as iron saccharate and soluble ferrocyanides, the paper being afterwards stained with indigo or diamond fuchsin.

When such paper is treated with an acid, Berlin blue (Prussian blue) will be formed, if ferric and ferrocyanides have been used; whilst, in the case of chromates, chromic acid will be liberated, thus destroying the indigo. Chlorine and bleaching powder also destroy the indigo, and cause a yellow stain to appear.

CALOMEL PAPER FOR PREVENTING FALSIFICATION OF DOCUMENTS.

According to the recommendation of Ballandé, of Paris, paper is coated with calomel that has been stirred up in a solution of glue, gum, etc. The coating is applied with a brush, and the quantity of calomel required is equal to 4–8 per cent. of the weight of the paper. The calomel can also be added to the paper pulp in the making; but in this case a much larger amount is needed, 20–30 per cent. After being prepared, dried, and pressed in the usual way, the paper is ready for use. Writings or drawings on this paper must be executed with a special ink containing sodium thiosulphate (hyposulphite) and alum, the most suitable mixture being made of—

Gum water	1000 parts.
Alum	40–60 ,,
Sodium thiosulphate	25–50 ,,

If the ink is to be used as copying ink on the prepared paper, it receives an addition of 5–7 per cent. of calcium phosphate. The reaction of the sodium thiosulphate on the calomel causes the writing to show up as a black stain, which would bleach, however, were it not for the fixing action of the alum. This fixing is so complete that, when the calomel has been added to the paper in the making, the writing or printed impression (produced in the same way) cannot possibly be eradicated without causing a readily detectable alteration in the structure of the paper.

ANTIFALSIFICATION PAPER.

The paper is printed with three colours or inks, two visible and one invisible. The two former are of the same shade, but differ chemically in the one being permanent, the other fugitive. The impression may be applied both as a ground design and as text. On any attempt being made to remove the ink by means of the usual eradicating fluids, the fugitive colour is taken up and reveals a hitherto hidden word, design, or sentence, whilst at the same time the hitherto invisible colour is developed as a dark shade. The design or word can be formed by printing on a ground in two similar colours, with an ink composed of white lead or zinc white (ground in mucilage, fats, or varnishes) with 25–30 per cent. of cobaltous chloride or manganese sulphate. This impression is applied to the parts on which the figures, dates, signatures, or other signs are written. Another way is to print the text on a plain ground in two colours of equal shade, but different chemical properties. The following are suitable as permanent colours for the ground or text:—

Cobalt blue, Prussian blue, vermilion, ochre, lampblack, chrome yellow, orange chrome, chrome green, etc., the fugitive colours being—

Aniline blue, indigo, aniline red, cochineal lake, ponceau, azo dyes, Bismarck brown, aniline grey, fustic, etc.

To produce the invisible colours, the aforesaid permanent colours are mixed with cobaltous chloride or manganese sulphate, to the extent of 20–30 per cent. Under the influence of chlorinaceous bleaching liquids, these salts develop a brown coloration. To prevent elimination by means of alkaline reagents the inks are mixed with gallic or pyrogallic acid, which will give a brown stain with alkalis or chlorine.

In preparing safety inks that will change colour in contact with acid reagents, benzyl red may be used, which, on the slightest contact with acids, furnishes a permanent dark stain. These inks must be made with fats and varnishes. Invisible printing is also employed for preventing any falsification of the numbers on share certificates, coupons, debentures, etc., by printing with colours or inks prepared with dyestuffs that react with alkalis, *e.g.*, alizarine, purpurin, logwood, redwood, orchil, phenols, or phthalein, about 20–30 per cent. of such colours being mixed with the ordinary black printing ink. When alkali is applied to the figures printed with such ink, a bright permanent colour develops at once. Dry alizarine to the extent of 20–30 per cent. may also be added to the ink for printing these figures; and to prevent the changed colour, developed as mentioned above, from being removed by eradication or washing, the entire surface of the paper is impressed with an embossed pattern. The invisible impression can be produced by printing with a preparation of manganese ferrocyanide (or an equivalent mixture of dry potassium ferrocyanide and manganese sulphate), in gum water containing glucose or glycerine, this impression being printed over with ferric sulphate ground with fat or varnish. On applying acid liquids to this impression, Prussian blue is formed.

CHAPTER VI.

Paper Articles.

VULCANISED PAPIER MACHÉ.

THIS substance is made by treating paper with a concentrated solution of zinc chloride (density 65°–75° B.), or with the chlorides of tin, calcium, aluminium, or magnesium. After this treatment the paper must be washed with clean water, until all the superfluous chemicals have been removed. Owing to the circumstance that about 4 parts by weight of zinc chloride are required for one of paper, the process would be too expensive for practical application were it not that the zinc chloride can be recovered in the following manner:—

The washing water is used over again until it reaches a concentration of about 30°–46° B. It is then treated with sodium carbonate, which throws down the whole of the zinc as carbonate, leaving only common salt in solution. The selling price of the recovered zinc carbonate covers the cost of the zinc chloride solution. Moreover, the zinc carbonate can be reconverted into chloride by treating it with hydrochloric acid. The paper treated in the above manner will swell up when damped, sometimes to such an extent as to become useless, and it must therefore be made waterproof. This is done by immersing it for 24–48 hours in a bath of concentrated nitric acid, followed by a thorough washing in water. The time required varies with the thickness of the article, and is longer in proportion as the acid penetrates more slowly. Owing to the difficulty in obtaining nitric acid of the requisite strength, it is preferable to use a mixture of nitric acid sulphuric acids, the proportions of the mixture depending on the strength of the components. The necessity of making the articles waterproof led to the idea of vulcanising the fibres by treatment with concentrated sulphuric acid, *i.e.* by an improved method of parchmenting. Since the articles made of vulcanised fibre are generally very thick and frequently made up of a number of layers of paper, the existing methods of parchmenting cannot be used.

According to a patented process, 1 part of metallic zinc is placed in 32 parts of commercial sulphuric acid, until as much as possible has been dissolved. As soon as the solution is cooled it is mixed with 20 per cent. of dextrin, which has a remarkable influence on the action of the bath, namely, that the paper immersed in the bath is not immediately destroyed by the acid, but retains its adhesive properties for some time after removal. In this way sufficient time is gained to form a millboard from two or more bands of treated paper, or to mould the treated material. This done, the substance is entered into a bath of common salt and water, where, apparently, a kind of double decomposition is set up, the resulting salts, sodium, sulphate, and zinc chloride, being soluble in water, the article is afterwards washed in clean water and subjected to any further suitable treatment. The essential feature of the invention is the addition to the sulphuric acid bath of any substances that are capable of ameliorating or retarding the powerful action of the acid; and the adjuncts specified, namely, zinc and dextrin, are merely mentioned as examples. Zinc, for instance, may be replaced by another metal, *e.g.* iron, and the dextrin by blood, albumin, paper, or paper-stock, the scraps and waste from the material and articles of vulcanised fibre or parchment, and even crude petroleum is said to be suitable.

All kinds of vegetable fibres or fabrics, paper and paper-stock, cotton and all cotton goods and products, can be treated in this way. When sufficiently treated and assembled, they furnish a useful substitute for leather belting. Specially thick millboard is made by rolling in the usual way, and then uniting several layers by coating both sides with the described parchmenting liquid, sticking the pieces together, and then washing them, as already specified. To make the product watertight, a little potassium sulphate is added to the acid bath.

Articles of any desired quality can be produced by this method: hard, soft, flexible, or plastic, such as overlays, belts, tubes, boxes, roofing sheets, figures, ornaments, furniture, etc.

PAPER BOTTLES.

For the production of bottles and other hollow ware, the previously impregnated sheets of paper are made into millboard. Any kind of paper can be used, provided it is well-sized, a typical kind being made from—

Rags	10 parts.
Straw	40 ,,
Brown wood pulp	50 ,,

The paper is impregnated in order to render it waterproof, and also to fasten the individual sheets together. With this object the sheets are coated on both sides with a mixture of—

Fresh, defibrinated blood	60 parts.
Sifted powdered lime	35 ,,
Aluminium sulphate	5 ,,

When the coating is dry, 10–15 of the treated sheets are laid together and immediately placed in heated moulds, and pressed with a stamping press into a shell of suitable form for the purpose in view.

The moulds are made in two parts, each producing a half shell provided at the top, with a mouth and neck for the bottle, and at the bottom with the base of the bottle. The moulds are gently warmed before inserting the paper, and during the pressing the lime enters into combination with the blood albumin, to form a compound that is completely indifferent to water or spirit; after about 5 minutes, the paper mass will be set hard, and the finished half bottle can be taken out of the mould to finish drying in the air, this taking 6–8 days. Half shells of this kind can be bevelled at the adjoining edges, placed together and cemented with waterproof glue or fairly hard rubber cement, which done the vessel is finished.

The finished vessels are provided with the necessary fittings and mounts. In the case of bottles, for instance, a tin stopper is attached, two rings of tin being drawn over the neck and pressed tight on the lathe, with a tool similar to that used in pressing the tubes into tubular boilers. The stopper can also be cast on, but this is undesirable where rubber cement is used, as it injures that material. To the outer tin ring is attached the head of the stopper, containing a tubular projection for holding the stopper itself. When the ring is screwed down, the locking device is screwed over the stopper. The bottle is next coated inside with wax or paraffin, the latter being preferred as being without taste or smell. The finished bottles are varnished or polished on the outside to improve the appearance.

UNBREAKABLE WRITING TABLETS.

Ruled paper is coated on the face with a mass consisting of—

Pale boiled oil	80 parts.
Rectified turpentine	10 ,,
Chemically pure glycerine . . .	4 ,,
Benzol	3 ,,
American petroleum	3 ,,

After drying for 5 days, this coating is backed by a thick pulp, prepared from—

Boiled oil	70 parts.
Oil of turpentine	10 ,,
Zinc white	100 ,,

whereupon the lines will be found to show through the paper. The resulting sheet is backed with two thicknesses of pasteboard, the whole being stuck together in such a manner that the edges of the paper are completely hidden. This prevents the edges from turning up and the lines being washed out in cleaning the tablets. To prepare these tablets for writing on, they are coated with a finishing layer of white shellac, absolute alcohol, petroleum, and benzol.

PLASTIC ARTICLES OF PAPER.

Plastic articles of all descriptions, especially decorations and ornaments, can be made from paper, so as to resemble plaster casts, stamped metal, or carved wood. Two press moulds are used—the one positive, the other negative—fitting one into the other. Sheets of damped ordinary paper are laid one above another in the negative mould, and pressed down with the finger into all the depressions and corners of the pattern, a liquid adhesive—glue, gum, paste—being applied between each adjacent layer. When a sufficient number of layers—usually 10–15 sheets—of ordinary wrapping paper have been put in, the positive mould is laid on the negative, and the whole is subjected to heavy pressure in a press. This forces the paper mass into all the irregularities of the negative mould, so that the article on being taken out of the mould gives a very accurate reproduction of the contours of the negative. The pressed articles are dried carefully and then trimmed, *i.e.* the protruding, superfluous parts are cut off, in accordance with the contours of the article to be produced, and the latter is finally painted or ornamented with bronze powder or gold or silver leaf.

WATERPROOF COVERINGS FOR WALLS AND CEILINGS.

A band of linen, calico, or canvas, and another of strong brown paper are passed through a bath of strong paste, and then united by means of an adhesive composed of 2 parts of flour paste and 1 part of glue.

Before the material is quite dry it is passed through a calender, in order to fasten the two layers tightly together and give the article a smooth surface. The next step is waterproofing, by means of a coating of drying oil (linseed oil), which at the same time imparts an appearance similar to leather, a second coating being given if necessary, together with any desired colouring matter. If a printed design is to be produced, the material is passed between rollers, one of which is coated with an overlay of felt or rubber—which may also be in the form of an endless band—whilst the other is engraved and coated with ink or colour. The second roller may be heated, and the two rollers can be set at variable distances apart. Motion is imparted to the elastic roller, the other being carried round by friction. The printing roller is supplied with colour by an ink roller, which in turn receives it through a number of distributing rollers from an ink duct.

This process is the subject of English Patent No. 354 or 1889, which also covers the machine for carrying out the process. This machine contains four rollers in pairs, one roller in each pair being heated, the other solid. One pair effects the union of the paper and canvas, the other the printing or pressing of the united material, and being, for this purpose, fitted with an inking device. If desired, the material can be coated with linseed oil on the under side, and the impression may also be coated in the same manner.

PARCHMENT SLATES.

Good paper is soaked in boiled linseed oil and coated with several layers of the following composition—

Copal varnish	1 part.
Oil of turpentine	2 parts.
Fine sand	1 part.
Powdered glass	1 ,,
Ground slate, as used for slate tablets	2 parts.
Lampblack	1 part.

these ingredients being intimately mixed together and ground fine. The finished sheets can be written on with either lead or slate pencil.

FLANGES AND MANHOLE RINGS.

These rings are made of good, strong millboard, and are primed with a mixture of graphite 100 parts, asbestos 100, alum 2, rye meal 20, and water 75 parts. The mass is ground very fine in a colour mill and applied evenly to the rings, three coatings being given. The rings, when perfectly dry, hard, and solid, are coated three times with a mixture of—

Graphite	50 parts.
Chemically pure white lead	5 ,,
Manganous borate	½ part.
Good boiled linseed oil	20 parts.

and will then be ready for use. Before putting them in position for fastening, the rings are coated with a stiff, putty like mixture, made from the same ingredients as the above, the joint being also packed with rings of rubber or similar material. This system of jointing is very staunch, and the rings, which are very light, can be used repeatedly.

PAPER WHEELS, ROOFING, AND BOATS.

Paper railway wheels consist of a cast iron or steel skeleton, the intermediate spaces being filled with compressed pulp, in place of the wood formerly used. A wheel of this kind is shown in Fig. 4, in which the white parts are intended to be filled with paper, the latter being thoroughly embedded and bolted in. *A* is the steel hub for receiving the axle, and is surrounded by a circular extension that is firmly held in the mass of paper. *B* is the steel rim, resting firmly on the paper filling; and iron plates on either side are connected by bolts passing through the substance of the paper.

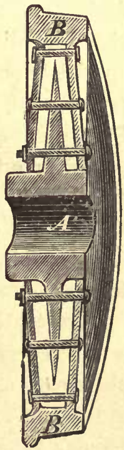


FIG. 4.—Paper railway wheel.

In America, cupolas and domes are now made of paper. They are characterised by extreme lightness, and are made in 24 or 30 sections, produced by sticking together a number of large strips of suitable paper over a wooden model. Each section extends from the base to the apex of the semicircular dome, and thus forms an arched strip, broad at the base and tapering upward. Good paper is cut into shape from a roll, damped and laid on the wooden model, a sufficient number of these strips being stuck together to give the desired thickness. The strips retain their shape, and when dry are hard and strong. They are waterproofed by oiling, hot ironing, tarring, and varnishing, and then fitted together to make the dome.

The inventor, Waters, of Troy (U.S.A.) also makes paper boats in the same way. He first employed best Manila hemp paper, cut into strips of the length of the boat. The first strips were moistened and pinned on to a wooden model of the boat, and these strips were pasted over with successive layers of the same material until a thickness of about $\frac{1}{8}$ inch was reached. The boat, after being thoroughly dried, waterproofed with oil, varnish, and tar, and taken off the model, was perfectly staunch, the walls being stiff and retaining their shape perfectly. The boat was much lighter than wooden craft, and seamless, consisting of one piece of felted and coherent paper.

The inventor commenced building paper boats on a manufacturing scale, and afterwards constructed vessels of larger size, including a steam yacht. This was 25 ft. long, made of special paper obtained in the form of damp sheets from the paper mill, and the sides were $\frac{2}{5}$ of an inch thick, a layer of asphaltum being interposed between the sheets of paper, in order to keep out the water more effectually. The paper hull was fitted with a wooden keel, and wooden ribs for the purpose of carrying the floor planking and the steam engine. The large hull was made in two parts, fastened together at the keel and caulked.

A method of making a skating rink of millboard and paper was recently patented in Germany, the material employed being sheets of millboard, impregnated with paraffin and boiled oil, subjected to powerful pressure, and covered with parchment paper. The sheets were carefully laid on a perfectly level cement foundation, so as to form a smooth track, the surface being coated with a special waxing composition. For such a rink it is, of course, necessary to use skates that have perfectly smooth bottoms, without any sharp edges that could cut into the track.

PAPER BARRELS.

The paper for making barrels is manufactured from wood pulp, and is wound into large endless rolls on iron cores. The end of the roll is passed over a smoothing roller, that takes out all creases, and then over a large roller, where it is sized by contact with a third roller. It is next wound 30–40 times on a mould, consisting of a collapsible steel cylinder, the diameter of which can be reduced to allow the mould to be taken out of the paper shell. The rough paper cylinder is placed in a moderately warm room to dry, and is next glazed in a stove. Thorough drying is necessary to prevent the formation of bubbles or blisters. The cylinder is hooped with paper hoops, and fitted with an inner ring at each end to hold the barrel ends. The hoops are drawn on whilst wet, and shrunk on by drying. These hoops are made in the following manner: The barrel mould already mentioned is fitted with an attachment consisting of a comb with wide-set teeth and a cutting device, so that the layers of paper are cut, in the winding, to the right breadth for the hoops. The ends of the paper cylinder are turned in a lathe and fitted with ends, the latter being made by gluing a dished sheet of millboard on to the inner ring, and covering this sheet with a thicker one or a wooden end. Over the latter is laid a broad wooden or millboard crosspiece, and over this again an inner hoop, fastened to the outer end hoop by nails. For holding liquid chemicals these barrels are lined with a resistant coating, the nature of which varies according to that of the contents. The absolute impermeability of these barrels is demonstrated by the fact that they are largely and successfully used for the conveyance of aniline dyestuffs. At one time these dyes were always packed in wooden casks lined with sheet metal; but these did not always prove satisfactory, whereas the paper barrels now used are never known to leak. As already mentioned, paper barrels are not only lighter—which is an important consideration in the cost of conveyance,—but are also cheaper than good barrels of hard wood. On the other hand they are dearer than soft wood casks, such as are used for dry materials like gypsum, cement, etc., though they have the advantage over the latter in point of greater durability and being perfectly watertight. Smaller vessels—vases, and the like—are made by stamping; but this seems impracticable for large sizes, not only on account of the larger appliances required, but also since the distribution of the paper mass is less uniform, and the risk of cracking is consequently greater.

PAPER GASPIPES.

Paper gaspipes, which are being successfully used, are made by lapping good cellulose paper round a solid core of suitable diameter, each layer being dipped in melted asphaltum. The resulting pipes are quite impervious to air and water, and are able to stand heavy pressure and all other destructive influences. The lengths of pipe are fastened together by means of asphalted paper connections. This class of piping offers the advantages of being cheap, light, and unbreakable, as well as being stronger than the other materials in use for the same purpose.

PAPER BOXES.

To make paper boxes, large sheets of paper are stuck together by means of a paste prepared by boiling fine wheaten flour and glue with water. This paste is applied to one side of each sheet of paper with a brush, the two pasted surfaces being then laid together and pressure applied by working over the whole surface from the centre outwards with a coarse woollen rag, to drive out all air bubbles, the united sheet being then dried in a stove. This done, the sheets are treated in the same way in pairs, and this is repeated till the desired thickness is obtained. The thick sheets are pressed in oiled moulds, dried, coated with oil and baked in a stove, whereby they acquire the hardness and solidity of wood.

PAPER HORSESHOES.

Horseshoes are made from paper that has been rendered impervious to moisture by parchmenting, or by impregnation with oil, turpentine, etc. A sufficient number of these thin sheets of prepared paper are stuck together with a wet-resisting composition that does not become brittle on drying. Such a composition is found in casein glue, chrome glue, ammoniacal copper oxide, or a mixture of Venice turpentine, levigated chalk, varnish, and linseed oil (raw or boiled). The separate sheets of parchment paper can be cut to the desired shape, the nail holes being stamped out at the same time, and then fastened together as described; or the shoes can be stamped out after the sheets have been pasted together. This stamping is done while the paper is still damp, since it is more difficult to work when dry. The shoes are subjected to powerful pressure, *e.g.* in a hydraulic press, and dried, followed by filing or planing true.

The shoes may also be made from paper pulp, containing an admixture of chalk, clay or sand, turpentine, varnish, linseed oil, etc., in sufficient quantity to make the mass waterproof when dried. At the same time these substances impart the desired elasticity and toughness to the mass, which is next stirred to a thick pulp and pressed in suitable moulds, or cast in sheets and stamped out to the proper shape, subjected to heavy pressure and dried.

The first method, by pasting together thin sheets of paper, is, however, the best, the shoes being more elastic and tougher. The shoes may be attached to the hoof by nails or by means of an adhesive such as asphaltum, caoutchouc, or a mixture of 1 part of gum ammoniacum and 2 parts of gutta-percha. The fact that the surface of the shoe roughens in wear, is advantageous as preventing the animals slipping on greasy roads.

CHAPTER VII.

Gummed Paper.

THE adhesive for making gummed paper is prepared from 1 part of gum arabic and 2 parts of cold water; a weaker form containing 3 parts of water and 10 per cent. each of honey and glycerine.

The finished solution, which must not be made with hot water, or it will cause the paper to cockle, is strained through flannel, and applied to the paper by means of a good bath sponge, the paper being laid on a smooth, even piece of millboard. The gummed sheets are placed on thin millboard, or a drying rack, and allowed to dry. To accelerate solution and prevent the gum arabic balling in the water, a quantity of coarsely crushed glass is added to the mixture, this substance separating the fragments of gum and presenting a larger surface to the solvent action of the water.

Machines are frequently used for gumming or varnishing large sheets of paper, but are not economical unless they can be kept constantly running. These machines may be divided into two classes. In the one the paper is gummed, while passing over a large cylinder, by contact with quick-running flexible rollers which take up the gum from a trough and distribute it evenly, by centrifugal force, over the surface of the paper. These machines, however, have not made much headway in practice, since they do not apply the gum as uniformly as can be done by hand.

The machine shown in Fig. 5 is intended to obviate these defects, and is characterised by the feature that two sheets can be gummed during one revolution of the cylinder, and by the absence of clips. The gum is applied by means of rollers, which are kept moist with liquid adhesive, and transmit the

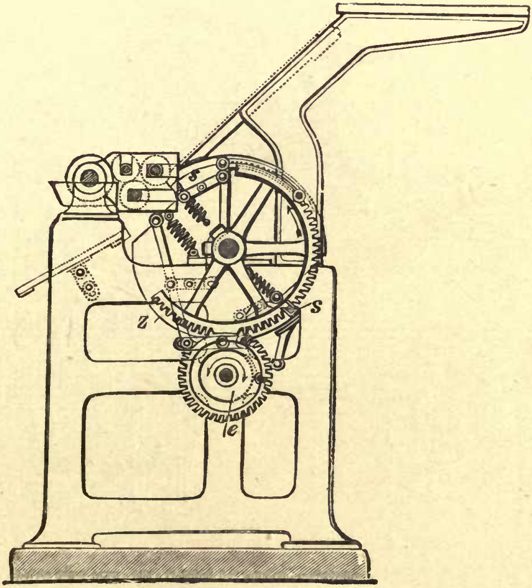


FIG. 5.—Steinmesse and Stollberg's gumming machine.

same to the surface of the paper running between them and the cylinder.

The cylinder Z, carrying the paper, is driven from a shafting by means of cogwheel gearing. To enable two sheets to be gummed in one revolution, a stop motion is provided in the gearing, so that the cylinder can be stopped twice for a short time during the turn. For this purpose two blank spaces are left at diametrically opposite positions in the periphery of the large cogwheel, and one such space on the small wheel, which is half the size of the former. The surfaces of the blanks on the large wheel are concave, that on the small wheel being convex and somewhat longer, so that when these spaces come

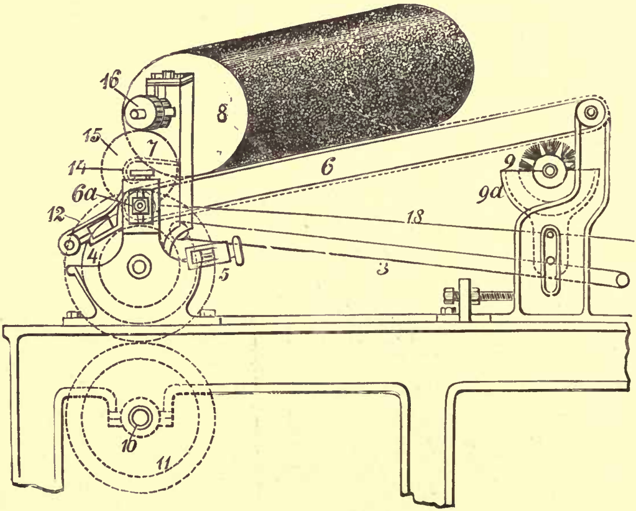


FIG. 6.—Machine for gumming paper.

into position together, the driving wheel slips by the other without moving it, for a short time.

During this stoppage the gumming device is drawn back from the cylinder, leaving a small intermediate space between them, and at the same time a sheet of paper is fed into the machine. With this object, the sheet is pushed from a sloping table above the cylinder *Z*, so that the lower edge of the paper rests against a small pin *s*, projecting from the cylinder. When the latter starts again, the pin is pushed back, and at the same time the gumming device is moved toward the cylinder. The sheet is thus drawn between the cylinder and the gumming rollers, and is coated by the latter. The movement of the setting pin and gumming device is transmitted from the driving shaft by means of eccentrics or cams and a train of levers, slides, rods, and springs, as shown in the drawing.

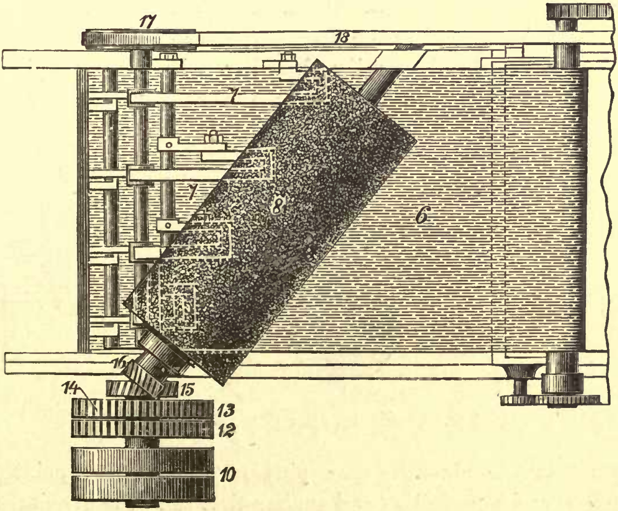


FIG. 7.—Machine for gumming paper.

The gummed sheet is delivered on to a second sloping table at a lower level; and the parts are so calculated and arranged that, as soon as a sheet is finished, the cams again come into contact with the roll, and the operation is repeated.

The gumming device consists of a series of close-fitting rollers, with elastic surfaces, driven by friction from a roller mounted on the shaft. The last named roller revolves in a trough charged with liquid gum, and transmits this gum to the rollers in the usual way.

MACHINE FOR GUMMING PAPER.

The sheets to be gummed, varnished, etc., are laid on the endless bands 3 (Fig. 6), which feed it to the gumming rollers. The adjustable, revolving roller 5, wipes the superfluous gum from the roller 4′, and determines the thickness of the layer of gum to be applied to the paper.

The endless band or roller 6, is covered with small pins of brass wire, of the same type as the card clothing used in

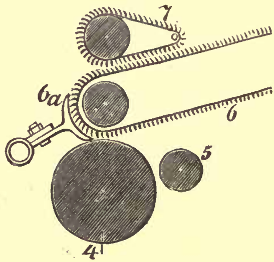


FIG. 8.—Machine for gumming paper.

carding textile fibres. These pins form numerous points of support, and a perfectly level surface that can be easily cleaned, an essential feature for doing good work.

The advancing sheet of paper is deflected by the curved guide 6*a*, on to the upper surface of the band 6, and under the similar endless bands 7. These hold the paper firmly while it comes under the cylindrical brush roller 8, which is usually mounted slantwise over the band 6, and spreads the gum or colour evenly over the surface of the paper. For special purposes it can also be arranged to produce a stippling effect. The band 6 is cleaned by a roller brush 9, dipping into the trough 9*a*.

The machine is actuated as follows: The driving shaft 10 carries a pinion 11, engaging with a corresponding pinion 12 on the shaft of the gumming roller 4. The latter shaft also carries a pinion 13 (Fig. 7), engaging with the pinion 14 on the shaft of the drum actuating the endless band 7. The same shaft carries a pinion, transmitting motion to the pinion 16 on the shaft of the brush 8. The feeding band 3 is driven from the pulley 17 by the belt 18.

CHAPTER VIII.

Hectograph Papers.

HECTOGRAPH SHEETS.

Gilder's glue	200 parts.
Water	300 ,,
Glycerine	700 ,,

THE gilder's glue is broken into small lumps and placed in a vessel with the water, to stand over night. Next day the vessel with the swollen glue is transferred to the water-bath and the glycerine is poured in, the whole being left as quiet as possible, except for an occasional gentle stirring to facilitate mixing and dissolving. When the glue is dissolved, and the mass is so far concentrated that a small sample sets to a fairly solid, non-tacky mass when dropped on a cold stone, the surface is wiped over with a stiff sheet of paper to remove the bubbles, and the mass is formed into sheets in the following manner:—

The mass is poured out in a fairly thin layer on to a large, clean, warm sheet of glass, and immediately covered over with fine, soft blotting paper, which is pressed on to the surface, the whole being transferred to a cool place to harden. When cold, the paper with the sheet of jelly is taken off the glass, and forms a hectograph sheet with an extremely fine, smooth surface.

ENDLESS HECTOGRAPH PAPER.

This product is a strong paper, coated on one side with a very thin film of copying composition (glue and glycerine). The apparatus for coating the paper (Figs. 9 and 10) consists of

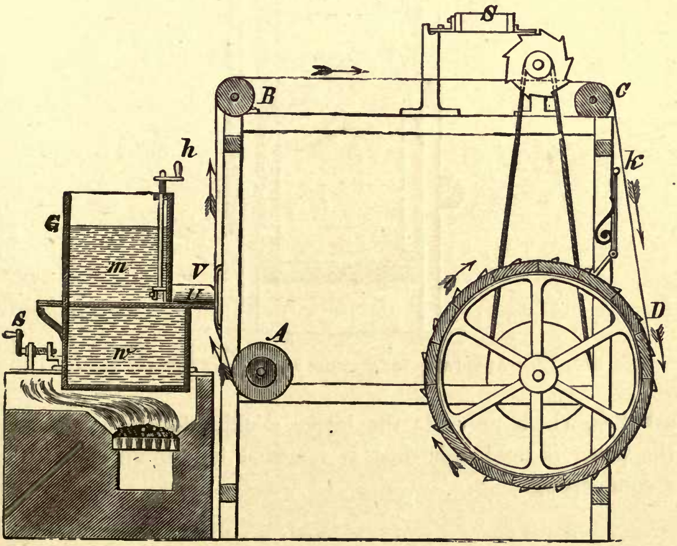


FIG. 9.—Apparatus for making endless hectograph paper.

roller *A* carrying the roll of paper, a pan *m*, for the composition, heated by a water-bath *w*, and provided with a spout *U*; an elastic backing support *V*; a drum *D*, for winding up the finished hectograph paper, and a vibrating device *S*, charged with dusting powder.

The ascending paper is coated with a thin film of the hectograph composition in passing before the mouth of the spout *U*. The composition sets immediately, but as it is too tacky to stand rolling, it is dusted over with a fine powder, *e.g.*

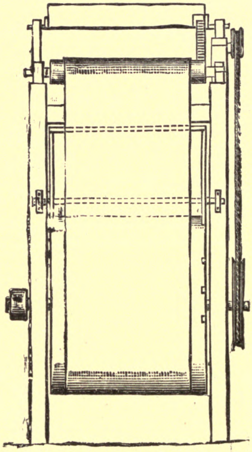


FIG. 10.—Apparatus for making endless hectograph paper.

asbestos, which prevents the layers sticking together. Before the paper is used, this dust is removed by wiping over with a damp sponge.

CHAPTER IX.

Insecticide Papers.

FLY-PAPERS.

THE majority of fly-papers are not of a perfectly harmless nature, consisting, as they do, of a poison sweetened with sugar. A certain amount of caution is therefore necessary in both making and using these papers. On the other hand, the employment of poisons, especially arsenic, mercury, or antimony compounds, can be easily avoided, and fly-papers made that are perfectly harmless to men and mammals.

(a) *Saccharin Paper.*

Saccharin is greedily consumed by flies, on which, however, it acts as a fatal poison. Being too expensive to use alone it must necessarily be employed in the form of fly-paper. A fairly strong solution in water is used, mixed with a few drops of aromatic honey, the (unsized) paper being drawn once or twice through this solution, and then quickly and thoroughly dried at a moderate temperature. Rough or embossed paper is better than smooth, as being less liable to soften or sink under water, and presenting a larger number of points of contact for the flies.

(b) *Non-Poisonous Colocynth Paper.*

Quassia 40 parts, colocynth 5, black pepper 8, syrup 10 parts, boiled in water sufficient to make 120 parts of extract. Paper is dipped in this solution, and then dried quickly to keep it from turning sour.

(c) *Non-Poisonous Quassia Paper.*

One part of quassia chips is suffused with 5 parts of water, left to stand over night, and boiled until it furnishes 2 parts of liquid after straining. The chips are again boiled with 2 parts of water until the latter has diminished to one-half. The two strained solutions are mixed, and $\frac{1}{2}$–$\frac{3}{4}$ part of sugar is dissolved in them. Fairly thick, unsized red blotting paper, printed beforehand, is dipped in the solution, drained, and hung up to dry.

(d) *Non-Poisonous Vegetable Fly-Paper.*

Ground black pepper is mixed to a thick paste with sugar solution, and applied to blotting paper in such a way as to be absorbed by the latter. The sugar soon dries, and this property makes the paper more convenient for packing and transport than when syrup is used. For use, the paper is moistened with water and laid on a plate. The finished paper may be sent out in pressed packages. The same product can be obtained by mixing sugar and $\frac{1}{3}$–$\frac{1}{4}$ of ground black pepper with the paper pulp, which is then quickly worked up into a porous paper of loose texture.

(e) *Poisonous Fly-Paper.*

Filter paper is dipped in a solution of 2 parts of white arsenic and 4 parts of colocynth in a sufficient quantity of water, and is then dried.

A second recipe consists of—

Potassium bichromate	10 parts.
Sugar	30 ,,
Ethereal oil of pepper	2 ,,
Alcohol	20 ,,
Distilled water	120 ,,

These ingredients are intimately mixed and left to stand for several days, with occasional shaking, and then filtered. Unsized paper is dipped in this solution several times, and then dried.

Again—

Larch turpentine	24 parts.
Castor oil	4 ,,
Syrup	4 ,,

are dissolved in warm water, and applied to the paper with a brush.

NON-POISONOUS PAPER FOR DESTROYING RATS AND MICE.

This paper is made with the assistance of the plant known as squills. The most suitable shape for putting this preparation on the market is that of millboard cakes, which, however, must be friable, porous, and absorbent, and not firm and tough like the ordinary millboard. The squills are cut up into cubes, well dried, and then ground, the powder being mixed with the fluid pulp, and the whole mixed with starch and poured quickly into moulds, forming cakes about $\frac{1}{5}$–$\frac{2}{5}$ of an inch thick.

The most suitable proportions are about equal parts of powdered squills, dry millboard-stock, and starch, made up into square cakes stamped with a name. For use, the poison cakes are soaked by smearing them with hot fat, and laid in suitable places.

MOTH PAPERS.

(*a*) Naphthalene Moth Paper.

Carbolic acid	25 parts.
Ceresine	25 ,,
Naphthalene	50 ,,

The ingredients are melted together and applied to paper spread on a hot iron plate, in a similar manner to that practised in making wax paper.

(*b*) Wax	10	parts,
Olive oil	10	,,
Camphor	15	,,
Naphthalene	250	,,

are carefully melted over a slow fire, and employed for dipping blotting paper. A tight-fitting cover should be provided for the pan, in the event of the naphthalene taking fire.

(*c*) Carbolic acid	25	parts,
Ceresine	25	,,
Naphthalene	50	,,

are melted together, and the mixture is applied to unsized paper spread out on a copper or iron plate.

(*d*) Manila paper is impregnated with a solution of the following composition, and is then pressed and dried over hot rollers. The mixture consists of—

Coal tar	70	parts,
Crude carbolic acid (containing at least 50 per cent. of phenol)	5	,,
Thin coal tar, warmed to 70° C.	20	,,

mixed with

Refined petroleum	5	,,

(*e*) Naphthalene	450	,,
Eucalyptol	20	,,
Ceresine	250	,,
Alcohol	100	,,

The naphthalene is melted with the ceresine in an iron pan, the strong alcohol, in which the eucalyptol has been dissolved, being added to the liquid mass after the same has been taken off the fire. The mixture is constantly stirred and warmed at intervals, whilst it is being applied to the surface of white blotting paper with a wide paint brush, the paper being hung on strings over a source of heat to dry.

The naphthalene should be as chemically pure as possible, owing to the almost unbearable smell of some kinds of crude naphthalene. If necessary, the mass may be scented with about 1 part of ethereal oil of bergamot to every 10 parts of naphthalene, and it may even pay to put the two grades of moth paper (scented and plain) on the market to meet requirements. Moth paper is in good request in the spring, and is preferable, on the score of convenience, to moth spirit or moth powder. The paper is merely laid among the apparel to be protected from the ravages of the moths. The paper is packed for sale in packets of 10, wrapped in tinfoil or waxed paper and securely fastened; or, for larger buyers, 100 papers may be packed in a suitable tin. Instead of using a label, the name, etc., may be printed on the papers themselves.

CHAPTER X.

Chalk and Leather Papers.

1. glacé chalk paper.

Parchment cuttings	4 parts,
Isinglass	1 part,
Gum arabic	1 ,,
Water	236 parts,

are boiled together until the volume has shrunk to $\frac{1}{2}$. The strained decoction is divided into 3 parts, which are mixed with 39, 32, and 25 parts of white lead respectively, a single coating of each being applied to the surface of smooth writing paper with a soft brush, 24 hours being allowed for drying after each application. The paper is finally passed between polished copper or steel rollers. White lead is frequently replaced by zinc-white or permanent white, and isinglass by colourless gelatine.

2. warren de la rue's recipe.

Zinc-white is ground extremely fine in water and mixed with glue (1 part of dissolved glue in 60 of water), in the proportion of 34 parts to 10. The liquid is strained through a fine sieve, and applied to the paper in three or four coatings. After the last coating is dry, the paper is calendered between press sheets.

3. CHALK PAPER: PAPIER MÉTALLIQUE, IVORY PAPER.

This paper, which can be written on with metal pencils (an alloy of 1 part of tin to 2–3 parts of lead), so that the writing cannot be obliterated with indiarubber, is made by coating very strong, smooth Berlin paper on both sides with milk of lime. The paper is then dried, smoothed with a paper folder, laid between polished sheets of copper, and put through a copper-plate press.

A simpler way is to coat the dry paper with levigated chalk, and rub it over with cotton wool until no more particles of chalk come off.

LEATHER PAPER.

Vegetable leather or leather paper, which is more widely used than real leather for Japanese fancy goods, is prepared, according to Ransonnet, by repeatedly crimping vegetable paper, until it has been reduced in size and made more compact, without being thickened to any appreciable extent. The crimping, which is performed in all directions and so as to form irregular wrinkles, makes the paper look something like shagreen leather. The product is as tough and durable as leather, and much less susceptible to the action of water. In order to obtain these results it is of course necessary to use paper of long-staple. A kind of imitation pigskin can be made by hammering the paper in addition to the crimping.

Kellog's Leather Paper.

Leather scraps are pulped in a mill and mixed with long-staple paper-stock, gelatine being then added, and the whole worked together under the influence of heated steam. The homogeneous mass is made up into sheets and rolls in the papermaking machine, and is pressed and dried like ordinary paper. The finished sheets are finally tanned, and stained or printed according to requirements.

Leather Paper.

The imitation leather produced by the Oriental Leather & Lederette Company is preferably made from long-staple paper, of the requisite thickness, dyed or stained to the ground colour the finished article is desired to possess. The surface is then coloured with any other desired shades, and varnished with a solution of shellac in naphtha or water (1 part of shellac to $4\frac{1}{2}$ parts of solvent), to make it waterproof. The suppleness of the paper is increased by the aid of glycerine. If the paper has been stained by dipping, the glycerine is added to the dye-bath in the proportion of 1 part in 15, otherwise the glycerine is worked into the surface of the paper by brushing or other means, or by dipping in an aqueous solution of glycerine (2 : 1). The prepared paper is grained to imitate any kind of leather that may be required. For this purpose a skin or hide of morocco or other leather to be imitated is taken, and a mould is prepared from this of any suitable material (shellac, for instance), the moulding composition being applied to a strong metal or other plate. If shellac be used, a cast iron plate with an even surface and upturned edges is employed. This plate is covered with shellac and warmed until the shellac has melted and run evenly all over the surface. The hide or skin is first dusted or rubbed over with powdered graphite, and pressed evenly on the shellac. As soon as the latter is cold the hide is taken off, and the mould will be ready for use. To transfer the impression to the prepared paper, the latter is laid on the mould, backed with a rubber or gutta-percha sheet, and subjected to heavy pressure in a hydraulic press. Where the pieces of paper are of considerable length, the impressions are allowed to overlap a little, so as to prevent any visible line of demarcation between them. On removing the paper from the press the grained surface is smoothed, polished, and varnished, in order to make the imitation perfect.

Finally, the paper is waterproofed with a coating of thin shellac varnish, applied by a brush.

Klein's Imitation Leather.

According to the Patent Specification, a material suitable for replacing good, waterproof leather, is obtained from wood cellulose and fats, the product being specially adapted for shoe heels, welts, and inner soles, but also for making waterproof trunks, handbags, school satchels, etc.

The material for this imitation leather consists of thin board made from boiled wood pulp. These sheets of board are impregnated with fatty substances as follows: Good, pale linseed oil is boiled continuously for 5–6 hours with $3\frac{1}{2}$ per cent. of litharge and a little Frankfurt black, the resulting thick oil being allowed to settle, then mixed with 2 per cent. of drying varnish, and applied hot to both sides of the sheets, so as to thoroughly impregnate them. This done, they are left to dry and harden in the air, and are afterwards calendered between iron rollers, this operation forcing the oil into still more intimate contact with the fibres, and imparting the necessary toughness and close texture of good leather.

To make the imitation more complete, the product may be varnished on both sides with a preparation obtained by boiling the above varnish with 2 per cent. of powdered driers, and 3 per cent. of prepared burnt sienna for 3–4 hours. When clarified, this varnish is laid on hot in the same manner as before, and the dried sheets are pounced and smoothened. In this second coating, no more boiled oil should be used than the paper can absorb, otherwise the surplus will form a glossy, tacky coating on the surface. The added driers are intended to accelerate drying, and the sienna gives an excellent imitation of the reddish shade of real leather. The product thus obtained is claimed, too, for a satisfactory, cheap, and durable imitation of the genuine article.

For making hand and travelling bags, satchels, etc., thinner sheets are treated in the manner described, until the desired elasticity has been attained. When dried, the paper can be stained in any desired shade, or made to imitate patent leather, and grained as desired.

CHAPTER XI.

Luminous Papers—Blue-Print Papers—Blotting Papers.

LUMINOUS or phosphorescent papers will only shine in perfect darkness, and not even then unless they have been previously exposed to daylight for at least 10 hours. Articles decorated with these luminous papers, such as candlesticks, matchboxes, etc., are rendered visible in the dark, and any figures or inscription can be read, but the luminosity does not extend beyond these limits. These papers are prepared by coating with luminous paint, the basis of which is barium sulphide, or calcium sulphide ground to an extremely fine powder, for which purpose it is essential that the grinding surfaces should be of unequal hardness. Calcium sulphide mixed to a paste with water can be ground under the same conditions as pigments, and the finished mass must be stored in a tightly closed vessel, to prevent desiccation. In addition to being finely ground, the pigment must be uniformly and closely distributed over the paper, and to secure this only the smallest possible quantity of medium can be used. It should be of the best quality, and the greater the fluidity of the mass, the more uniform will be the distribution. Each coating must be so far dry before the next is applied, that the paper can be bent without cracking the coating. The thinner the several layers, the more closely will they adhere together, and the greater the uniformity of the coating, the higher the luminosity. After 3–4 coatings have been applied, the surface is subjected to strong pressure, in order to fill up any interstitial spaces. Isinglass forms the most suitable medium for the pigment. To enable the coating to better resist moisture, it is coated with a dilute solution of potassium bichromate whilst still moist, and exposed to direct sunlight. The operations are somewhat troublesome and lengthy, but this is compensated by the good result, since the surface so prepared will, after exposure to light, continue luminous for 30 hours in the dark. The most suitable paper for coating is Japanese satin paper or copying paper, but a certain amount of care is necessary in lifting the prepared paper, since it is penetrable and therefore tends to stick on the under side. The paper being obtainable in roll form, the luminous surface may be made in long lengths and cut into any shape. At the same time the method of preparation can be performed with the utmost care. The thin paper can be stuck on metal as well as on glass; and if the coating be thin ($\frac{1}{25}$–$\frac{1}{15}$ inch), the paper can be bent without causing the coating to crack or peel off. It is, however, important that each coating should be thoroughly dry before the next one is applied, and also that the isinglass should be made waterproof with bichromate as already described. Again, pressing should be repeated so long as the coating remains damp and soft. To thoroughly fill all the interstitial spaces the coating should be finished off by rubbing a little of the liquid composition into the surface with an agate burnisher, which produces a compact surface, glossy when dry. Where the method has not given satisfaction, the cause must be attributed to insufficient attention to the details given; but when the instructions have been carefully followed, the product, after exposure to light, is sufficiently luminous to show the time by a watch. It may be mentioned that isinglass can be replaced by the best gelatine.

2. The luminous mass is prepared from—

Potassium bichromate	4 parts.
Gelatine	4 ,,
Calcium sulphide	50 ,,

The ingredients are ground in a thoroughly dry state until intimately mixed; and 1 part of this mixture, triturated with 3 parts of hot water, forms the coating composition. When dry, the coating is waterproof. The composition is applied to paper, cardboard, in one or more coatings, with a brush in the usual way. Then, in order to distribute the coating uniformly over the entire surface of the paper, and ensure even luminosity, the sheets are passed through a kind of calendering machine, the rollers of which are set close enough together to squeeze the coating to a uniform thickness. The rollers, etc., may be heated. Instead of applying the composition as above, the paper, cardboard, etc., may be coated or printed with size or other adhesive, and then dusted over with powdered calcium sulphide, the thickness of the layer being made uniform by calendering. By means of this dusting process the coating may be limited to certain parts of the paper surface, such as letters, figures, etc., printed with the adhesive medium. The inscription will then show up in the dark against the non-luminous background.

LUMINOUS PAPER.

A waterproof, luminous paper, retaining its phosphorescent powers for several months, can be prepared from—

Dry paper-stock	40 parts,
Water.	100 ,,
Phosphorescent powder . . .	10 ,,
Gelatine	1 part,
Potassium bichromate	1 ,,

mixed together, and made into paper in the usual way.

BLUE-PRINT AND SIMILAR PAPERS.

Albumin Blue-Print Papers.

Very fine effects can be obtained by the use of ordinary albumin paper sensitised by floating on a solution of—

(*a*)	Ferro-ammonium citrate . . .	15 parts,
	Water	65 ,,
(*b*)	Potassium ferrocyanide . . .	10 ,,
	Water	65 ,,

for half a minute, and then placing it in a dark room to dry. The prints, which are developed by washing in water, are as distinct and full of detail as albumin prints, whilst the process is cheaper and simpler. The prints may be mounted and glossed. Neither the sensitised paper nor the solutions will keep, and should therefore be prepared freshly for use.

Haupt's Sensitive Paper.

A sensitive paper, similar to Talbot's, with good keeping properties, is prepared by floating strong arrowroot or albumin paper on a bath of—

Water	32 parts,
Silver nitrate	3 ,,
Citric acid	1 part,
Tartaric acid	$\frac{1}{2}$,,

for a minute, the paper being dried and finally passed through a weak solution of tartaric acid.

This paper will print without fumigation with ammonia, needs a strong and alkaline toning bath, and, if air and moisture be excluded, will keep good for 2–3 months after sensitising.

Ferro-Prussiate Blue-Print Paper.

(*a*) For Blue Lines on a White Ground.

Plain photographic or, preferably, albumin paper, is floated for half a minute on a bath of—

Ferric chloride	10 parts.
Water	100 ,,
Citric acid or tartaric acid . . .	5 ,,

This and the drying must be done in the dark. The correct exposure in printing must be determined by trial, the average being 15–20 seconds in the sun, and 15–20 minutes when the sky is clouded. The faint image is developed in a bath of 25 parts of potassium ferrocyanide and 100 of water. The blue lines can be intensified and the background reduced, after washing in plenty of water, by a short immersion in water acidified with hydrochloric acid (1 : 100), followed by rewashing and drying.

(*b*) For White Lines on a Blue Ground.

Two solutions are prepared: one containing 1 part of ferro-ammonium chromate in 4 parts of water, and the other 1 part of potassium ferrocyanide in 6 of water, the two being mixed and kept in the dark. Townsend sensitises the paper by applying the solution with a broad camel hair brush, a very small quantity being sufficient. The exposure takes longer than mentioned above, but printing is complete when the white lines have disappeared and the ground has assumed a greyish green tone.

The print is developed in pure water, the ground showing up a handsome blue, which can be intensified by immersion in a 5 per cent. solution of hydrochloric acid. Of course this acid must be afterwards eliminated by washing. If the paper be sensitised with ferro-ammonium chromate only, an exposure of 15–20 seconds will suffice, but in this case the print must be developed with potassium ferrocyanide.

Indigo Blue-Print Paper.

The indigo process has long been used for colouring blue-print paper for technical purposes, not only on account of its handsome colour, but also in view of its high power of resisting sunlight. Of course, indigo can only be used when the paper sells at a good price, since the dyestuff is more expensive than aniline colours, as well as more troublesome to work with. The method is based on the vat process used in dyeing textile fabrics, the vitriol, zinc, and hydrosulphite baths being all used, though Valentine and Schwarz's "sulphurate" bath is best for paper. This bath is prepared by dissolving 100 parts of "sulphurate powder" in 400 parts of water; that is to say, the two are stirred up together for about 2 minutes, and then mixed with 1200 parts of 2 per cent. caustic soda lye, stirred awhile and left at rest for 24 hours to clarify. The clear liquid is employed to dissolve the indigo-white and charge the dye-bath as follows: 1 part of indigo-white, made into a pulp with water, is mixed with 8 parts of sulphurate solution and gradually warmed up to 50° C., a clear, wine-yellow solution being formed. Three to four parts of this liquid are mixed with 100 of water and 10 of sulphurate solution (at 25° C.), the mixture being applied to the paper with a brush or by dipping, in the dark and out of contact with air.

The paper now has a greenish look, but oxidises in the air and turns blue. The bath can be used over and over again, but the precipitated indigo must be reduced every time by adding a little sulphurate solution, and warming until the deposit has all dissolved. The bath liquor itself should have a greenish-yellow appearance.

Heliographic Paper.

Black Lines on a White Ground.

According to Rolland's French Patent, a sheet of paper is sensitised one side in the usual way, the other being coated with a solution of gallic acid, to keep the front and rear sides from coming into contact when the paper is rolled. To prevent any reaction (which would inevitably occur in a damp atmosphere), the side coated with gallic acid is either protected with a very thin layer of paraffin wax, or else a thin sheet of opaque paper is inserted in rolling up the paper. Again, in sensitising, a narrow strip can be left along each edge of the paper, and coated with gallic acid. After exposure, the paper is immersed in water, whereupon the gallic acid dissolves out, and the print is then fixed without further trouble.

Photographic Transfer Paper.

The paper for this purpose is first coated in the usual way with a thin layer of substance soluble in water, and then prepared by covering the latter with a thin layer of fat, oil, or resin, or a mixture of these, the impression being printed on this top stratum, which takes the colour well. Since the moist gelatine film does not stick to either the fat stratum or the paper, whilst the fat prevents the moisture of the gelatine from passing to the soluble substance, very complete pictures are said to be obtained. According to the hardness and nature of the fat, oil, or resin, or mixture of same, the fatty stratum is applied to the prepared paper by means of a brush, rubbed over with the powdered ingredients if solid, or by pouring on to the surface a solution of the constituent substances in alcohol, benzol, ether, or other volatile solvent.

BLOTTING PAPERS.

Ink Eradicator Paper.

White, thick absorbent paper is dipped into a solution of 100 parts of oxalic acid in 400 parts of water, until thoroughly saturated, whereupon the sheets are hung up on lines to dry in the air. The combination of an ink eradicating medium with blotting paper, capable of absorbing wet blots immediately, deserves the preference over other eradicators on account of its convenience. Unfortunately, this paper will act only on inks containing iron, and has no effect on aniline inks. Nevertheless, since the iron inks are by far the most largely used, the paper is indispensable for office use. The paper may be cut to convenient size, and packed in tens in a white wrapper bearing the directions for use, the main tenor of these being that a fresh ink stain can be eradicated by touching it with the paper while it is still wet, but that a dried stain must first be thoroughly wetted before the paper will act.

Blotting Paper.

According to an American recipe, the paper-stock for blotting paper is mixed with a certain proportion of vegetable or animal charcoal, the latter being made by calcining bone, blood, etc. This bone-black can be made more efficacious by treating it with hydrochloric acid, to dissolve the calcium phosphate, and then washing it with water.

In order to obtain good results, the proportion of charcoal should not be so large as to lessen the coherence of the paper—about 6–20 per cent. according to the strength of the fibres.

PAPER STENCIL PLATES.

Paper intended for stencil plates should be a good, solid, handmade paper, free from straw or wood pulp—not a chlorine-bleached, and probably loaded, machine-made product.

The design is traced on the paper and cut with a stencil knife, such as a sharp penknife, or a clock spring, set in a wooden handle and ground sharp and pointed. The small strips of paper left, in cutting out the design in order to hold the various parts together, form a not inconsiderable defect in all stencil plates. They are indispensable for large patterns, and the larger the latter the thicker and wider must be the retaining strips. However, by the exercise of a little care in arranging the distribution of the holding strips, the solidity of the stencil plates can be adequately secured; and besides, their presence is a distinctive characteristic of stencil work. Though it is easy to understand the desire for stencil plates without strips, one realises the impracticability of the notion; moreover, their absence is by no means essential, for stencilling should appear to be what it is, and not ape at imitating hand-painting. No attempt should be made to reduce the number of strips unduly; but on the other hand it is inadvisable to leave too many. The best plan is to leave them in the places where they are most needed, large spaces being bridged over with X's. Rounded holders should be avoided above all things; though they are looked on as decorative, they really do more harm than good.

The making of a correct stencil plate requires both artistic and technical skill, combined with practical experience. The artistically educated designer, who draws the pattern, cannot judge what the effect will be in practice; neither can the cutter, who is usually a subordinate; and it is to these circumstances that technical defects of many ready-made stencil plates are due.

Imitations of old textile fabrics are popular in many quarters, but are open to a good many objections. Apart from the fact that many of these patterns are not worth copying, there are fundamental differences between woven and stencilled patterns, just as there are on the other hand with printed patterns. In the case of curtains the imitation is practicable, but not so in the case of stencil work, which is an entirely different art. A pattern, which is complete in a fabric of curtain, is broken up by the holders on the stencil plates, and rendered obscure and incomprehensible. Stencil work requires its own special style of design, and this style is still to be developed; perhaps the angular patterns of embroidery on canvas, with corresponding vertical and horizontal holding strips, would be the right style.

As already mentioned, the stencil plates are cut with a knife, freehand, the contours of the pattern being followed and complete patterns obtained. A skilled cutter can cut two or three thicknesses at a time, according to the strength of the paper. The cuts are made, not with the point of the knife, but with the sharp rounded portion of the blade next the point.

The paper is usually laid on a glass plate for cutting, this forming the best underlay, though it must be changed as soon as it gets cut and scratched, or it will quickly blunt the knife. Stone and marble are too soft, and wear out sooner; poplar or lime boards would be suitable, but the knife cuts furrows in them if pressed down too much, and this causes ragged edges on the paper. Strong grey millboard behaves like these two kinds of wood. Circular holes, especially small ones, are seldom cut with the knife, being preferably punched out with suitable hollow punches of semicircular cutters. In this case the paper is laid on a sheet of lead or a block of heart timber, and the blow is given without any unnecessary force. Stencil-cutting machines, in which mechanical pressure replaces that of the hand on the cutter, have not proved a success, and only negative results have attended the numerous attempts to cut a large number of stencil plates at a time. One of these methods was to make about 20 sheets of paper into a block, fix the pattern to the top with an adhesive, and cut with a fret saw. The sheets, however, could not be pressed tight enough to prevent them giving under the action of the saw, and consequently the edges turned out ragged. The same lack of success was met with in an endeavour to fix stencils, without holders, on to canvas, and then work with these; but the canvas was too thick to allow the colour to pass through with sufficient freedom.

The best method of cutting several stencils at once is by means of punches. Five or six, sometimes more, sheets of paper are pinned on to a block of heart timber, and, the pattern being laid on top, the punch held upright is struck with a mallet, the blow being just hard enough to drive it right through the paper. This requires a certain amount of skill to judge correctly without cutting into the wood, in which case the edges would become ragged, as is often found with punched holes. Well sharpened punches are essential, and any that are chipped at the edge must be discarded.

The cut or punched stencils must be waterproofed to prevent them softening when used with water colour, this being effected by dipping them in linseed oil, and then applying 2–3 coats of linseed oil paint. It is said that oiling makes the paper fibres brittle after a time; but the fashion in stencil designs changes considerably, and so this does not matter very much; besides, the defect can be obviated by impregnating the paper with paraffin in wax, dissolved in benzol with the needful precautions against fire that the use of this solvent entails. The first solution must be so thin that it remains liquid when cold, without any separation of particles of paraffin on the surface. The solution is placed in a vessel deep enough to accommodate the stencil plate vertically. When saturated, the plate is taken out and left to drain, being reversed once or twice during the process and hung out, preferably in the open air, to dry. For the second dipping the solution is made so thick that it jellies on cooling. While in use it is kept liquid by standing the vessel in a pot of hot boiled oil. The stencils are dipped several times in the solution, and dried after each immersion.

Bohemian reversible stencil plates are made by tracing a symmetrical pattern on the paper, marking out parts of one moiety of the design with pencil on one side of the paper, and the remainder on the other side of the paper. The marked portions are so small that no strips are needed; and the stencilling is performed by working first with the one side, and then turning the paper over and working on the same place from the other side, thus making the pattern complete.

Another type of stencil plate also consists of two parts, one carrying the pattern and the other cut so as to overlap the holding strips left on the former.

CHAPTER XII.

Metal Papers and Medicated Papers.

METAL papers are sheets of paper the surface of which is entirely coated with metal. They are of three kinds: one coated with sheet metal foil; the second being brushed over with bronze powder; and the third prepared by electroplating. The first class includes real and imitation gold and silver paper, according to whether gold or silver leaf or imitation leaf metal is used. The paper is first coated with a priming layer of size and ochre, bole, umber, or vermilion, for gold; and zinc-white for silver; in order to produce a perfectly flat surface and increase the lustre of the metal.

When this coating is dry it is rubbed with shave-grass or smoothed in a calender, after which it is coated with thin size and glycerine, and covered over completely with leaf metal.

Bronzed papers are made in the same way as glossy coloured papers, except that bronze powder, instead of colour, is mixed with the varnish and laid on with the brush.

According to Poppenburg, metal paper is made as follows:—

A bath is prepared of 5 parts of silver (or other noble metal), 15 parts of potassium cyanide, and 5 of potassium bicarbonate in 1000 of water, sufficient hydrochloric acid being added to clarify the solution. A bright metal plate is then coated with fat or oil, and dipped in the bath, at a temperature of about 60° C., whereby a thin film of silver (or other noble metal) is deposited on the plate. When the latter is dry, a sheet of paper is stuck on to the plate, and when withdrawn brings the metal film away with it, this being facilitated by the layer of fat.

BRANDT AND NAWROCKI'S METHOD.

An extremely thin film of metal is deposited on a smooth, properly insulated metal plate by chemical or electro-chemical means. This film is dried, with the underlying plate, and coated with a medium, whereupon a sheet of damp paper is laid over the whole and pressed until it sticks so intimately to the metallic film as to bring away the latter entire when the paper is lifted.

Instead of one metallic film, two or more of different metals may be superimposed before proceeding to attach them to the paper; and the paper itself may be coated with the binding medium before spreading the sheet over the film. Another method is to throw down a thin electro deposit of nickel, silver, or copper, on a highly polished metal surface, from which it is then removed and attached to paper.

Other colours can be obtained by suitable varnishing. Metal paper has all the properties of gold or silver paper, but in an increased degree. The metal especially is stronger, whilst retaining its softness.

According to another method, a picture is produced on a highly polished metal plate by photographic means, so that the ground consists of a clean surface of the metal, whilst the lines of the picture are made of a non-conducting, acid-proof substance, or *vice versâ*. The exposed parts of the metal having been etched, the resist covering the remainder is removed, leaving the underlying metal bright. The next step is to coat the plate with a film of oxide, by immersing it in a bath containing suitable compounds of the metal that is to be subsequently transferred to the plate, or rather to the paper in the case of silver. The bath will consist of—

Water	1000 parts.
Potassium bichromate . . .	1 ,,
Caustic potash	2 ,,
Magnesium sulphate . . .	2 ,,

After this treatment the plate is introduced into an electrolytic bath, where it is coated with an exceedingly thin deposit of the metal with which the paper is to be covered; and upon this film the paper is fastened with paste. On withdrawing the paper, the electro deposit comes away, adhering very firmly and reproducing the design on the plate.

MOLTEN METALLIC PAPER.

This paper, which is of American origin, is prepared in the same way as marbled paper. Instead of water colour, however, oil colour is used, that is to say, ordinary paint, which is thinned with turps until of the proper workable consistency for painting on wood. The colour is applied by means of a zinc or other tub, large enough to accommodate the paper to be coloured. This tub is nearly filled with water, a few drops of oil of turpentine being run in, until a thin film forms on the surface, and the thinned oil colour is sprinkled on this film, over the surface of which it distributes. Only enough of the colour to coat the paper is added at a time. A sheet of strong white paper is next laid on the film of colour, just as in the marbling process, and to this the colour will adhere when the sheet is removed and hung up to dry. When bronze powder is to be incorporated in the design, it is strewn on the colour in the tub, or mixed therewith beforehand. If the paper is merely to be coloured, it is dried just as it comes out of the tub; but if to be embossed, it must be pressed whilst still damp. After the colour has been taken up by the paper, a fresh quantity of turps is dropped in to form a new film, and more colour is added as before.

Coloured and bronzed papers of this kind exhibit a peculiar, cloudy surface of oil colour, and are very glossy when varnished. Rough Whatman paper has been successfully treated by this process; but any other kind of paper may be used.

MEDICATED PAPERS.

Aseptic and Antiseptic Paper.

Aseptic paper is prepared from pure linen fibres, mixed with 25 per cent. of cotton, the material being purified with alkaline solutions, alcohol, etc., and then exposed to a temperature exceeding the boiling point of water. The paper is made in the usual way, and is pressed between rollers, also heated above 212° F., and then exposed repeatedly to a temperature of 250° F., which will make it perfectly aseptic.

This aseptic paper is employed for making antiseptic paper, by first soaking it in glycerine, vaseline, alcohol, ether, or chloroform solution, and then impregnated with iodoform by steeping it in an ethereal solution of pure iodoform. The percentage of iodoform may range between 5 and 20 per cent.

Iodoform may also be replaced by carbolic acid or a 1 per cent. solution of corrosive sublimate, the solvent in this case being alcohol or distilled water. Paper prepared in this manner is suitable for application to wounds, and for replacing the ordinary surgical bandages.

Varnished Paper.

One hundred parts of linseed oil are triturated with a third part of manganese carbonate, and heated at 200° C. for half an hour with constant stirring. After leaving to clarify, which takes some time, the varnish is passed through a doubled paper filter. It dries in 8 hours.

This varnish is applied to the paper by means of a sponge or brush, the paper being laid on a warmed plate as in making wax paper. The paper is hung on parallel cords in a dry room and dried at ordinary temperature, being held in position the while by means of wooden clips or pegs. It may be regarded as dry when it will no longer stick to the fingers, or only to a slight extent. At first the paper remains white, and is glossy like atlas fabric, but in the course of a few days it turns yellow, and finally a reddish brown tinge, without losing its gloss. It should be perfectly waterproof, and also air-tight to some extent, besides being transparent and supple. It is stored carefully in dry, uninhabited rooms.

GOUT PAPER.

Yellow Gout Paper.

Sixteen parts of pine resin and 5 of yellow wax are melted at a gentle heat, 1½ parts of cantharides tincture and 1 part of euphorbium tincture being stirred in. When the spirit of the tinctures has evaporated, the mass is poured out to cool. The resulting plaster is spread out on thin paper, laid on a warmed iron plate to facilitate even distribution.

Brown Gout Paper.

The ingredients and method of preparation are the same as before, except that one-half of the pine resin is replaced by pitch. According to another recipe, the paper is coated with a mass consisting of—

Black pitch	6 parts,
Turpentine	6 ,,

Yellow wax	4 parts,
Colophony	10 ,,

melted together and strained through flannel.

CHRISTY'S CHROME-GELATINE (BANDAGING).

This article, also known as "Christia," is intended as a substitute for caoutchouc and gutta-percha paper. It is made by soaking 300 parts of gelatine (glue) in 2000 parts of water, and then dissolving it by heat, 300 parts of glycerine (density 30° B.) and 30 parts of finely powdered potassium bichromate, being stirred in. This mass is applied, as a coating, on one side of thin imitation parchment paper, at the rate of about $1\frac{1}{4}$ oz. per sq. yd., and when that is dried the other side is coated in the same way, the paper being afterwards exposed to light. The initially yellowish tinge thereupon turns a dirty green.

RICOU'S ANTI-ASTHMA PAPER.

Ordinary printing paper (8vo), steeped in saltpetre, and containing chalk, alum, gypsum, and a trace of alcoholic extract of lobelia.

PAPIER CHIMIQUE.

Sheets of very fine satin paper, about 16 inches by 12 inches, are coated with melted lead plaster, free from camphor.

BLISTER PAPER (PAPIER EPISPASTIQUE).

This article is a paper coated or impregnated with a melted mixture of—

Pitch	1 part,
Lard	1 ,,
Resin	4 parts,
Yellow wax	4 ,,
Cantharides powder	6 ,,

WINSLY PAPER (PAPIER WINSLY)

is a preparation of the same character as the foregoing.

EAST INDIAN PAPER PLASTER FOR SLIGHT FLESH WOUNDS.

One part of isinglass is dissolved in 4 parts of distilled water and 3 of rectified alcohol, and the solution is applied in several coatings to stretched paper. The other side of the paper is coated with collodium lentescens (collodion 100 parts, glycerine 1), which protects the plaster from the action of moisture when in use.

MUSTARD PAPER.

1. Ordinary light writing paper is cut into strips measuring about 4 inches by $2\frac{1}{2}$ inches, which are moistened uniformly with oil of mustard and packed in paraffined paper or tinfoil, so as to prevent the volatilisation of the oil. One of these sheets applied to the skin and covered with a cloth will act like a mustard plaster.

2. Mustard powder is entirely freed from oil by means of benzol in an extractor, and applied to unsized paper in the following manner:—

The powder is mixed with a solution of—

Caoutchouc	500 parts,
Colophony	100 ,,
Gum dammar	100 ,,
Benzol	1500 ,,

and spread in a uniformly moderately thick layer, on a sheet of strong paper, by hand or in a suitable machine. The solution may also be applied by itself, and then sprinkled over with the mustard powder and dried.

HYGIENIC PAPER HANDKERCHIEFS.

The purpose of these paper handkerchiefs, invented by J. Krum of Goeppingen, is to prevent the germs of any infectious diseases, that are communicable by inhaling, from being conveyed through the medium of the handkerchief. With this object he proposes to replace handkerchiefs made of ordinary textile fabrics, by those of such a nature that they can be destroyed immediately after use, or else rendered harmless in some other way. These handkerchiefs must be thick enough to keep the sputum, etc., from penetrating through the material, and on this account they are made of thin paper, impregnated with glycerine to impart flexibility and strength, and backed with light bandaging material. The handkerchief material can be prepared from a roll of paper and another of fabric, the former being treated with glycerine and then united with the fabric by means of an adhesive or by pressure. The material is afterwards cut into pieces, 6 or 7 inches square, and stored, preferably in a damp place, to keep it soft and flexible.

MILLBOARD SPLINTS.

The millboard is first beaten with a mallet, to make it soft and flexible, and if very stiff will need lixiviating with alkali. After this treatment careful drying will be necessary, and indeed all millboard for the purpose in question must be well dried, since all kinds contain a good deal of moisture though apparently dry enough to the touch. Thus prepared, the millboard is steeped in an alcoholic solution of—

Shellac	100 parts,
Violin resin.	,,
Pine, elimi, or other resin . . .	,,

the kind of resin used depending on the degree of stiffness required in the product. In order to ensure uniform impregnation the steeping should be performed under pressure, which is the more necessary owing to the foliaceous character of the material. After steeping, the millboard is placed in a drying and distilling apparatus, to recover as much as possible of the alcohol. The final stage for ordinary splint material is softening by steam and pressing between warmed zinc plates. The better qualities, however, are also coated with gutta-percha (chloroform solution) and a layer of copal or other varnish.

To convert the material into splints for surgical purposes (dislocations and fractures), it is soaked in warm water for a short time, to make it soft and flexible for moulding to the required shape, and sets hard again in a short time.

IODINE PAPER.

A sheet of paper is impregnated with potassium iodide solution, another sheet being similarly treated with tartaric acid and potassium iodate. Between the two is laid a third thin sheet of paper, and the whole is wrapped in gutta-percha paper. On moistening the prepared sheets with water, free iodine is liberated, the tartaric acid acting on the potassium iodide and setting free hydriodic acid, which is then converted into iodic acid. A sheet 6 inches by 4 inches will furnish 0·5 grm. of iodine, or three times as much as can be applied to the same surface by means of iodine tincture. The liberation of iodine continues for three-quarters of an hour.

GAUTIER'S NASCENT IODINE PAPER.

This paper, which resembles the preceding one in its mode of action, is composed of three colourless sheets of filter paper packed in gutta-percha paper, the instructions for use being printed on the top sheet. When moistened with water the sheets quickly turn brown to black, and a strong smell of iodine is liberated. The paper is applied to the skin, printed side up, covered with the accompanying sheet of gutta-percha paper, pressed firmly into place and bound with cotton wadding. Examination of the different layers has revealed that the printed top sheet consists merely of filter paper, which, together with the gutta-percha paper, protects the others from moisture and destructive atmospheric influences generally. The middle sheet contains a mixture of potassium iodide and iodate, whilst the strongly acid bottom sheet contains potassium bisulphate. The quantities required per sheet in the preparation of this paper are—

Potassium bisulphate . . .	340 mgrms.
Potassium iodide	340 ,,
Potassium iodate	85 ,,

On complete decomposition, each sheet yields 318 mgrms. of free iodine. The method of preparation is simple, the ingredients for the two sheets being dissolved in such a quantity of water that the solution can be uniformly distributed through the folded paper by gentle pressure. One or two points, however, must be borne in mind; for instance, the temperature employed for drying the paper must not be too high, or the latter will become brittle. Again, if the amount of bisulphate in the paper be too high, *e.g.* 0·5 grm. per sheet, there is a risk of the paper charring and turning black at even a moderate drying temperature; but this may be entirely avoided by keeping the quantity of bisulphate within proper limits and drying carefully. The middle sheet must be treated with the potassium iodide and iodate at a low temperature, and in a dark room where no carbonic acid or other volatile acid can gain access; and when this is done, the paper will be colourless. Nevertheless, the paper will not keep very long, even in a dry state, without undergoing decomposition, this being indicated by a yellow stain, gradually turning brown, as the result of a liberation of iodine. On this account it would be advantageous to add a little sodium sulphate to the water used in dissolving the iodine salts—or better still, a few drops of deci-normal solution of sodium thiosulphate (hyposulphite). This would prevent the staining, and could not lead to a loss of more than a few milligrammes of iodine. The finished sheets of prepared filter paper are stuck together by a few spots of an adhesive that is insoluble in water, then covered with a sheet of filter paper of equal size, and the whole placed, in a thoroughly dry state, between gutta-percha paper and packed in a gummed envelope.

CHAPTER XIII.

Marbled Paper.

In order to obtain a commingling of colours to match a given pattern, it is essential that the colour should be applied to the surface of the paper in drops, and in a certain order, so that as they spread they will produce the desired result. With regard to the serial order of the colours, it must be laid down as an axiom that each colour must be endowed with greater spreading power than the one before it, so that it can drive the preceding drops together and produce a fuller tone. According to this rule, therefore, the lightest colours (specifically and in shade) must be applied first, since these require the smallest admixture of diluent in order to float them; and it also follows that a difference can be artificially produced between colours of equal density and shade by the addition of diluents. In the same way, by using diluents of different strength, it is possible to cause certain of the colours to draw together in the form of wavy lines, forming the true veins of the marbling, in contrast to the false or light veins formed by the exposed surface of the ground.

Now, the drops forming on a rod that has been dipped in a liquid and then withdrawn, will vary in size—other conditions being equal—with the depth of the immersion and the thickness of the rod, small drops being formed on slender rods, and large drops on thicker ones. Hence the best means of applying the drops of colour to the ground, in the marbling process, is by a bundle of rods varying in thickness according to the size of drops desired. Such bundles are preferably arranged in the form of brushes, made of finer or coarser bristles, or other brush material (rice straw, piassava), the distribution or setting of the individual bristles also influencing the formation of the drops, so that in this way different effects can be produced.

The brush is dipped in the prepared colour, held over the paper, and tapped with a rod held in the other hand, the blow sprinkling the colour over the paper. The force and direction of the falling colour influence the shape of the drops, and their distance apart is regulated by the height of fall, so that by properly utilising these influences, in conjunction with a selection of colours, the marbler has ample means available for producing a great variety of effects in marbled paper. Additional diversity can be obtained by certain manipulations facilitated by the motility and viscosity of the drops. For instance, the drops will follow the movement of a rod drawn over the surface, and will thus be modified into stripes. By combining a number of such rods or teeth into a comb or grainer, and drawing this tool through the sprinkled colour from one side of the marbling tub to the other, the marbling will be converted into stripes of colour, that may be straight, wavy, or zigzag, according to the motion of the grainer. If this operation be repeated crosswise, the teeth of the comb will break up the streaks of colour into taper lines, with intermediate semicircular lunettes, forming the characteristic feature of grained marbling. The size of the lunettes and the "feather" of this graining, depend on the thickness and setting of the grainer teeth, the depth of penetration into the layer of colour, the rate at which the comb is drawn through, etc., so that here again a possibility is afforded of producing a great variety of designs.

Moreover, since the drops or streaks of colour will also follow the movement of the grainer when moved so as to produce circles, ellipses, or spiral lines, still greater diversity can be introduced into the design. In this way, bouquet, tufted, and peacock-eye marbles are obtained. When a more uniform design is desired, the colours are not sprinkled, but applied by means of rods, equidistantly mounted on a frame of the same size as the marbling tub. The harrow-like tool thus formed is dipped into the colour, and then carefully transferred to a floating surface, on which it produces spots of uniform size. Another way is to dip the various rods into a number of colour pots in succession, for instance, in accordance with the subjoined diagram, in which *r* equals red, *b*, brown, and *y*, yellow—

b. r. b. r. b. r.
y. r. y. r. y.
b. r. b. r. b. r.
y. r. y. r. y.

When the design has been applied, as described, to the floating surface, and all the colour spots are quiescent, the next step is to transfer the colour to the paper, by laying the latter on the marbling without disturbing the colour, and then taking it up as soon as paper and colour have stuck together. To ensure this adhesion and preserve the continuity of the design, the paper must be flexible and in a suitable condition for taking up the colour. The formation of bubbles between the paper and colour may be prevented by damping the paper and bringing the two surfaces into gradual contact, either by holding the paper at two corners, so that the middle portion touches the colour first and the corners are gradually lowered, or else by placing one edge of the paper in contact with the colour and carefully lowering the rest until contact is complete all over. Directly afterwards, the paper may be lifted by the lowest corner, bending it backward so as to draw it away from the floating surface without sliding. Damping the paper beforehand also facilitates the adherence of the colour.

If desired, the design can be modified by moving the paper from side to side when lifting, this method being adopted for producing the so-called Greek, watered or wavy marble, characterised by slightly sinuous parallel streaks, of alternately light and dark shade, running slantwise on the paper. To obtain this effect, an intermittent horizontal motion is imparted to the edge of the paper as soon as it is laid on the colour, the operator moving his hand gently to and fro, whilst after each movement a further portion of the paper is brought in contact with the colour. On removing the paper in a single sweep, the design appears with wavy lines, and these waves may be curled by making the marbling tub vibrate whilst the paper is being taken off, or else by previously creasing the paper in two directions at right angles. Finally, marble, with elongated spots, is obtained by lowering the paper intermittently, as just described, but without any lateral motion, the paper being moved straight forward, for about an inch, every time.

APPARATUS FOR MARBLING PAPER.

The machines for marbling paper perform all the operations previously effected by hand. Such a machine, in the first place, contains a tank for the floating bath, preferably a solution of gum, together with a device for distributing the colour on the surface of the bath, and a means of feeding the sheets of paper in succession on to the surface of the colour. In addition, the machine may be fitted with a device for lifting the coloured sheets of paper.

A machine of this kind is illustrated in Figs. 11 to 13, Fig. 11 being a view of the central portion, Fig. 12 the back and 13 the front. Fig. 14 is a vertical section through the colour tank, whilst Figs. 15 to 19 are longitudinal sections through various working parts.

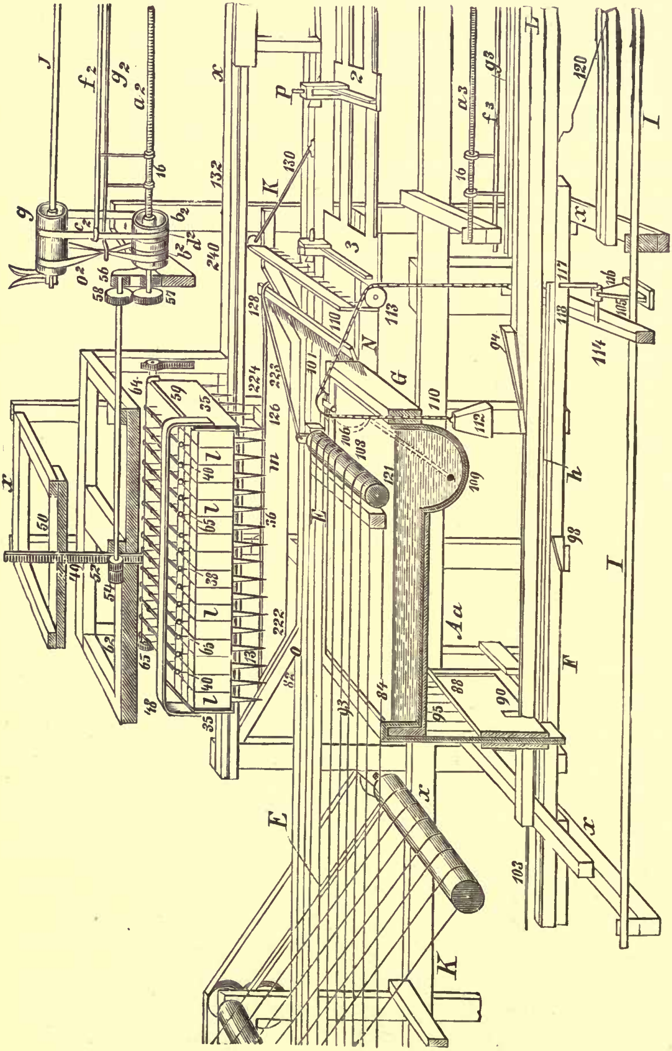


FIG. 11.—Machine for marbling paper (central portion).

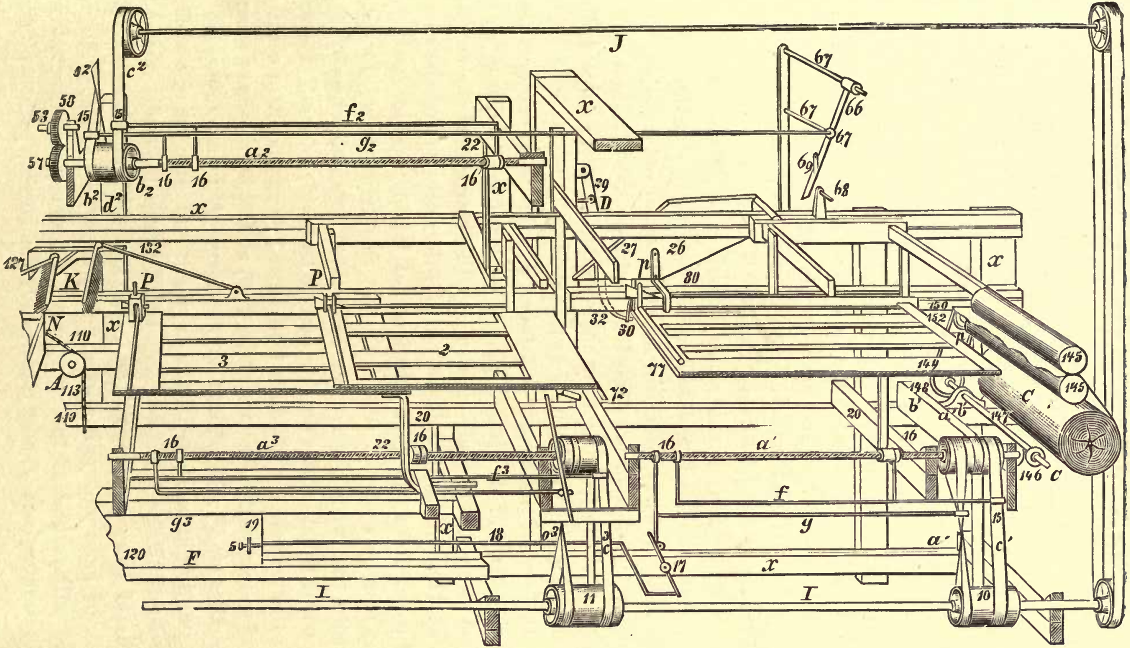


FIG. 12.—Machine for marbling paper (rear portion).

The colour is floated on the surface of a solution of gum *a*, in the tank *A*; *B* is the colour tank, with distributor; *C*, the paper feed, consisting of a roll, with sliding tables, 1, 2, and 3 in front of it. The slide 1 moves forward over the slide 2, and draws with it the paper attached to the front end, until the front end of the slide 2 is reached. The clips on the slide 1 then release the paper, which is gripped by the clips on the front end of the slide 2, whereupon slide 1 returns to its original position. The paper on the slide 2 is next separated from the rearward portion by a cutter *D*, mounted between the slides 1 and 2, whereupon the slide 2 moves forward over the slide 3, transferring the paper to the clips on the latter and then returning. The slide 3 carries the paper over the tank *A*, the floating surface in which has been already coated with colour. The paper is released by the clips of the slide 3 and is gripped at the front end by clips mounted on the tank *A*, the slide 3 thereupon returning to its original position.

In front of the tank *A* is a frame *E*, of parallel endless cords or threads, and this frame moves backward over the tank *A*, so that its rear end comes close up to the rear end of the tank *A* (Fig. 11). A turning device *G*, lifts the back end of the sheet of paper from the gum solution and lays it, upside down, on the rear part of the frame *E*. As this frame moves forward again, the cords receive an accelerated motion, whereby the paper is lifted off the floating surface and laid, coloured side up, on the frame *E*. Motion is transmitted from the main shaft *I* and countershaft *J* to the slides 1, 2, and 3, by means of screw spindles a', a^2, and a^3, and to the frame *E* by a screw spindle *e*, running in bearings in the frame *x*, and each spindle works in a nut 22 attached to a fixed arm 20. Each spindle carries a pair of loose pulleys, $b'b'$, b^2b^2, b^3b^3, and $e'e'$, and between each pair of loose pulleys is a fixed pulley d^1, d^2, d^3, and e^2. Above the pulleys b^2b^2 of the spindle a^2, a drum *q*, is mounted on the countershaft *J*, and underneath the belting pulleys of the spindles, drums 10, 11, and 12 are mounted on the main shaft *I*, and connected with the belting pulleys by straight belts $c^1c^2c^3c^4$, and crossed belts $o^1o^2o^3o^4$. To move the slides forward, the straight belts can be shifted from the one loose pulley on to the middle fixed pulley of the corresponding screw spindle, the rearward movement of the slides being obtained by shifting the crossed belts on the fixed pulleys. When both the sets of belts are running on their loose pulleys, the slides do not move at all.

The belts are shifted by means of the forks $F^1F^2F^3F^4$ for the straight belts, and $g^1g^2g^3g^4$ for the crossed belts. The forks 15 are connected by rods with clutches 16, which are moved along the screw spindles by the impact of movable attachments.

In the position illustrated in Fig. 11, for instance, the frame *E* is shown in position over the tank *A*, ready for taking hold of a sheet of paper. It then retreats into the position shown in Fig. 16, which indicates the end of its travel. This movement is shared by the under-frame *F*, consisting of longitudinal rods *h* rigidly connected with the frame *E*. Under the left clutch 16 of the belt fork g', is a pivoted lever 17, the upper arm of which rests close against the left side of the clutch 16, whilst the other arm of the lever is connected with a rod passing loosely through a guide 19 on the frame-rod *h* and carrying a crosshead or stop 5. It is easily seen that as soon as the frame *E* reaches the end of its forward stroke, the eye 19 will push the rod 18 forward, and thus turn the lever 17, which operates the belt fork g' and draws the crossed belt of the slide 1, on to the fast pulley d', so that the screw spindle a' advances the slide 1, and the parts take up the positions shown in Fig. 17. The cutting blade *D*, which moves in the vertical guide 25, has ends projecting beyond the guide, and the slide 1 carries side plates 26, the sloping surfaces of which, 27, raise the knife after its descent. On reaching the top of its stroke, the knife is held by a stop consisting of the swing lever 28, the

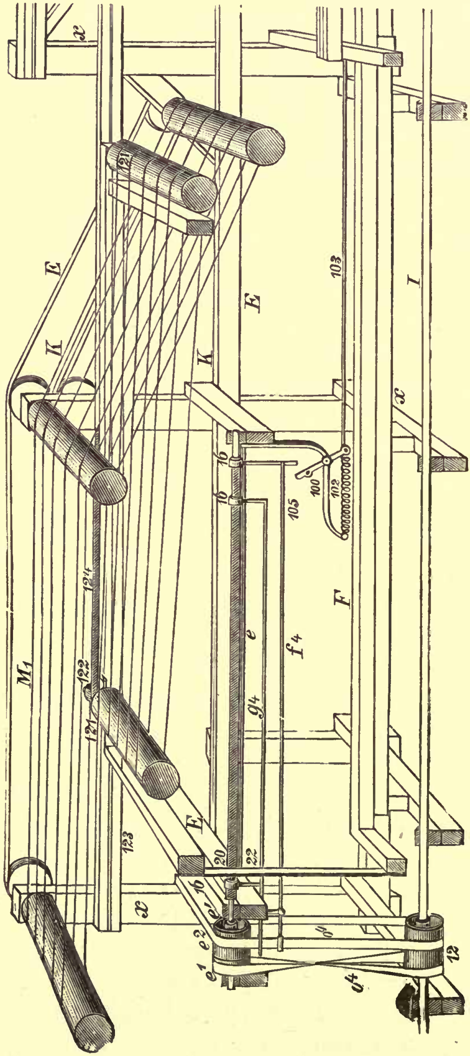


FIG. 13.—Machine for marbling paper (front portion).

arm 29 carrying the knife, and a striker 30. When the slide reaches the front end of its stroke, the striker 22 comes in contact with the left clutch of the belt fork f' for the straight belt C', and pushes this belt on to the fast pulley d'. The left clutch 16 of the belt fork g' being now immediately to the left of the left clutch of the belt fork f', the fork g' is also pushed

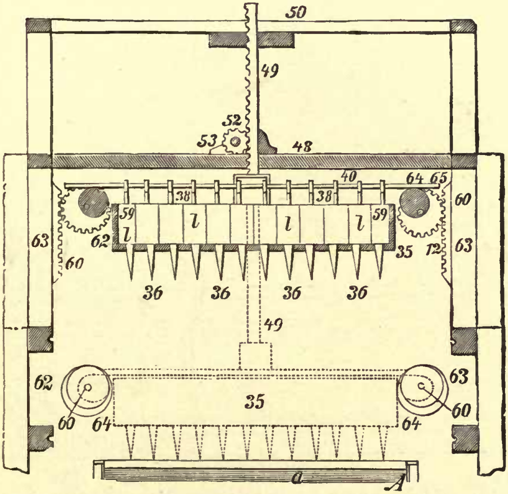


FIG. 14.—Machine for marbling paper. (Vertical section through the colour tank.)

forward, removing the crossed belt from the pulley d'. Under the influence of the straight belt, the slide now returns to its first position, and, on nearing the end of its stroke, the striker 32 on the slide 1 comes in contact with the studs 30, of the lever 28, and lifts the same, thus releasing the knife, allowing it to fall and cut off the paper resting on the slide 2.

The device *B* for distributing the colour comes into action during the forward movement of the slide 2. It consists of a box 35 with a number of colour receptacles, each terminating in a tapered nozzle below the bottom of the box. Each receptacle is traversed by a central wire passing through the top and terminating at the upper end in a ring. The wire is kept in the raised position by a spiral spring. The box 35 is held over the marbling tank *A* by means of a suitable frame, fitted with a rack moving up and down through a guide in the frame *x* of the machine. This rack engages with a pinion 52 on the

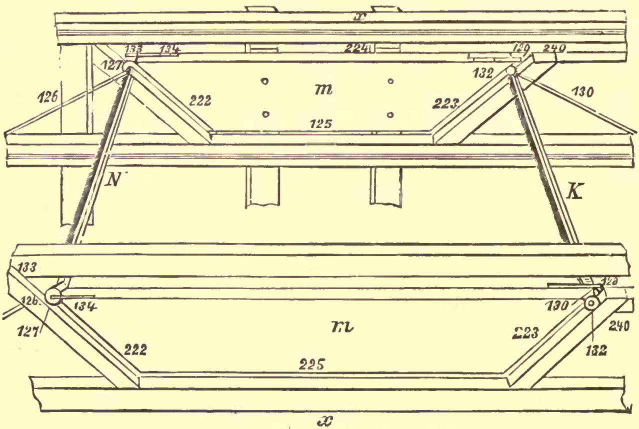


FIG. 15.—Machine for marbling paper. (Details of the brushing and graining device.)

shaft 53, receiving intermittent motion from the screw spindle a^2, through pinions 57 and 58 (Figs. 11 and 12). Lengthwise of the machine are horizontal shafts 60, 60, turning in bearings 59 in the box 35, and fitted with terminal pinions engaging with fixed vertical racks. Each shaft is also eccentric, or fitted with eccentrics of some length, 64, on which rest the ends of rods 65 that pass through the rings 40 of each row of colour receptacles 1. Consequently, when the box 35 is lowered by the rack and pinion 52, the pinions 62 are turned by the racks

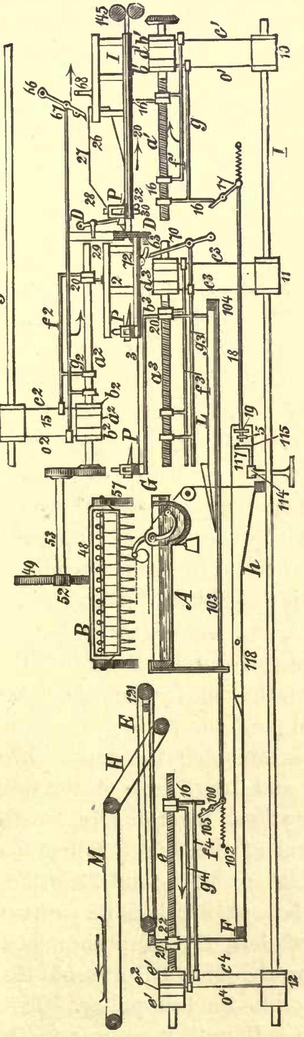


FIG. 16.—Machine for marbling paper. (Discharge of the finished sheet.)

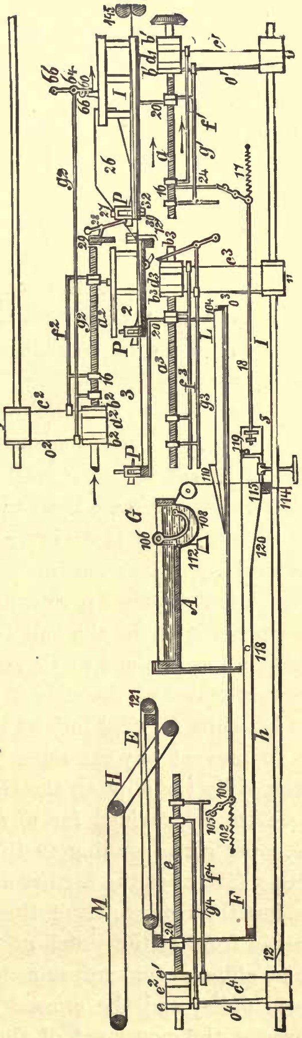


FIG. 17.—Machine for marbling paper.

68, and the eccentrics are brought into such a position that the rods and attached wires are lowered, so that the colour adhering to the wires is deposited on the floating surface in the tank *A* as soon as the wires come in contact therewith. The highest and lowest positions of the box 35 and its accessories are shown in Fig. 14. The racks 63 are short, so that the pinions 62 engage with them only just sufficiently to move the wires 38 to and from at each ascent and descent of the device. The wires 38 and the lifting device can also be dispensed with, the colour then running out of the receptacles 1, when the iron nozzles come in contact with the bath. The orifice of the nozzles should only be large enough to allow the colour to trickle through gradually.

When the slide 2 has reached the forward end of its travel, the nut 22 on same strikes against the front clutch of the belt fork f^2, and causes the straight belt o^2 to be pushed on to the fast pulley. At the same time, the clutch of the belt fork g^2, which up to now rested close in front of the clutch of f^2, is pushed forward, so as to push the crossed belt on to the loose pulley. The slide 2 thereupon returns, until the nut 22 strikes against the rear clutch of the belt fork f^2, and the slide comes to a standstill at the end of its rearward travel. At the end of the forward travel of the slide 2 and of the belt fork g^2, the lever 66 is swung forward into its normal position.

To prevent any excessive pulling strain on the paper when gripped by the clips on the slide 2 and drawn from off the roll, a device is provided for unwinding from the roll *C* a length of paper corresponding to the travel of the slide. When the frame *E* reaches the further end of its travel, the nut 22 strikes against the rear clutch of the belt fork g^4, which is in position just in front of the clutch of the belt fork f^4, and pushes both these clutches forward, so as to move the straight belt on to the loose pulley and the crossed belt on to the fast pulley. This reverses the movement of the frame *E*, until it returns to its normal position, whereupon a striker on the frame meets the belt fork f^4 and pushes the crossed belt o^4 on to the loose pulley again. As shown in Fig. 13, the front roller 121, carrying the endless cords of the frame, carries pinions 122, on each end, and a corresponding portion of the rails 124 (on the machine frame *K*), on which the pinions run during the first half of the forward travel of the frame *E*, is toothed like a rack. In the return movement of the frame *E*, the engagement of these racks and pinions causes a reversal of the travel of the endless cords; but as there is then no paper on the frame *E*, this movement does no harm. However, when the farther end of the sheet of paper has been lifted off the bath and has been turned over and laid on the rear end of the frame, the cords receive an independent movement forward as the frame begins to advance, the removal of the paper from the liquid being thereby accelerated.

As the frame *E* begins to

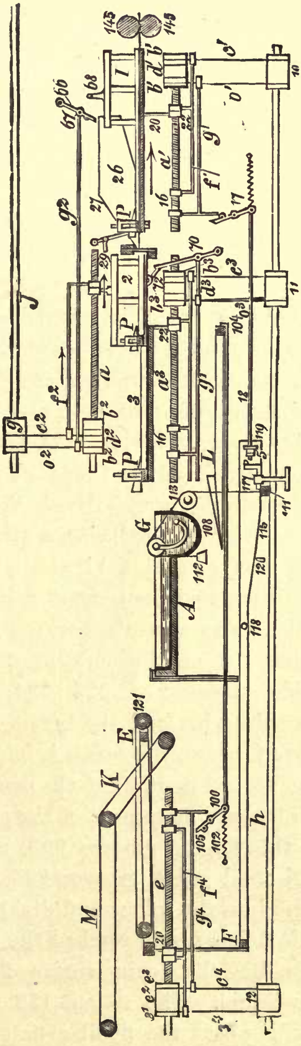


FIG. 18.—Machine for marbling paper.

return, about half the sheet of paper is already in position on the frame, and the advance of the latter draws it off from the bath with a peeling motion. On reaching the inclined travelling plane *H*, the paper is carried up this latter, and is delivered thence on to a horizontal travelling plane, which may be of sufficient length to form a drying frame.

To ensure the paper being laid evenly on the surface of the colour in the baths, so that its underside will become uniformly coated with colour, the machine is fitted with a brushing device (Figs. 11 and 12). At the sides and top of the bath *A* the machine frame *X* is covered with a board *m*, provided with a pair of guide grooves. The grooves 222, at the front end of this board, slant upward and forward, whilst those at the rear end slope backward, both sets passing into the upper and lower guide tracks. Swing rods 126 are arranged at either side of the rear end of the frame *E*, which rods project rearward and support a horizontal brush *N* placed crosswise of the tank *A*. The device for producing a grained or cloudy effect of colour is also shown in Figs. 11 and 15. On both sides of the slide 3 are articulated the forward-pointing rods 130, the front ends of which carry a comb reaching all across the tank *A*. Friction rollers 132 on the ends of the comb carrier also run in the guide grooves 222, 223, 224, 225, but have a broader gauge than the wheels of the brush 127. As the slide 3 and paper move forward, the comb *k*, is pushed in front by the rods 130. The normal position of the comb is shown in Fig. 11. During the forward movement of the slide 3, the rollers 132 run down in the sloping grooves 223, and then forwards in the lower horizontal guide grooves 225, thus dipping the teeth of the comb into the colour and dividing the latter. By the time the slide 3 has nearly reached the end of its travel, the rollers are ascending the sloping surface 223, thus raising the comb out of the liquid. The rollers 132 issue from the grooves 222, by bending back the flexible tongues 134, and ascend the sloping

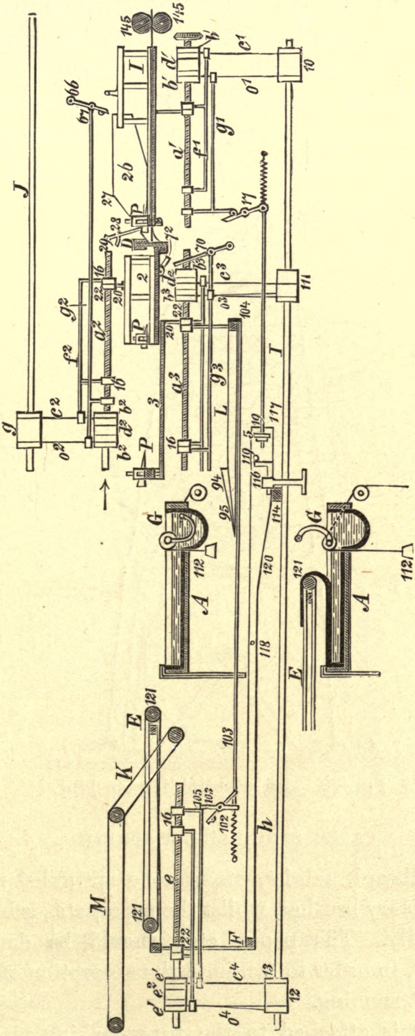


FIG. 19.—Machine for marbling paper.

extension of the grooves as the slide continues to advance. When the slide retreats, the tongues 134 prevent the rollers re-entering the grooves 222, and guide them into the upper guides 224. Owing to the difference in the gauge of the brush and comb, both devices can be moved in the same guides without getting in one another's way.

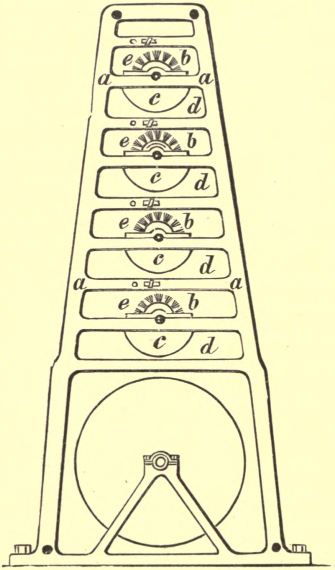


FIG. 20.—Paper sprinkling machine.

PAPER SPRINKLING MACHINES.

Paper, millboard, fabrics, etc. can be sprinkled with colour by means of rotary brushes, whilst the paper, etc., is being moved forward rapidly. The paper, etc., should be damped to a certain extent, in order to facilitate the absorption of the colour and prevent it running.

The device is attached to the paper-making machine, preferably behind the swing roller. In the ordinary paper machine it may be mounted, as shown in the drawing, on the frame of the drying cylinder. In the frame *a*, of the sprinkling machine are mounted any convenient number of rotary brushes *b*, set in motion by pinion or other suitable gearing. Each brush dips into a semicircular colour trough *e*, which is fed by

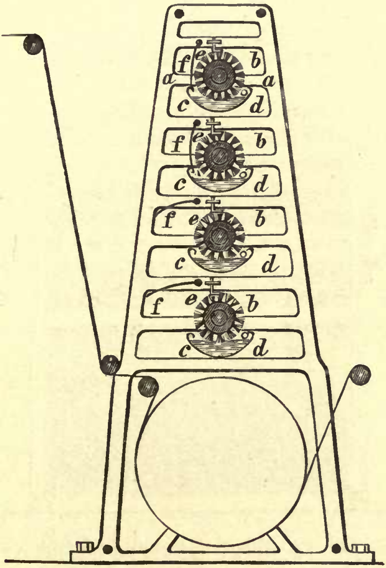


FIG. 21.—Paper sprinkling machine.

a perforated pipe *d*. Each brush presses in turning, against a vertically adjustable angle-iron bar *e*, the spring of the released bristles throwing the colour against the rapidly moving paper. Any of the brushes can be thrown out of action by lowering the cover *f*, which is long enough to reach down into the colour trough and returns to the latter the colour thrown off by the brush. In order to prevent the undesired spraying of a number of different colours on the same part of the paper, the angle-irons *e*, can be provided with recesses in alternating positions, so that the bristles remain unbent in these places and therefore do not throw off any colour on to the paper. Where

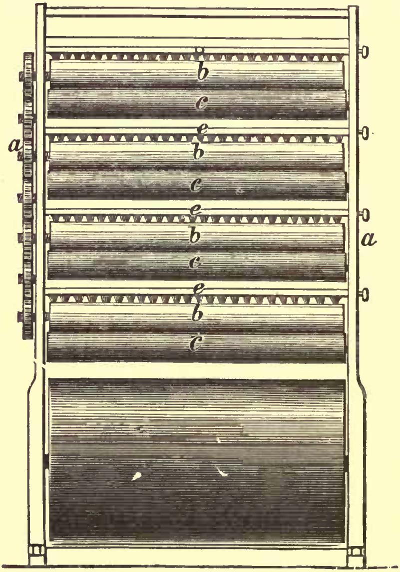


FIG. 22.—Paper sprinkling machine.

very fine distribution of the various colours is required, the angle-irons assume the form of combs, and may then be made of spring steel.

By arranging another sprinkler on the opposite side of the paper, the latter may be coloured back and front.

CHAPTER XIV.

Tracing and Copying Papers.

THE tracing paper used for copying plans, machine, and other drawings, designs for weaving, embroidery, etc., is usually made from hackled flax, clean tow, or straw, by the ordinary process. It is yellowish grey or brownish yellow in colour, thin, and as stiff as though half sized, so that lines drawn on it in Indian ink will not run. It is troublesome to make, both on account of the large dimensions required and relative thinness, as well as the undesirable tendency to wrinkle when dried in the open air. For this latter reason it is laid between sheets of blotting paper (which are frequently renewed) and dried in the press. Other grades of tracing paper are made from thin white Berlin writing paper, or good satin paper, treated with cotton-seed oil, nut oil, poppy oil or almond oil, boiled linseed oil or various kinds of varnish, etc. The resulting transparent paper is termed straw paper, since it forms a substitute for paper made from that material; and it is also known as oil—or varnish—paper. The article known in France as papier glacé or papier gelatine, is not paper at all, but isinglass in the form of very thin transparent sheets, obtained by pouring a warm solution of isinglass on to an oiled sheet of plate glass, and covering it with a similar sheet until cold.

With regard to the tracing papers prepared with the aid of oil, fat, etc. the following may be said:—

Paper fibres have only a limited capacity for absorbing fat, and any surplus fat is given up by the paper. No increased transparency is obtained by using too much fat. Another essential point is that the oil used should not impart any yellow stain, as is often found, more particularly at the edges of the paper that are more exposed to the action of the air. Another property closely connected with the oxidation of the fat, is the smell; and this also is imparted to the treated paper, which then smells like rancid oil and grows worse in this respect with age. Another essential feature is that the treated paper must not become hard and brittle. Most fats resinify or "gum" in drying, the resulting hardness being imparted to the paper.

The usual method of making these tracing papers is to rub the roll of paper from the paper mill with a suitable fat or oil and hang it up to dry in the air. The process has now been so far modified that the rubbing is effected by machinery, instead of with a hand brush or sponge. Drying in the air is essential, since artificial warmth facilitates rancidity. The use of quick-drying varnish is also precluded, owing to the brittleness imparted to the paper; and for the same reason no "driers" may be employed. The main point therefore is to select an oil or fat that is very fluid at ordinary temperatures, so that it can be easily applied to the paper, and only in the small quantity necessary to make the paper transparent; furthermore, that this small quantity shall dry as quickly and completely as possible. These requirements are best fulfilled by poppy oil, which, when prepared in the ordinary way from Indian poppies, is a quick-drying oil. It must, however, be bleached for good tracing paper, since otherwise it soon turns yellow; and in addition it becomes rancid and gives the paper a bad smell. To obviate these disadvantages, the poppy seeds must be cold pressed. The first runnings, obtained under moderate pressure, are pale yellow, very fluid and less liable to oxidise. Similar properties are also possessed by castor oil, which is used for the same purpose.

Pergamyn paper is largely used as a substitute for tracing paper. Sulphite cellulose paper weighing a little less than half an ounce per sq. yd. is very transparent, and can be made still more so by satinising. This paper is stronger than impregnated paper, is perfectly inodorous and will take colour, whereas the colours used on oiled paper must contain an admixture of alkali. The only relative drawback of pergamyn paper is its brownish colour, that of the best tracing papers being bluish white.

This yellowish brown colour of pergamyn may give rise to difficulties in tracings intended for photo-chemical reproduction; and for this purpose the bluish paper should be used. Pergamyn paper is much cheaper than oiled tracing paper, and its use for tracing drawings is undoubtedly increasing.

There is no reason to apprehend that tracing paper made from sulphite cellulose is less durable than oiled rag paper; in fact, if a tracing so made were required in ten years' time, it would be found in better condition than on oiled paper, owing to the hardness and brittleness of the latter through the changes sustained by the oil.

RECIPES FOR OIL OR VARNISH TRACING PAPER.

1. The paper is coated with thin dammar varnish and allowed to dry. (This paper, however, becomes tacky at the temperature of the hand, and soon gets brittle.)

2. Fifteen hundred parts of oil of turpentine are mixed with 500 of boiled linseed oil, warmed and employed to dissolve 100 parts of colophony, 100 of Venice turpentine, and 35 of white wax. This quantity will be sufficient to treat a book (44 sq. yds.) of satin paper.

3. Pure, pale poppy oil or linseed oil varnish prepared without boiling, and mixed with a little turps, is applied to the paper,

which is then sprinkled over with pine sawdust by means of a fine sieve, the sawdust being removed again, without delay, by the aid of a brush. This removes the superfluous varnish or oil, which would otherwise form a glossy crust. (After some time, the paper turns an undesirable dark colour.)

4. Thirty-seven parts of finely powdered gum dammar are dissolved in 200 parts of oil of turpentine, by shaking, and the clarified solution is mixed with 130 parts of pale poppy oil varnish. The mixture is applied to the paper, which is then treated with sawdust as already described. (This paper will permanently retain its pale colour and perfect transparency.)

5. A mixture of—

Oil of turpentine	8 parts,
Castor oil	8 ,,
Canada balsam	2 ,,
Copaiba balsam	1 part,

is applied evenly to a thin, unsized paper, the excess being wiped off with a rag. After hanging up to dry for 30 hours, the paper is again rubbed with a clean woollen rag and dried completely.

6. Esslinger employs a solution of—

Bleached shellac	15 parts,
Mastic	5 ,,
Strongest alcohol	100 ,,

The sheets of paper are coated with the clarified solution, and hung on lines to dry until the paper has lost all its moisture and tackiness. This paper always remains sufficiently transparent, and is specially adapted for drawings that are intended to be coloured, provided the colours are mixed with strong alcohol instead of water.

WAXED TRACING PAPER.

Waxed tracing paper has the advantage over those prepared with solutions of resins that it does not get brittle.

A mixture of—

Bleached beeswax	10 parts,
Strongest alcohol	30 ,,
Ether	5 ,,

is placed in a glass bottle and left, tightly closed, in a warm place for several days, with occasional shaking. The clear solution is poured off into another bottle for use. The paper when coated is hung up to dry, and is then smoothed. A lead pencil drawing on this paper can be made ineradicable by wiping the surface over lightly with strong alcohol, or the solution given above. This treatment covers the drawing with an extremely thin, colourless film of wax which can even be washed without injuring the drawing.

TEMPORARILY TRANSPARENT TRACING PAPER.

For making paper temporarily transparent there is no better agent than petroleum, this oil penetrating the pores very readily and making the paper so transparent as to reveal the finest details of a drawing or writing laid underneath. The quantity required for treating even thick drawing paper is very small, a point that should be remembered when this method is employed.

The sheet of paper is laid on a very flat backing, preferably a sheet of polished glass, and is then firmly rubbed over with a sponge that has been dipped in petroleum and squeezed out again. The paper at once becomes transparent, and can be used for copying without delay, provided the quantity of oil was so small that the paper appears to be quite dry within a few minutes after the application. In the case of thick drawing paper the sheet is turned over after the oil has penetrated a certain depth, and the application is repeated on the other side, though in this case a smaller amount of oil will suffice. Petroleum being a volatile liquid, the treated paper will lose its transparency in a few weeks, though it can be kept transparent for some time if stored in a box with a tight-fitting lid. In such case the evaporation of the oil proceeds so slowly that the paper can be kept for years without becoming unfit for use.

VICTORIA TRACING PAPER.

This is parchment paper sized with glue, and is claimed to be far more transparent than any similar article, to have a surface free from grease, be devoid of smell, and permit corrections to be made by merely washing off with a damp brush. It does not shrink with Indian ink or colour, and finally does not cockle.

It is prepared from best, perfectly dry parchment paper in rolls, the band of paper being conducted by six guide rollers through a trough about six yards long, charged with water-white size, and squeezed between a pair of copper rollers at the farther end to remove the surplus dressing. The paper is rolled up damp, and is slowly dried in the open air without steam.

COLOURED COPYING PAPERS (CARBON PAPERS).

This class of papers is coated on one or both sides with some readily transferable colour, in order to enable drawings to be copied by interposing one of these coloured sheets between the drawing and a sheet of plain paper, and then going over the lines of the drawing with a style. In the case of double-coated copying paper, a thick sheet of white paper is laid underneath and a thin satin paper on the top On writing on the latter with an ivory (or similar) style, the writing appears on the face of the under sheet, and also reversed on the back of the upper sheet, showing up legibly through the latter. This is the method used in manifold books, in which the original and copy are made simultaneously. The writing is blacker than with lead pencil, and is not so easily rubbed out.

For making these carbon papers, fine lampblack, ivory black, indigo carmine, ultramarine or Paris blue is mixed with soft soap, and the mass is rubbed over the surface of thin, strong paper with a stiff brush.

Fatty oils, such as linseed oil, castor oil, etc., may also be used, but soap is preferable.

GRAPHITE PAPER (BLACK CARBON PAPER).

Thin (satin or post) paper is rubbed over with fine graphite, by the aid of a ball of cotton wool, until the paper is evenly coated with a pale grey film. After the superfluous graphite has been removed by repeated rubbings with clean cotton wool, the paper is ready for use, the method of employment being that described above, a fine style with rounded point being used.

DOUBLE-COATED CARBON PAPERS FOR COPYING FROM THE NEGATIVE INSCRIPTION.

This invention relates to the preparation of carbon sheets for obtaining, simultaneously, from an original, a positive copy that is not to be reproduced, and a copyable negative from which impressions can be taken by the simple process of pressing it on damped copying sheets of plain paper.

The carbon sheets for this purpose are coated on one side with a copying composition, and on the other with a non-copying preparation. One of these prepared sheets is laid between two sheets of satin paper, the copyable side of the carbon paper being upward. On writing on the top sheet of paper, or on a sheet laid over the same, a positive, non-copying impression is obtained on the upper side of the bottom sheet, whilst a copyable impression is formed on the under side of the top sheet of satin paper. This when laid on damped paper and smoothly pressed by the hand, will give 40–50 copies or more, the colour depending on the pigment used in the compo. The latter is prepared by mixing 5 parts of printer's ink with 40 parts of oil of turpentine, and stirring this with a mixture of 40 parts of tallow and 5 of stearine, both melted by heat. For black copying, this stock pulp is stirred with a mixture of—

Finely powdered ferrous oxide . .	30 parts.
Pyrogallic acid	15 ,,
Gallic acid	5 ,,

For red, violet, or blue, the stock mixture is incorporated with 30 parts of fuchsin, methyl violet, or indigotin respectively, together with 30 parts of magnesium carbonate.

The non-copying preparation is made as follows:—

Printer's ink	5 parts,
Oil of turpentine	40 ,,
Melted tallow	30 ,,
Melted wax	3 ,,
Colophony	2 ,,

the first two being mixed together and stirred up with the rest, either together or successively. About 20 parts of lampblack are added to the finished mixture. If instead of on paper, the copying mass be spread on a smooth stone, porcelain, vulcanite, or glass plate, or on the surface of any hard material, this latter may be used as the backing or support for the paper on which the negative impression is to be produced. The writing may either be on this paper or on another laid above it. The resulting negative will yield copies on damped paper on being pressed thereon by the hand or by a roller.

BACKING FOR SHEETS OF COPYING PAPER.

A sheet of ordinary paper is coated on both sides with a thick solution of gum arabic (or dextrin) and tragacanth, in equal parts, and left to dry. The thin sheet of paper carrying the (ink) copy to be backed, is laid on this backing sheet (with the writing legible side upward) whilst still damp from the copying press, or after redamping by contact with a wetted sheet. The copy sheet and backing are then laid between metal plates and subjected to suitable pressure, which makes them cohere and form a single sheet. The other side of the prepared paper can be used in the same way for backing another copy, either at once or afterward. In any event, both sides of the backing sheet should be coated with the gum, to prevent warping in drying. The copying paper pasted on to another copying sheet in the manner described, can be made suitable for writing on by treatment with ordinary paper size or powdered sandarach and pressing.

FERRUGINOUS COPYING PAPER.

Since good copying inks are usually more or less inconveniently thick, the idea arose of preparing paper in such a manner that it would yield good copies from writing in ordinary ink.

Herzog prepares a copying paper containing an addition of ferrous sulphate or other salt of iron, either while the paper is being made, or by subsequent impregnation (by means of felt-covered rollers, etc.). Letters, etc., written with ordinary ink, made from gallnuts or containing tannin, will yield good copies when placed in contact with a damp sheet of this prepared paper and pressed, either in a copying press, or even when the pressure of the hand is applied through a superimposed sheet of blotting paper.

Schnell prepares, with the acid of chalk, a writing paper that will intensify the colour of pale ink, so as to make the writing more legible, and at the same time will yield good press copies. With this object, ordinary writing paper is dipped for 2–3 minutes in a creamy mixture of finely powdered chalk and water, the paper being then washed, dried, and finished in the usual way. The same result is obtained by incorporating $12\frac{1}{2}$ parts of chalk with each 1000 parts of paper-stock, in the paper machine, or by adding the chalk in the sizing trough.

IRIDESCENT OR MOTHER-OF-PEARL PAPERS.

Reinisch's Iridescent Paper.

Copal	2 parts,
Sandarach	2 ,,
Gum dammar	4 ,,

are dissolved in an equal quantity of absolute alcohol, then mixed with half their volume of oil of bergamot or rosemary, and distilled in a retort, fitted with a collector, until the residue is of about the consistency of castor oil. This residue is applied in a very thin film, with the aid of a brush, on the surface of water (at 40° F.) containing 5 per cent. of size. This beautifully iridescent film is then transferred to the surface of a sheet of paper and dried. A variety of designs can be obtained by the same means as are used in the production of coloured papers.

Puscher's Iridescent Paper for Visiting Cards, etc.

This paper is prepared by dissolving 15 parts of lead acetate in an equal weight of boiling water and mixing with it a 1 : 3 solution of gum arabic. This liquid is applied warm to the surface of paper, with a soft hair brush, the paper being laid on a cold table the while. The rapid cooling gives the coating the appearance of a fine white crystalline deposit. The paper is at once transferred to a metal plate warmed to 212° F. till the crystals have remelted, whereupon the sheet is placed on a level table in a warm room. If the paper has dried in places whilst being warmed, it is brushed over again with the same solution before removal.

To prepare coloured papers, the solution is given an addition of aniline blue, fuchsin, indigo carmine, aniline yellow or ammonium picrate. When dry, it is coated with a varnish of 1 part of molten gum dammar in 6 parts of petroleum ether.

In a later recipe, Puscher has superseded the injurious lead acetate by magnesium sulphate. Equal parts of the crystallised sulphate, water, and dextrin, with $\frac{1}{24}$ part of glycerine, are heated together, and when somewhat cooled, the liquid is applied to the surface of paper that has been already coated with size or gelatine. Crystallisation ensues in 10–15 minutes.

Imitation Mother-of-Pearl.

An imitation mother-of-pearl, to replace the genuine article for inlaid work, which it closely resembles in lustre, is prepared by coating fine, light-grey sized paper with the following composition :—

The iridescent superficial layer from the insides of oyster-shells and those of other molluscs, is detached by means of a fine rotary grindstone, then ground to very fine powder in a stone mill, and mixed with an alcoholic solution of isinglass. This mixture is spread evenly on the pale grey paper with a wide brush and rubbed in, this operation being repeated until the grey paper no longer shows through. The paper must then be smoothed and satinised. The iridescence is improved by adding a little finest graphite or silver-bronze powder to the ground shell.

Mother-of-Pearl Paper.

When a solution of nitro-cellulose in alcohol and ether, or in water glass, is sprayed over the surface of wood, paper, porcelain, glass, or metal, it produces a film resembling mother-of-pearl in appearance. The best method is to dissolve 1 part of nitro-cellulose in 78 parts of 90–100 per cent. alcohol and 21 parts of ether, or in a mixture of 10 parts of water glass and 90 of water. In the former case, ethyl alcohol or methyl alcohol, and sulphuric or acetic ether are used. The nitro-cellulose may be either in the crude state or in various stages of nitration, the result differing accordingly. The colour sequence and lustre of the iridescent film can also be modified by the addition of 25 parts of carbon disulphide to each 100 parts of solution, or by the addition of benzol.

CHAPTER XV.

Photographic Papers.

ALBUMINISED PAPER.

EIGHT parts of egg albumin and 2 parts of a 10 per cent. aqueous solution of ammonium chloride are beaten to a froth, or shaken up, and allowed to settle down for several hours. The fibrin which is present in the albumin and would produce bronze streaks on the paper, is thereby precipitated. The clarified albumin is placed in a flat dish, and rough paper, with the sized surface downward, is floated thereon for $1\frac{1}{2}$ minutes, then removed and hung up to dry. If any air bubbles have been formed, the paper must be floated again.

Another formula consists of—

Albumin	900 parts,
Water	30 „
Ammonium chloride	20 „

The chief difficulty is in preventing the formation of streaks, which afterwards exhibit a bronze sheen; but these may be avoided by floating the paper with a uniform motion. Papers that take up the albumin very slowly, owing to their fatty character, require an addition of 32 parts of albumin and 2 of alcohol, or a few drops of an alcoholic solution of ox gall to the solution. On being taken out of the bath the sheets of paper are fastened up to drain, by means of clips at each end, and are afterwards dried in a warm place, all four sides being fastened with clips. Finally, the sheets are pressed and stored in a moderately warm room.

Bott prepares albuminised paper by surfacing the sheets with a waterproof layer of barium sulphate, and then coating them with a film of albumin.

King prepares a stable, sensitised albumin paper as follows: two solutions are made ready—

1.	Distilled water	3600 parts.
	Silver nitrate	300 ,,
	Pure sodium nitrate. . . .	250 ,,
	Sugar	15 ,,

This solution is clarified with the aid of a little China clay.

2.	Water	300 parts.
	Pure sodium nitrate	30 ,,
	Silver nitrate	60 ,,
	Sugar	7 ,,

The paper is floated on solution No. 1, after the addition of 60 parts of No. 2, and is dried in the dark. After every fourth sheet has been treated, a further 30 parts of solution No. 2 are added to No. 1. This paper will keep good for 10–14 days if stored in a tube or box containing calcium chloride. It can also be stored for any length of time if the sheets be floated, face up, for half a minute on a solution of 105 parts of citric acid in 3000 parts of water, and then dried. The strength of the sensitising bath should be tested at intervals.

Abney recommended potassium nitrite for imparting stability to these papers. The sheets, sensitised by floating for a minute, are passed through several changes of water, hung up to drain and then floated, face upward, on a 5 per cent. solution of potassium nitrite before drying. The sheets must be stored in airtight tin boxes.

BROMIDE ALBUMIN PAPER FOR ENLARGEMENTS.

Ordinary albuminised paper is immersed in a 3–5 per cent. solution of potassium bromide, and then floated for 15 minutes on a sensitising bath of silver nitrate. The resulting paper is very rapid.

BROMIDE PAPER.

Twelve grms. of gelatine are soaked in 240 c.c. of water in a stone jar, 5 grms. of potassium bromide, and 0·13 grm. each of citric acid and chrome alum, the vessel being hermetically closed, shaken up well and heated on the boiling water bath for 10 minutes with frequent soaking. Seven grms. of silver nitrate are next added in the dark room, and the mixture is shaken up well for another 5 minutes, by which time the emulsion will be formed and can be laid on one side to settle down. Whilst still liquid, the emulsion is poured into a porcelain dish in the dark room, and when set is washed by squeezing the mass through canvas in cold water, at least half a dozen times. The washed product is drained, remelted, and mixed with 25 c.c. of alcohol, followed by sufficient hot distilled water to make up the total volume to 300 c.c. This solution is employed for coating coagulated, damp albuminised paper, spread on sheets of glass.

ZITTEROW'S COLLODION PHOTOGRAPHIC PAPER.

Equal volumes (150 c.c.) of nitric acid, density 1·4, and sulphuric acid, density 1·845, are mixed together, and employed at a temperature of $64\frac{1}{2}°$ F., for steeping 18 grms. of satin paper, cut into strips. At the end of half an hour the paper is taken out, washed, and dried.

FERRO-GUM PAPER.

This sensitive paper is prepared by the aid of a solution of ferric chloride, carefully treated with ammonia under constant stirring, until the mixture attains a condition of persistent ebullition. The liquid is then filtered and employed for steeping paper, which is afterwards dried in the dark and coated with a fairly thick layer of gum arabic. The finished paper does not change colour at first, but gradually becomes deep yellow. In the dried state it remains flexible for a long time, and has a beautiful gloss.

GELATINE PAPER FOR PHOTO-ZINCO WORK.

Where sensitised paper is in constant use it is advisable to stock the gelatinised paper and only sensitise it the day before it is wanted.

For the preparation of gelatine papers 1 part of gelatine is melted in 30 parts of water over the water bath and then pressed into a flat porcelain or glass dish. One side of the paper is drawn over the surface of the gelatine, taking care that no air bubbles are formed, and when the surplus gelatine has drained off at the one corner, the paper is hung up to dry in a well-ventilated spot protected from dust.

An equally good result can be obtained by laying the sheets of paper on a sheet of glass and dipping them under water for a few minutes. The surface being then freed from superfluous moisture by means of blotting paper, the edges of each sheet are turned up about half an inch all round, and supported in that position by wooden or metal rods. The moderately warmed gelatine is poured on to the surface of the paper, distributed evenly and dried in daylight, the edges of the paper being subsequently trimmed off. The gelatine surface can be coated with a layer of albumin, which confers the advantage that the photo-chemical picture can be more easily transferred to the metal plate by an unskilled operator than is the case when a gelatine film is used alone.

The gelatine paper is sensitised with a filtered solution of 1 part of ammonium bichromate in 13 parts of water poured into a flat porcelain dish. The paper is immersed, face upward, for two minutes, being held flat, if necessary, by means of glass rods, and after being drained is placed in the dark to dry, whereupon it is ready for use, being sensitive to light. The sensitising solution will keep for a long time in tightly corked bottles in the dark, if treated with an addition of about one-fourth its volume of alcohol and sufficient ammonia to turn the reddish solution yellow and give off a strong smell of that reagent. The alcohol fulfils the additional purpose of accelerating the drying of the sensitised gelatine film.

The smoothness of the gelatine layer and rendering of fine detail will be improved by laying the drained sheet from the sensitising bath, face downward, on a sheet of glass coated with a solution of wax in benzol, covering the sheet with a clean piece of paper and squeezing out the superfluous moisture and any air bubbles between the gelatine and the glass, by means of a rubber squeegee. The air bubbles can be readily detected and removed by viewing the gelatine layer through the glass side. The sheet may be either left on the glass to dry, or stripped off at once and hung up. By this treatment the sensitive coating of the paper acquires a high gloss, and is smoother than if calendered.

MATT ALBUMINISED PAPER.

Thick paper or rough drawing paper is dipped for a few minutes in a solution of—

Alum	7 parts,
Gum	2 ,,
Water	200 ,,

allowed to drain, pressed between blotting paper, and whilst still damp, floated for 15–20 seconds on a bath of—

Ammonia	20 parts,
Albumin	100 ,,

after which it is hung up to dry.

STABLE SENSITISED PAPER.

Thirty parts of citric acid are dissolved in 450 parts of distilled water. The albuminised paper is sensitised in the usual way in a bath about 1 in 10, and hung up to dry. When the surface is dry, the edges are wiped with blotting paper and the sheet floated, face upward, on the citric acid bath for about 10 seconds, and hung up to dry. This paper will keep for 2–3 months if stored dry and away from the influence of the light.

When, from any cause, the ordinary sensitised paper cannot be used at once, but has to be kept for several days or more, it is very liable to get stale. It may, however, be saved by applying citric acid to the under side with a sponge. This keeps the paper white, and as the acid is not in contact with the silver, but is washed away in the bath, the image is not affected and the toning is not retarded as is the case when the citric acid is applied to the face of the paper. This remedy can be easily tested by treating one-half of a sheet of sensitised paper with citric acid on the under side, and storing it for a week before printing. If any difference is observable between the two halves of the picture, the one treated with the acid will certainly be the better in appearance and will tone quicker and better than the other.

Another way is to dissolve 15 parts of silver nitrate in 100 of water in one bottle, and make a 5 per cent. solution of sodium citrate in another bottle, the two being mixed together. A thick white precipitate is formed, and this is treated with chemically pure nitric acid, added by drops, until the precipitate redissolves. The paper sensitised in this bath will keep for several weeks without change. The image appears of a reddish brown shade in the printing frame and will tone in any good gold-toning bath.

Still another method is to dissolve 30–40 parts of silver nitrate and 2 of citric acid in 180 of water, with an addition of ammonia until no more silver citrate is thrown down. This precipitate is redissolved by the addition of a little nitric acid, care being taken to avoid any excess of acidity in the bath. The paper is sensitised in the usual way, and when dry is laid between blotting paper. It will keep good for five days, and the coating of albumin remains extremely glossy.

According to Laborde, sensitised paper will remain white for a long time when aluminium nitrate has been added to the sensitising bath; and, indeed, it never turns yellow like paper sensitised with silver solution alone. The quantity of aluminium nitrate used may vary from 50 to 100 per cent. that of the silver nitrate. The aluminium nitrate coagulates the albumin, so that the coating has an improved gloss and does not get so hard on drying, whilst the silver bath never gets discoloured. The only drawback and inconvenience is that the pictures will not tone so well, and require stronger toning baths.

HELIOCHROME PAPER.

Very fine-grained paper is immersed in a bath containing—

Silver salt	20 parts.
Water	20 ,,
Alcohol	100 ,,
Nitric acid	10 ,,

after which it is dried and placed in a bath of—

Uranium nitrate	. . . . .	1 part,
Alcohol	. . . .	50 parts,
Hydrochloric acid	. . . . .	50 ,,

in which a little zinc-white has been dissolved. After drying again, the paper is exposed for a short time to sunlight, until it turns a bluish violet. It is next sensitised again, dried, put through the second bath and exposed a second time; and this cycle of operations is repeated until it has acquired a deep blue colour. Finally, before getting perfectly dry, the paper is left for 5–10 minutes in an exceedingly weak solution of mercury nitrate, and is then dried between blotting paper. This paper, when exposed to direct sunlight, under a negative, for 20–30 seconds, will reproduce all the colours of the original, on a white ground.

SENSITISED PAPER FOR PHOTO-ZINCOGRAPHY.

When potassium or ammonium bichromate is mixed with an adhesive like glue, gelatine, albumin, gum arabic, dextrin, etc., and then applied to the surface of paper or other smooth flat material, it furnishes a coating that, on exposure to the light, after drying, turns darker in colour, becomes insolubly attached to its support and swells up when moistened. When this exposure is made under a negative, only the parts acted on by the light, *i.e.* the transparent portions of the negative, become insoluble and capable of repelling moisture and colour, whereas the parts unacted on by the light will absorb water and colour. This action of light on adhesives in combination with bichromates, forms the basis of a number of reproduction processes.

In preparing sensitised paper for photo-zincography, use is made of the finest photographic gelatine, which dissolves in 25 parts of water at 77°–87° F., but sets to a jelly when cooled to between 60° and 73° F. The melting point of the jelly increases with the proportion of gelatine, a 10 per cent. solution not melting below 15°–18° F. above its setting point.

Prolonged heating for several days at 86°–122° F. destroys the setting power of gelatine solution, by decomposing it into semiglutin, which is precipitable by platinum chloride, and is insoluble in alcohol. This decomposition is not a sign of putrefaction, though it reduces the setting power. This behaviour of gelatine indicates that, in making photographic papers, it must not be exposed for long to a temperature of over 95° F., whether alone or in presence of chromium compounds. The best method is to recool the liquefied gelatine solution to about 89° F. before applying it to the surface to be sensitised. When the gelatine layer is set hard and dry, it is sensitised in the bichromate solution, which should be kept as cool as possible, ice being used in summer if necessary.

The preparation of the sensitising mass is conducted as follows:—

One part of best, finely shredded gelatine is placed in a beaker with 1 part of ammonium bichromate and 30 parts of water, and frequently stirred with a glass rod until the gelatine has begun to swell and the salt to dissolve, whereupon the mixture is warmed on the water bath until solution is complete. After filtration the product is ready for use.

Good, doubly-sized, very smooth post paper is laid on a sheet of glass, and dipped in cold water. On being taken out of the water, the paper is drained, and pressed under blotting paper, to expel superfluous moisture and any air bubbles present between the paper and the glass. The glass and paper are then laid in a perfectly horizontal position (ascertained by means of a spirit level), and the requisite quantity of chrome-gelatine to form the coating is poured on and distributed evenly over the paper with a badger-hair brush. When the chrome-gelatine layer has set to such an extent that it will not give under the pressure of the finger, the prepared paper is stripped from the glass and fastened by clips on to a line to dry. The application and drying of the coating must be effected in the dark room, at least without any light stronger than a candle. This paper will not keep good for more than 2–3 days, and should be stored in a black-lined cardboard box, in a not too warm dark room.

INSTANTANEOUS POSITIVE PAPER.

Paper is floated on a saturated solution of mercury chloride, dried and sensitised in the dark room with a 1 in 12 solution of silver nitrate. The exposure under the negative is very brief, varying from two seconds to a minute, according to the time of year. The faintly visible image is developed with a 1 in 30 solution of ferrous sulphate in distilled water, 10 per cent. of acetic acid being added. Fixing in sodium hyposulphite (thiosulphate) gives a very fine black tone.

HALLEUR'S PHOTOGRAPHIC PAPER.

A saturated solution of copper sulphate is mixed with an equal quantity of dissolved potassium bichromate and employed to impregnate good firm paper, which is dried and stored in the dark. On exposure to light, the paper first turns brown and then grows lighter. The image is fixed with silver nitrate and washed in water. The addition of common salt or other chloride to the water causes the image to vanish, but it reappears when the paper is dried in the sun.

PHOTO-LITHOGRAPHIC PAPER.

The whites of four eggs are beaten to a froth and left to settle; or an equal quantity of blood albumin is used, the solution being mixed with 20 grms. of dextrin dissolved in 300 of water, and filtered.

Paper with a smooth, uniform surface is floated, face down, on the bath, or the latter is applied to the face of the paper with a soft brush, and distributed evenly. Rive's paper, which is also used for albuminised papers, is the best for this purpose.

Each sheet is held by two opposite edges, the middle portion being laid on the surface of the bath and the two halves lowered slowly on to the bath, care being taken to avoid air bubbles. After a few seconds, when the paper has ceased curling, it is removed and hung up to dry in a place free from dust. This paper will keep good for twelve months.

For use it must be sensitised in a bichromate bath, prepared by dissolving 100 parts of ammonium bichromate in 120 of water and 40 of alcohol, together with enough ammonia to change the reddish colour into yellow. The filtered solution is poured into a flat dish, and into this bath the prepared paper is slipped, face upward, care being taken that the hands do not come in contact with and injure the layer of dextrin and albumin. After half a minute the paper is taken out, drained, and dried in a dark place. The dried paper will keep good for 3–4 days. It is only suitable for use with negatives from line drawings. An exposure of 1–3 minutes in the sun, or 10–20 minutes in diffused daylight is given, until all the detail is clearly visible. This done, the print is repeatedly wiped over on the back with a wet sponge, care being taken that none of the water runs over the edges on to the face. As soon as the white parts of the print exhibit a damp gloss and are tacky, the print is pinned on to a large damp sheet of strong paper and laid, face downward, on the prepared stone.

PIGMENTED PHOTOGRAPHIC PAPER.

According to Volckmer, two methods of pigmenting paper are employed at the Military Geographical Institute, Vienna, namely, brushing and dusting. The former is suitable for line drawings and contrasty tones, the latter for very delicate half tones, such as portrait, landscapes, etc.

In both cases the paper is prepared by drawing it slowly through a 1 in 60 solution of gelatine, followed by drying. In the brush method, this prepared paper is coated as thinly as possible with the following mixture, laid on with a wide badger brush :—

Colcothar	22 grms.
Indigo (pounded, suffused with alcohol and ignited)	8 ,,
Frankfurt black	4 ,,
Gum arabic	16 ,,
White sugar	18 ,,
Potassium bichromate	12 ,,
Distilled water	400 ,,
Ammonia	15 ,,
Chromic acid	4 ,,
Glacial acetic acid	30 drops.

The brush is moved right across the paper, first from right to left, and afterwards from top to bottom, so as not to raise the nap of the paper, changing the brush without dipping into the pigment, and endeavouring to secure a thin and evenly distributed coating. The sheet should only appear of a greenish-grey shade to the eye, not forgetting that the underlying chrome image will intensify and supplement the pigment.

In the dusting process, the gelatinised paper is floated on or coated with a solution of—

Gelatine	10 parts,
Gum arabic	10 ,,
White sugar	20 ,,
Distilled water	80 ,,

being, for this purpose, first immersed in cold water to cause the gelatine to swell, and then laid face downward on a sheet of plate glass. After being squeegeed, to remove the surplus water, it is turned over and rolled with a leather roller, so as to flatten it against the glass, and in this position is brushed over with the above solution. The paper is preferably drained on a semicylinder, so as to drain uniformly on both sides, and is transferred, while still damp, to the dusting box.

The dusting preparation consists of a dry mixture of—

White sugar	100 parts.
Lampblack or Frankfurt black . .	5 ,,

The operation is performed in a rotable dusting box, which is turned 6–10 times at moderate speed, then tapped to dislodge the mass that has collected on the top and in the corners, and, at the end of 1–2 minutes, the gelatine-coated paper is quickly introduced. Here it is allowed to remain for 8–12 minutes, during which time the dust settles down uniformly on to the moist gelatine, on which it forms a kind of granular texture. The paper is then dried.

For use, the prepared sheets are sensitised by wiping them over with a soft linen rag, and immersing in a solution of—

Potassium bichromate	50 grms.
Ammonium bichromate . . .	50 ,,
Distilled water	6 litres.

This solution is treated with ammonia until it has turned a pale yellow, and is then completed by the addition of 20 grms. of chromic acid and 1500 grms. of alcohol, in order to prevent the gum arabic dissolving too quickly.

If used whilst still fresh, the paper prepared by either of these methods will part with its yellow colour in the high lights during the washing process; but stale paper needs longer soaking—generally all night—and in very obstinate cases ammonia must be added to the final water.

PLATINUM PAPER.

The chief point in the preparation of this paper is to use a chemically pure iron salt, and to dry the coating as rapidly as possible. The solutions for treating the paper consist of—

A.	Sodium-ferric oxalate	40 grms.
	Ammonium oxalate saturated solution (3 per cent.)	100 „
	Potassium chlorate	0·1 „
B.	Potassium-platino-chloride . . .	10 „
	Distilled water	60 „

The second solution will keep indefinitely; but the former should be freshly prepared on account of the instability of the iron salt. Ten drops of A and 9 drops of B will be sufficient for two 5 × 4 sheets. The paper is pinned on to two laths a little longer than the sheet itself, and the mixed solution is applied with a bristle brush with metal fittings, as quickly as possible, and distributed evenly over the paper with a round badger-hair brush of medium size. The operation can be carried out by daylight in a moderately well-lighted room. The paper is next transferred to a drying oven, heated to at least 112° F., where it will dry in a couple of minutes. The drying oven is a sheet-iron box, closed at the bottom, but open at the top, and must be deep enough to allow a space of at least 4 inches between the bottom lath (to which the paper is pinned) and the bottom of the box, to prevent risk of the paper scorching. In order to obtain the necessary depth of black in printing, the paper must have a certain degree of moisture, which is lacking when it comes out of the drying oven, and for this purpose the sheets should be hung up in the dark for a short time to enable them to absorb moisture from the air.

The paper is exposed under a negative until fully printed out, the image being then fixed by repeated washing with weak hydrochloric acid (1 part in 80 of water), until the bath ceases to become tinged with yellow; it must then be washed for 2 hours in frequent changes of water. To obtain good tones the paper must be fresh and the printing rapid. In winter or dull weather the coating is liable to decompose during printing, to prevent which a sheet of rubber or waterproof cloth should be laid behind the paper in the printing frame, to prevent an undue absorption of moisture. It is advisable also to try whether printing cannot be accelerated in dull weather by increasing the proportion of solution B in sensitising. Quick printing is desirable, as it appears to yield warmer tones: and if the negative is of such a character that it can be printed in direct sunlight, so much the better for the result. In any case the negative should be plucky.

A good platinum paper is obtained by the following method: To prepare the sensitising bath, 125 grms. of dry ferric chloride are dissolved in 1000 c.c. of distilled water, the solution being filtered and treated with ammonia until a precipitate ceases to form. This gives a brownish-red jelly of ferric hydrate, which is washed on a filter until the washings no longer taste salt. Meanwhile a second solution is prepared from 50 grms. of oxalic acid in 150 c.c. of water, this being raised to the boil and poured over the moist ferric hydrate, which thereupon dissolves. This solution should be a saturated one and devoid of any acid reaction, on which account it is desirable to leave a little of the ferric oxide undissolved. The filtered solution is treated with 2·5 grms. of sodium-platino-chloride, and the volume is made up to 250 c.c. with distilled water, the solution being filtered again if any turbidity appears. It is now ready for use, and will keep indefinitely if stored in the dark. For use it is applied with a brush to paper, sized with arrowroot or gelatine, it being important that the solution should not permeate the paper, but remain on the surface, otherwise the prints will be devoid of brilliancy. The sensitising is, of course, performed in the dark room, and when the solution has been evenly distributed, the paper is hung up by one corner to dry in the dark. Exposure under the negative is as usual.

SHELLAC PAPER.

Powdered shellac is dissolved in a warm 4 per cent. solution of borax, then boiled for 2 hours, allowed to settle and filtered through sponge and paper. On this solution the paper is floated for 15 seconds. After drying, the coated paper is floated on a 10–15 per cent. silver bath, dried in the dark and redipped in a shellac bath of the same strength as before. When exposed under a negative the paper is toned with an 8 per cent. solution of ammonium thiocyanate (sulphocyanide), and fixed for 20–30 minutes in a 15 per cent. hypo bath. After being thoroughly washed, the pictures should be permanent and exhibit a very fine tone.

FUMIGATING PAPERS.

COMBUSTIBLE.

Paper is soaked in a solution of saltpetre (10–15 per cent. strength), and after drying is dipped in a strong solution of benzol or incense.

A good fumigating paper is obtained from the following recipe :—

Benzol	150 parts.
Sandalwood	100 „
Lemongrass oil	10 „
Vetiver essence	50 „
Incense	100 „
Alcohol	11 „

For use, the paper is ignited by contact with a glowing, incombustible substance. It consumes without flame, throwing off innumerable sparks and disseminating an agreeable perfume.

INCOMBUSTIBLE.

This paper is prepared by steeping in a hot 10 per cent. solution of alum, followed by impregnation with a mixture of—

Benzol	200 parts.
Balsam of Tolu	200 ,,
Vetiver essence	200 ,,
Alcohol	600 ,,

This paper gives off a very agreeable scent when warmed, and can be used repeatedly. It will not burn, and chars only when exposed to great heat. Inferior grades of this class are made by steeping the paper in alum and then in molten benzol or incense. The above vetiver essence is prepared by dissolving 7 parts of vetiver oil (Oleum ivar anchusae) in 500 of alcohol.

OTHER RECIPES.

Benzol	30 parts,
Styrax	8 ,,
Alcohol	150 ,,
Balsam of Peru	10 ,,
Musk tincture	2 ,,
Lavender oil	1 part,

are dissolved together, and applied 3–4 times, with a brush, to the surface of cardboard, suitably ornamented with printed designs.

Oil of cinnamon	4 parts,
Liquid styrax	4 ,,
Benzol	4 ,,
Ambergris	0·3 ,,
Musk	0·3 ,,

are dissolved to a thin solution in rectified alcohol, filtered, and brushed on to fine paper. The paper is held near a light so that it merely smokes, without taking fire. It disseminates an agreeable perfume, and can be used several times over.

ARMENIAN PAPER.

This paper, which is very popular, is prepared by soaking unsized paper in a solution of saltpetre, and, when dry, saturating it with one of the following mixtures :—

(*a*)	Musk	1 part.
	Rose oil	1 ,,
	Benzol	100 parts.
	Myrrh	12 ,,
	Violet root	250 ,,
	Alcohol	300 ,,
(*b*)	Benzol	80 ,,
	Balsam of Tolu	20 ,,
	Styrax	20 ,,
	Sandalwood	20 ,,
	Myrrh	10 ,,
	Cascarilla bark	20 ,,
	Musk	1 part.
	Alcohol	200 parts.

Both these tinctures are obtained by maceration for a month, followed by filtration.

TEST PAPERS.

1. LITMUS PAPER.

The chief point in the preparation of litmus paper is to obtain the maximum sensibility, and for this purpose, Uetcher recommends the following method: 100 parts of litmus in cubes are ground fine to a pulp with 40 parts of water, and then washed into a suitable flask with 960 parts of water. After repeatedly shaking the mixture during the first six hours, it is left to stand for several days, then filtered, and washed with a little water, so as to obtain about 1000 parts of filtrate. This is treated with 5 parts of hydrochloric acid, warmed in a porcelain basin on the water bath to expel carbonic acid gas, and treated with a little more hydrochloric acid, if the liquid turns blue at the edges after a time, so that a permanent red solution is obtained. After evaporating down to about 900 parts, 1 part of the solution is treated with limewater until it turns wine-red, and is used for dipping strips of filter paper that have been rendered neutral with dilute ammonia, followed by drying. This gives a reddish violet test paper, sufficiently sensitive to satisfy all requirements.

The other part of the solution is first carefully treated with a few drops of normal caustic potash, and then with limewater, until the trial strips of filter paper steeped therein dry blue. This condition is easily obtained, and the resulting blue litmus paper is very sensitive.

According to another recipe, the papers are prepared as follows:—

Blue Litmus Paper.

One part of litmus is digested for a day with 5–6 parts of distilled water and filtered. The solution is divided into two portions, one of which is treated with phosphoric acid, added drop by drop, until the liquid turns red. The next step is to add some of the second portion until the whole is again blue, this finished solution being then used to impregnate fine white, slightly sized paper that is afterwards dried in the shade.

Red Litmus Paper.

Blue litmus paper is immersed in diluted phosphoric acid (1 part to 20 of water) and dried.

2. TURMERIC PAPER.

The colouring tincture is obtained by digesting 1 part of powdered turmeric root in 6 parts of alcohol, and filtering the extract. Strips of filter paper are dipped in this solution and then dried.

3. TETRAMETHYL-PARAPHENYL-DIAMINE PAPER.

A test paper for detecting minute quantities of active oxygen is prepared with tetramethyl-paraphenyl-diamine, which is readily stained a deep violet by oxidising agents. By this means the slightest trace of active oxygen can be detected, either in the free state or in combination. Since the reagent is inert toward all other influences, it is well adapted to replace all other indicators used for the purpose in question.

4. DIFFERENT TEST PAPERS.

The following test papers are prepared by steeping paper in solutions of the various salts in question, followed by drying:—

(*a*) Potassium ferrocyanide paper, prepared with potassium ferrocyanide, is a test for salts of iron and copper, giving a blue coloration in the former case and a brown in the latter.

(*b*) Potassium thiocyanate (sulphocyanide) paper, is a test for ferric salts, with which it gives a blood-red stain.

(*c*) Starch paper. This is a test for iodine, and when used is moistened with dilute nitric acid, and then with the liquid suspected to contain iodine, with which element it gives a blue stain.

(*d*) Tannin paper is a test for salts of iron.

(*e*) Brucine sulphate paper.

(*f*) Morphine chloride paper; both these give a blood-red stain with nitric acid or nitrous acid, it being, of course, an essential preliminary that the nitric acid must first be liberated from combination by the action of sulphuric acid and warmth.

5. OENOCRINE PAPER.

This paper, which is intended for detecting adulteration in red wines, is prepared by dipping white filter paper in lead acetate solution, followed by drying.

CHAPTER XVI.

Papers for Cleaning and Polishing Purposes.

THE papers of this class comprise glass paper, flint paper, sand paper, emery paper, and all others used for rubbing down and smoothing the surface of wood, horn, ivory, metal, etc.; in the case of iron the same treatment is applied for the removal of rust and exposure of the bright metallic surface underneath.

The thick, tough paper is made in sheets or rolls, to which the polishing material in the form of powder is attached by an adhesive, usually glue. Different degrees of coarseness are used, but each is made as uniform as possible. The efficacy of these papers depends on the sharpness and hardness of the coating material, the dimensions of the particles having also an influence on the result. Thus, larger and coarser particles will cut more deeply into the surface under treatment, and therefore these coarser grades of paper are more suitable for smoothing down considerable inequalities at a quick rate. On the other hand, finer papers, though of equally sharp material, make smaller scratches and therefore these papers are best adapted for finishing the smoothing process. For these reasons, various grades of fineness are made, the material varying from a powder so fine that the granules can hardly be detected by touch (the diameter of the particles being 0·005–0·01 mm.), to granules measuring 0·1 mm. and discernible by the unassisted eye. Between these extremes, granules measuring

0·02 mm., and of globular polyhedral form, can be detected by the finger of an experienced observer. In addition to the size of the granules, however, their form and character influence the feel, sharp-edged particles feeling coarser than rounded granules of equal or even larger dimensions; and all these considerations are matters of importance to the maker of cleaning and polishing papers. The finished article is graded in different degrees of fineness, marked by numbers, the finest being No. 000, and the next in succession: 00, 0, 1, 2, 3, 4, 5, 6, and 7, the last named being very coarse and capable of making deep scratches when used.

GLASS PAPER.

This is largely used in smoothing wood, and the finely powdered glass employed acts like an extremely fine file, besides being able to polish any substance softer than itself. Hence, in the absence of emery paper, glass paper can be used for rubbing metal, though, on the one hand, it does not bite into the metal so well as emery, and on the other the edges of the fine particles of glass soon wear down, so that the paper loses its sharpness in a brief space of time. Glass paper is, however, the best material for rubbing down such substances as wood, ivory, tortoiseshell, bone, mother-of-pearl, oil, and water paints, varnishes, etc., since it can be used dry, and being colourless does not dirty the articles under treatment.

Glass paper is made in ten different degrees of fineness, according to the purpose for which it is required, the size of the particles ranging from the fineness of flour to ½ mm. in diameter. The manufacturing process was long conducted in a very primitive manner, and even now there are only a few makers who have adopted improved methods, although the industry is a fairly important one.

One of the chief factors in the process is the grading of the powdered glass into the several degrees of fineness required.

In small works the usual plan is to pound the glass with a heavy iron pestle in an iron mortar. All kinds of waste glass (cullet) are used, the only essential point being that the material must be clean, free from fat, oil, dried paint, varnish, chemicals, etc., so that the glass waste should be carefully sorted.

The dirty portions may be coarsely pounded and then boiled in strong lye till all the adherent substances have been loosened, this being followed by repeated washings in changes of clean water until the latter is no longer alkaline. Dirty glass may also be purified by burning off the organic impurities in a reverberatory furnace, and then throwing the hot glass into cold water, the rapid cooling causing the glass to break into small fragments, whilst the carbonised organic matter floats on the surface of the water and can be easily removed. Millstones may be used for pulverising the glass, but stamps, driven by steam or water power, are preferable where operations are conducted on a large scale.

A stamp mill of this kind is shown in Fig. 23. It consists of a fixed chest *H*, with cast iron sides forming the supports for the mechanism. The bottom is also of cast iron. Inside the chest, which is closed in by means of wooden doors, to prevent inconvenience to the workmen from disseminated glass dust, are two iron cylinders *aa′*, turned true inside, and revolving intermittently (about an inch at a time) after each stroke of the stamps *bb′*. The glass is pounded by the impact of these stamps, which also rotate on their own axes. The machine is very strongly built, and measures about 64 inches long, 40 inches wide, and 84 inches high. It weighs about 27 cwt. and requires a motive force of about 1 h.p.

All degrees of fineness in the powdered glass can be obtained with this machine. The iron cylinders are charged with cullet, and on closing the doors the stamps can be set going. When it is considered that the powder has been crushed sufficiently fine, the machine is stopped, the contents are removed and the cylinders recharged, these operations being repeated until enough powder has been accumulated for the next process, that of sifting. When the glass is crushed in a mortar, the powder is sifted by passing it over a number of screens of different mesh, corresponding to the various grades required; but this is a troublesome operation, besides being injurious to

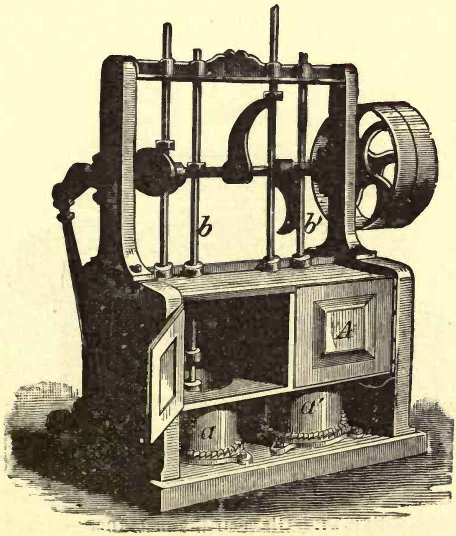


FIG. 23.—Stamp mill for pounding glass.

the men engaged, not merely in the sifting room, but also in all other parts of the building that are not hermetically shut off from that room. The fine glass dust remains suspended in the air for a long time, and being drawn into the lungs in breathing may give rise to dangerous illness. Workers engaged in this operation cannot be too strongly urged to cover the mouth and nose securely with respirators, so as to keep the dust out as much as possible. If, however, the work is conducted on a sufficiently large scale to employ a sifting machine, one of the type illustrated in Fig. 24 is recommended. It consists of a closed wooden chest, containing a cylindrical wooden frame *C*, covered with wire gauze and set in rotation by a belt pulley *B*. Another pulley *a*, at the opposite end of the same shaft controls the automatic feed of material to be screened. Inside the screening cylinder *C*, is a fan which sets up a current of air and facilitates the sifting process. The glass powder is placed

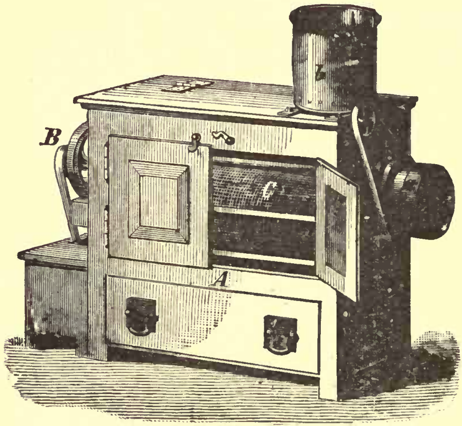


FIG. 24.—Glass-sifting machine.

in the hopper *b*, and fed thence by the automatic device into the cylinder, in proportion as the latter is ready to receive it. The fine particles traverse the screen *C*, and fall to the bottom of the chest, whilst the coarser portions remain in the cylinder. To enable the screenings to be graded in the one machine, a number of interchangeable cylinders with different mesh are provided. The coarsest screen is put in first, and all the particles left behind in this one are used for the coarsest glass paper. The second screen being then put in, gives a finer grain, and so on until the whole supply has been graded, the product from each screen being stored in its proper bin. The machine can be improved by fitting it with several cylinders of different mesh, so that the material passes from one to the other and is graded continuously. The experienced manufacturer will know how best to arrange these modifications to suit the requirements of his own particular case.

The paper should be strong and of long-staple, containing as little wood pulp as possible, or it will easily tear and break in use. It should be fairly thick, to prevent the glue soaking through, but not so heavy as to unnecessarily increase the price of the finished article. Freedom from lumps and irregularities is essential, any such found present being removed by the aid of pumice, in order to ensure a flat surface; otherwise they would project through the glue and coating of glass, or form little hillocks of glass and spoil the surface of the product, besides unfitting it for producing a level surface on the substances on which it is rubbed.

The paper cut into sheets of the proper size is laid on a large work table, fastened down with pins or clips at the four corners, and then coated evenly with hot glue, laid on with a wide brush. This operation entails some skill, since the glue soon thickens and becomes stringy and difficult to distribute. The glue also must be of the best quality and of suitable consistency if good results are to be obtained. If the glue be too thin and the paper poor, it will soak in, and there will not be enough left on the surface to stick the powdered glass properly, so that the latter will be liable to peel off in places and leave the surface more or less bare. This is especially the case with the coarser grades of glass paper, the glue requiring to be applied with great care, so as to hold the particles of glass, these being, from their nature, incapable of absorbing any of the glue, and tending, on account of their smooth surface, to spring off. On the other hand, glue that is too thick dries quickly on the surface, whilst the under part is still damp, so that the glass powder cannot become embedded in the coat. Uneven distribution of the glue gives alternate thick and thin streaks, which show up very prominently when the glass is dusted on, and spoil the paper for use.

As soon as the glue has been applied, the powdered glass is dusted over the surface by means of a small hand sieve; an operation requiring a certain amount of care, though not so much so as the preceding one. The best plan is to employ three men on the job, one to apply the glue, the second to sprinkle the glass, and the third to remove the superfluous glass. It is not practicable to work the sieve so as to apply only just the necessary quantity of glass to the sheet, but the sprinkling must be continued until the paper seems to be covered evenly all over. In this way, some of the particles will not be sticking to the glass at all, but simply lying on top of others; and these are got rid of by simply turning the sheet over. This done, a wooden roller is run lightly over the sheet, to press the glass into the glue and smoothen the surface, whereupon the paper can be hung up or laid on a rack to dry.

The maker's name, and any other mark, together with the number denoting the fineness of the paper, must be stencilled or printed on the back of the paper beforehand.

The foregoing method is undoubtedly susceptible of improvement in many respects, for instance with regard to the use of machinery for gluing and sprinkling the paper, and thereby reducing the risk of injury to the health of the workmen. It must, however, be remembered that the industry is still largely in the hands of persons of small means.

PUMICE PAPER.

This is made in the same way as glass paper, by coating strong paper with glue and sprinkling it with pumice powder of various degrees of fineness.

According to another report, the following method is practised :—

A quantity of pumice is calcined in a crucible, and then quenched in water and pounded to a fine powder, the latter being stirred up to a thin, workable pulp with good boiled oil. When a yellow coating is desired, a little ochre is added to the mixture, a bluish red colour being obtained by using colcothar and lampblack. A thin, even coating of this pulp is applied to strong packing paper with a brush, so that the paper is covered all over, and the whole is left to dry. A second coating is afterwards given, and when this is dry, the paper is run between rollers, in order to smoothen the surface as much as possible. To prevent the tendency of the pumice to settle down from the varnish, the mass must be kept constantly stirred in order to preserve its homogeneity. This paper is suitable for polishing rusty iron and steel, to which it will impart a perfectly bright surface.

SAND PAPER.

This paper is put to the same uses as glass paper, but, being of much harder material, will bite the articles under treatment more energetically, and therefore needs using with greater care. At the same time it does not wear out so quickly as glass paper, the particles retaining the sharpness of their point and edges better than glass.

The sand, or powdered flint, is graded by sifting, and is then applied to paper coated with glue. The paper should be of long-staple, free from wood pulp, short fibres, and irregularities, the latter being removed, if present, by scraping. When cut into sheets of suitable size, the paper is pinned down on a table, and coated with glue of the proper consistency. The glue, unless too thin, soon dries, and therefore the sand must be sprinkled over it without delay. The superfluous sand is removed by turning the paper over, the sheet is then rolled to fix the powder in position, and finally is hung up to dry.

EMERY PAPER.

Fremy divides the process of making emery paper into five stages, employing a special machine, as follows:—

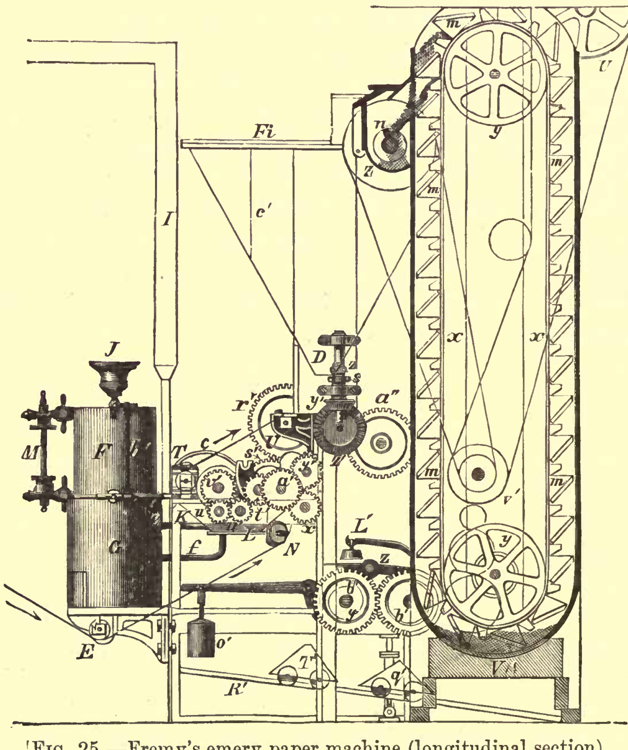


FIG. 25.—Fremy's emery paper machine (longitudinal section).

1. Coating the paper with glue.
2. Sprinkling the emery.
3. Removing the superfluous emery powder.

4. Cutting the sheets.
5. Piling up the cut sheets.

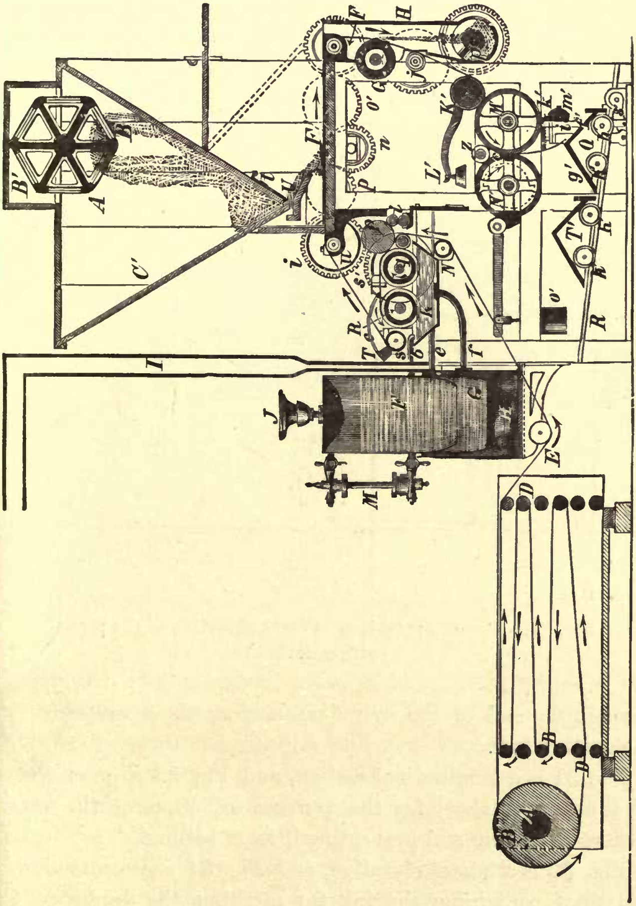


FIG. 26.—Fremy's machine (cross section.)

The apparatus used is illustrated in Figs. 25–35, of which Fig. 25 is a longitudinal section.

Fig. 26, a vertical section through the middle of the cylinder and hopper.

Fig. 27 is a vertical section through the paper-cutting device.

Fig. 28, a longitudinal section through the cutting cylinder in its frame.

Fig. 29, a cross section, and Fig. 30 a longitudinal section

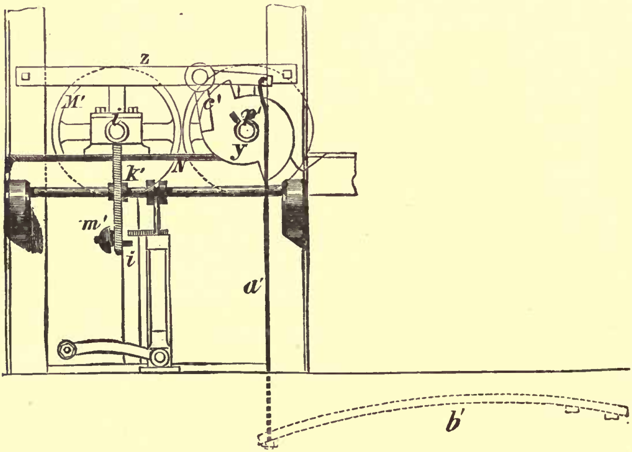


FIG. 27.—Fremy's machine. (Vertical section of the paper-cutting device.)

through the end of the cylinder, showing the arrangement of the cutting saw.

Fig. 31 is a longitudinal section, and Fig. 32 a cross section of the hopper shoe, for the purpose of keeping the emery powder in motion and preventing it from balling.

Fig. 33 is a lateral elevation, and Fig. 34 a cross section of the duct containing the ink for marking the backs of the sheets.

Fig. 35 represents the metal sieves covering the rotary hexagonal screen. The arrows indicate the direction of movement of the various parts and of the paper. A is a roll on which the paper B is wound, and is mounted in a box C in front of the machine. In unrolling, the paper passes over the rods D and under a guide roller E, situated under the feeding device for the glue duct. This latter consists of a cylindrical copper vessel F, resting in a water bath G, heated by a small coal fire H. The products of combustion escaped through the flue T above the vessel F is a funnel-shaped basin J, into

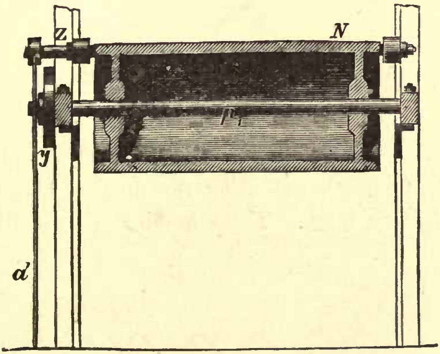
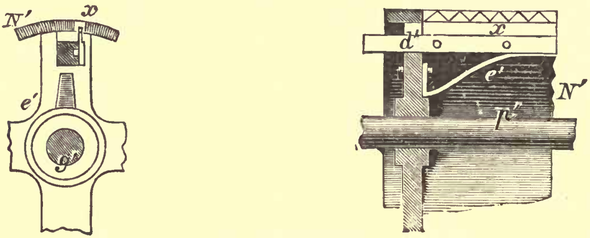


FIG. 28.—Fremy's machine. (Longitudinal section through the cutting cylinder in its frame.)

which the glue is poured. The stem of this funnel is fitted with a tap a, connected by a rod b, with a second tap e, situated between the pipes d, and admitting the glue into the duct K. This latter is fitted with a jacket L, filled with hot water from the bath G, through the pipe e, another pipe f, returning this water to the boiler, so that a constant circulation is maintained. The height of the glue in the glue pot F, is indicated by means of the glass gauge M. The boiler K is supplied with water through a funnel and pipe not shown in the drawings.

On leaving the roller *E*, the paper passes over a second guide roller *N* and then between the cylinder *O* and *P*. The first of these is covered with elastic material, *e.g.* leather, and



FIGS. 29 and 30.—Fremy's machine. (Section through the end of the cylinder.)

grasps the end of the paper, whilst the other cylinder carries in relief the figures representing the fineness of the paper, and also the factory mark. These are inked by a roller *G*, and

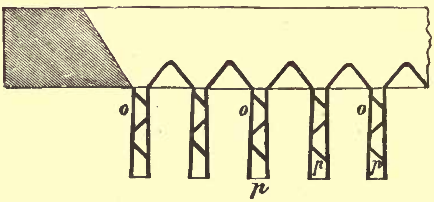


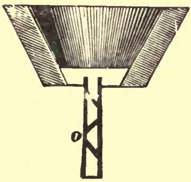
FIG. 31.—Fremy's machine. (Cross section through the hopper shoe.)

print on the paper accordingly. A second roller *P*, running in contact with *G*, receives ink from the duct *i* (Fig. 33). The duct can be raised or lowered by means of a notched bar *j*, engaging with a pawl, *k*.

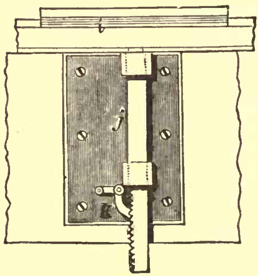
Q and *R* are the two felt-covered gluing cylinders, and one of them is mounted in adjustable bearings, so that their relative position can be altered as required. They receive the hot glue from the duct *K* and apply it to the paper, which then passes onward under the roller *s*, against which it is held by the spring-controlled presser *T*. This latter is elastic and covered with cloth, for the purposes of spreading the glue on the paper and removing any surplus applied by the cylinders. The presser has recently been modified, so as to receive a reciprocating motion, and the pressure of the holding spring, *l*, is also adjustable with ease. The presser is also concave, instead of convex as shown, in order that it may fit against the periphery of the roller. The journals are fitted with fingers engaging in a spiral groove cut in each end of the roller, so that as the latter revolves the presser moves to and fro. It is mounted in a movable iron frame, supported in collars in the frame of the machine, and the ends of the rods are surrounded by spiral springs, the tension of which regulates the pressure on the paper. After leaving the presser, the paper passes over a guide roller *u*, and under a series of long brushes, the first of which—made of strong pig's bristles—spreads the glue, which is then further smoothened by the second softer brush. On reaching this stage the paper is ready for the application of the emery powder. This is placed in the hopper *e′*, and escapes through a small, adjustable slide *t*, on to an inclined surface *u*, and thence on to the platform *b*. To stop the outflow of powder, the inclined plane *u* is lifted and thus closes the hopper outlet. When the powder used is so fine as to have a dull appearance, resembling meal, and will not run down of itself, the slide *t* is removed and replaced by the device shown in Figs. 31 and 32, consisting of a flexible diaphragm with a number of small tubes *o*, containing cross-wires *p*.

These tubes are mounted on a rack, receiving a vibratory motion from an eccentric *r*, on the shaft *D* (Fig. 25). Underneath the tubes *o*, is a horizontal metal sieve, which moves in the opposite direction to the tubes by the influence of an eccentric *s*, also attached to the shaft *D*. This arrangement ensures that, in proportion as the power is caused to descend in the hopper *C'* by the diaphragm, it enters the tubes *o*, and in consequence of their vibratory motion, assisted by the cross wires, is strewn on the metal sieve, which in turn throws it in the opposite direction and in uniform amount on to the platform *b'*.

The paper stretched and spread on the platform receives the powder, which necessarily attaches itself thereto. Next



Section through a hopper shoe.



Elevation of a duct.

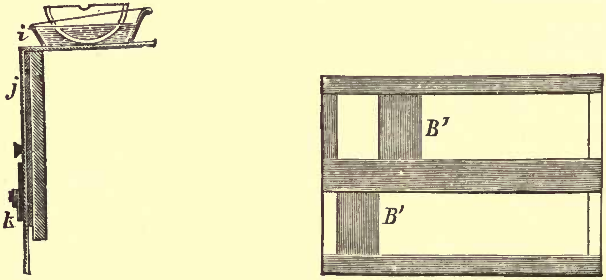
FIGS. 32 and 33.—Fremy's machine.

it passes over the guide roller *F* and comes in contact with the roller brush *E'*, which causes the paper to vibrate and shake off the superfluous powder into the box *H*. In the latter the powder falls into the trough-shaped bottom *T'* and is conveyed by the worm *o*, into the trough *V* whence it is raised by an elevate *x*, with the cups *m* (actuated by the drum *yy*), into a shute discharging into the trough *Z*, and here it is carried by another worm conveyor *r*, into the hexagonal bolting cylinder *A'*, mounted above the hopper *c'*, and covered with the metal sieve *B'*, as shown in Fig. 35. The cutting of the damp paper presented certain difficulties, which, however, have been overcome by the following device:—

On leaving the damp guide roller j', the paper is gripped by the cylinder K', which is pressed by a weight L' against the cylinder M'. This stretches the paper and brings it against a second cylinder N', which is acted upon by a weight o', and carries two saws X, equidistant on its periphery, these cutting the paper into sheets corresponding to half the circumference of the cylinder. These saws are movable, in order that they may give the quick powerful stroke necessary for cutting the paper.

For this reason the shaft p', of the cutting cylinder N' is fitted at each end with a double lifting cam J (Figs. 25 and 26), which, in turning with the shaft, raises the lever z. This is connected by a rod a', with a spring b', and also carries an arm c', which strikes a quick blow on the saw carrier d', when the lever falls over the cam, thereby forcing the saw X forward at the instant it comes opposite a slot in the cylinder M. The saw enters this groove in cutting through the paper, and is immediately withdrawn by the pull of the spring c'. This movement is repeated at every half turn of the cylinder and is perfectly uniform.

The moist paper, laden with heavy material, would fold on itself were it not taken from the machine in a manner preventing this drawback. At the moment the cylinders come in contact, an articulated finger, mounted at each end of the cylinder M' and close to the slot, inserts itself between them, pressing gently on the paper and holding it fast until the end of the paper comes into position under the cylinder. At this point a striker on the machine frame lifts the finger from the paper, which then fits against the inclined plane F' of the carriage Q'; and when the sheet has been cut off, the other end, on issuing from the cylinders M' and N', lies on the second inclined plane g' of the carriage, which is mounted on wheels h, h', running on the sloping track B', and only kept at rest by the stop S'. When 60 sheets of paper have been collected in this manner on the carriage, a hammer i strikes on the bell m', and indicates that it is time to bring the second carriage F' under the cylinder. The hammer i is attached to a pinion k, rotated by a worm l', on the shaft of the cylinder M. To bring the carriage T' into the position of the carriage Q', the workman releases the stop S, whereupon the carriage Q runs down the sloping track



Section through ink duct. Metal sieves.

FIGS. 34 and 35.—Fremy's machine.

R', and is replaced by the empty carriage T', which in turn is held in position under the cylinders by lowering the stop S'.

The machine is driven by any convenient motor from the large pulley U', motion being transmitted thence to the second belt pulley V', on the same shaft as the rotary brush G', which drives the rest of the machinery through the pinions n', o', p'. The pinion n' drives a pinion s' on the shaft of the cylinder Q. On the other end of this shaft is a pinion t', which drives the cylinder R through the pinions, $uquq$ and V'. The pinions X, X' driving the rollers g and h, have now been omitted, in order to simplify the mechanism. The shaft D' is driven by a pinion J' engaging with a cone-wheel z', which in turn is actuated by the pinion a''. Motion is imparted to the cutting cylinder by the pinions C'', C'', actuated through a train of gearing from the belt pulley V.

To complete the operation, all that is necessary is to place the paper in a hot chamber, provided with a fan, where it is hung on cords and dried by degrees.

Another machine for making emery and glass paper has been constructed by Brückner. The paper or cloth to be coated is wound on a roller, and unwinds from this over a guide roller conducting it between two rollers, one of which is adjustably mounted so as to exert a controllable pressure on a felt-covered roller that dips into the glue duct. The distribution of the glue on the paper is effected by a roller, actuated by friction from one of the rollers aforesaid. The paper is next passed under two sprinkling hoppers, which discharge the emery powder over revolving steel rollers. Ribbed rollers behind the hoppers cause the paper to vibrate and thus facilitate the distribution of the sprinkled emery, the hoppers being in duplicate for the same purpose. The paper next passes over a roller, whereby the loose powder is dislodged and falls into a box, whilst the paper passes onward over two steam-heated cylinders, by which it is partially dried, and thence between chilled cast rollers, which smoothen it and compress the still viscid adhesive. One of another pair of rollers, afterwards traversed by the paper, stamps it with the factory mark. Drying is completed by the aid of two hot cylinders, and the paper is then cut into lengths by a two-roller machine, a further cutting device dividing these lengths into sheets by transverse cuts.

The cut sheets fall on to an inclined plane, whence they are lifted by a rake and laid on a table. The chief advantages of this machine are that the sheets are coated and finished without being touched by hand, and that a larger output is obtained than with other machines of the same category, though this is only possible by employing a very quick-drying adhesive of special composition.

Dumas has introduced several improvements for removing the difficulties usually encountered in making emery paper, and reducing the cost of production. This firm turns out sheets ranging in size from 8×12 to 16×10 inches, according to the quality. The works cover a large area, and all the rooms are well ventilated, to clear the air of dust. The ventilating fans are lubricated with solid grease instead of oil, so that there is no risk of dirtying the paper by oil droppings.

The glue used for coating the paper is made from hide scraps cut into fine shreds. Of this material 230 parts are mixed with 100 parts of rabbit skins, 15 parts of alum, and 930 of water, plus 1–2 per cent. of glycerine, the whole being boiled in a pan for about 7 hours, after which the mass is put through a sieve and pressed with an improved Revillon press, fitted with a perforated central pipe through which the whole of the liquid drains, and is forced outward by atmospheric pressure. The residue is sold for manure, whilst the glue on cooling is treated with 24 parts of sulphurous acid, and at the end of 12–15 hours has attained the proper consistency for use. From 16–24 cwt. of glue are used daily, and this quantity must be freshly prepared. The various kinds of paper are made of different thicknesses from old rope, nets, and similar material.

Thirty coaters are employed, each working at a separate wooden bench with a filleted edge all round, and an emery powder box. The workwoman lays a sheet of paper on the iron grid mounted on the bench, and coats it with glue from a jacketed pot resting on an earthenware stove heated by a mixture of wood- and peat-charcoal. The glue is laid on with a brush, and the emery powder sprinkled on, after which the paper is placed on a board to dry. Each finished sheet is examined for defects, which are either remedied or trimmed off. The different numbers are stored in separate boxes. The materials consumed in making 1000 sheets average 75 lb. of emery, 66 lb. of iron slag, $17\frac{1}{2}$ lb. of sandstone, 22 lb. of glass, and 22 lb. of flint.

For the best grades of emery paper, powdered Naxos emery is used, iron slag furnishing a cheaper, but less durable, article. Whereas natural emery polishes metal without scratching, the iron slag scratches without polishing. Emery is greyish brown in colour, slag blackish brown. In the factory just referred to, the powder is passed through bolting sieves and separated into different grades of fineness, the dust being first eliminated and the various grades classified by hand sifting. Female labour is almost exclusively employed, and the yearly output of the works is $4\frac{1}{2}$–5 million sheets. The finest powder is only used about every 18 days, and as this is the only grade that gives off dust, the workers are only occasionally exposed to the influence of the latter, an arrangement preventing any injury to their health. The ventilation of the workrooms greatly facilitates drying. The health of the workers is also protected by the following precautions :—

1. They remain only a short time in the drying room, and therefore inhale only a very small quantity of the vapours liberated during that process. 2. A regular change of work is provided. 3. The workrooms have asphalt floors and are therefore easily kept clean. 4. All the bolting machines are fully enclosed.

Another method of making emery paper, by which all the finest polishing grades can be produced is as follows :—

The sheets coated with glue are hung up on lines at different levels in a closed room, in the same manner that bookbinders hang their sheets up to dry. When the room is filled with these sheets it is closed, and unsifted emery powder is blown in by means of a fan. This dust fills the room and separates into various degrees of fineness by gravitation, the finest dust remaining near the ceiling and coating the papers there, whilst the coarser particles adhere to the sheets lower down. In this way the sheets on the various levels are graded automatically.

Day patented a process for making waterproof emery powder, by coating paper with emery on both sides and fixing it in position by means of a waterproof cement, so that the injurious action of moisture on the sheets should be entirely prevented. This waterproof and flexible composition is made by melting 2000 parts of hard African copal, and pouring it into 3000 parts of boiled linseed oil, followed by a 1000 parts of lac, 1000 of Venice turpentine, 25 parts of Prussian blue, 25 of litharge and 1000 of dissolved rubber. The ingredients are well mixed together, and if too thick, the product is thinned with boiled oil, then applied evenly to the paper and finally sprinkled with the emery powder.

PAPER SUBSTITUTE FOR COTTON WASTE.

Soft paper is an excellent cleaning material, capable of advantageously replacing cotton waste or rags, and can be manufactured from these latter. The paper resembles grey blotting paper in texture, is made in a cylinder machine, and weighs about $1\frac{1}{2}$ oz. per sq. yd. Whilst very absorbent and soft, it is strong enough to take up lubricating oil without tearing. It is free from sand, and, being cut into sheets and packed in piles, cannot become contaminated before use.

Semi-woollen and woollen rags are used for making this paper, all the seams, etc., being unpicked, to keep out dirt and lumps. To facilitate the working of the stock in the machine, these rags are boiled with water only, under a pressure of $1–1\frac{1}{2}$ atmospheres, no alkali being used at all. As this stock is not strong enough when used by itself to furnish a paper with the requisite qualities, it is mixed with jute that has also been boiled under similar pressure without chemicals, the proportion of jute employed depending on the tensile strength of the rag-stock. Wood pulp may also be used in place of jute, but only sulphate—or soda—cellulose, since these increase the strength and absorptive capacity of the paper, which sulphite cellulose does not, at least to such an extent. A sample of this kind of paper was found on examination to consist of one-third wool fibre and two-thirds solid material.

The manufacture of this paper should be profitable to small makers using cylinder machines, the consumption of power in working this class of materials being low, and therefore enabling the capacity of the works to be fully utilised.

CHAPTER XVII.

Lithographic Transfer Papers.

THESE papers are prepared in the same way as transfer pictures, the paper being coated with a film that prevents the printing colour from penetrating the fibre of the paper, and keeps it on the surface of the film, so that it can be transferred completely on to stone, zinc, etc. Hence the same points have to be considered as in the case of making transfer pictures.

Two hundred and fifty parts of pure starch are mixed with a little cold water, 1000 parts of boiling water being added slowly with constant stirring. This preparation is treated with a mixture of 10 parts of neutral chrome yellow and 4 of gum arabic, dissolved in water. Five hundred parts of carefully purified glycerine are next added, and the whole is stirred until cold, to prevent the formation of a crust.

To remove all undissolved or other solid impurities, the preparation is carefully strained through a bolting cloth, and will then be ready for application to the paper. It is laid on with a brush and as evenly as possible, the sheets being afterwards hung up to dry in the air. This transfer paper will keep moist, and can therefore be stored in an unrolled state; the stone or plate will not require wetting, and the transfer will remain the same size as the negative.

SCOTCH TRANSFER PAPER.

The sole ingredients used are: wheaten flour 50 parts, gypsum 50 parts, and laundry starch 18 parts, but the gypsum must be of the very best quality, the inferior kinds being quite unsuitable. The flour and starch are made into paste, and the gypsum is mixed in a separate vessel with sufficient water to make a creamy pap, in which state it has lost the tendency to set hard, and will not settle out. The paste and pap are well mixed together, a little saffron being added to tinge the whole with yellow and enable the face of the coated paper to be distinguished from the back. This, however, is not essential, the skilled worker being able to tell at a glance which is the right side of the paper. Before use the mixture should be strained through muslin, to keep back any solid particles. The coating is laid on in the usual manner, a small addition of glycerine preventing the paper from curling. The finished paper requires damping before use, but workers accustomed to glycerine paper can incorporate sufficient glycerine with the paste to render damping unnecessary. Finally, it should be noted that this paper adheres very firmly to the stone when put through the press, and therefore the back of the paper will require to be wetted several times with a sponge. This treatment will generally enable the paper to be stripped from the stone, though occasionally it will have to be rubbed off with hot water.

UNSTRETCHABLE TRANSFER PAPER.

Ordinary transfer paper for photolitho work is liable to stretch in the press, a circumstance that is disadvantageous in some reproductions. To remedy this, Otto floats Steinbach paper on a solution of—

Shellac	1000 parts,
Borax	250 ,,
Water	5000 ,,

and coats it, after drying, with a solution of 140 parts of gelatine in 2000 of water mixed with another solution of 60 parts of shellac in 1000 of alcohol.

These coatings form the substratum for the true gelatine or gelatine-albumin layer, which, after immersion in a bichromate bath, is exposed under a negative and rubbed over with transfer ink. The method gives very satisfactory results.

UNSTRETCHABLE SENSITIVE TRANSFER PAPER.

To prevent grained, sensitised, or transfer paper from stretching under the influence of moisture, a metal plate is coated in places with a warm strong solution of resin, wax, and tallow in a very little oil of turpentine, and the edges of the transfer paper are coated with the same solution and pressed on the plate. When the paper has afterwards to be damped for transferring, its adhesion to the coated parts of the plate prevents its stretching all over. The plate can be removed by warming, and the paper is accessible to treatment with the damp sponge, owing to the number of places left uncovered by the resinous adhesive. The method is specially adapted for carbon paper in chromolithography.

TRANSFER PAPER.

Starch	1 part.
Flour	$\frac{1}{8}$,,
White lead	$\frac{1}{2}$,,
Gelatine	$\frac{1}{2}$,,

The flour is stirred with cold water to a uniform pulp, the starch being added with just sufficient water to enable the mass to be stirred. The gelatine having been dissolved in water is next stirred in boiling hot, this condition being essential to success. Last of all the white lead is added, having been previously mixed with $1\frac{1}{4}$ parts of glycerine in summer, or 2 parts in winter. This composition is applied to the paper in two coatings, the first one being dried before the second is laid on.

TRACING AND TRANSFER PAPER.

Fine, unsized satin paper is used, the method consisting in laying both sides of the paper in succession on a stone that has been covered with boiled linseed oil by means of a roller, and then putting the sheet and stone through a press. The semi-dry paper is next brushed over on both sides with a mixture of 2 parts of a solution of copal or amber in boiled oil (quick-drying coach varnish) and 1 part of pure, inodorous oil of turpentine. After drying, the paper is washed with soap and water and afterwards swilled with water only, then run through the press on a clean stone and passed through the satinising machine.

AUTOGRAPHIC PAPER.

The following instructions, if carefully observed, will give a paper that will transfer the finest points and most delicate lines to the stone with such fidelity that the plate can be etched without any retouching, and will give thousands of excellent prints.

Strong, unsized printing paper is treated with a mixture of—

Gelatine	10 parts.
Water	100 ,,
Tannin	5 ,,
Water	100 ,,

The paper is spread out flat on a plate and coated with the gelatine solution by pouring, the plate being then tilted to enable any surplus to drain off. This done, the tannin solution is poured on the paper, and when dry the cycle of operations is repeated two or three times, the paper being then well dried and strongly pressed in the satinising machine. This paper will reproduce on the stone the finest writing or drawing, and even the finest copper or steel engraving can be transferred to the stone by taking a pull from the plate with autographic ink on to this paper, and transferring the latter to the stone.

CHAPTER XVIII.

Sundry Special Papers.

1. SATIN PAPER.

A PAPER highly suitable for fancy paper goods, fine box linings, etc., can be made by pasting fine, transparent Japanese copying paper over metal paper (silver paper especially), with a solution of palest gelatine, care being taken that the delicate covering sheet lies smoothly on all parts of the metal paper, without showing any creases. When this combination of papers is dry it looks like a fine satin fabric worked with silver thread, the metal shining through the thin paper with a mild lustre that gives an exceedingly pleasant effect. This paper can be printed on, whereas metal paper cannot; and if painted on with glaze colours and then oiled or varnished, very handsome effects unattainable by any other means can be produced.

2. IVORY PAPER FOR MINIATURES.

A substitute for sheet ivory for miniature painting can be made by fastening three sheets of Berlin drawing paper together with parchment glue, and then stretching the still moist sheet over a rather smaller writing slate and gluing the edges on the back, leaving the whole to dry. Three other sheets of the same paper are pasted in succession over the first, cut to the size of the slate, and when the whole is thoroughly dry, the surface is rubbed smooth with fine glass paper. The surface is next coated with a uniform layer of finely ground gypsum in thin parchment glue, this coating being also polished when dry, with the finest glass paper, and varnished with three coatings of thin size, after which the paper is cut loose from the slate.

3. ENAMEL PAPER.

This is made from glacé lithographic paper, which has a glossy white surface of barium sulphate. This coating has the drawback of being very sensitive to liquids, which soften it immediately, and consequently this defect must be removed before the paper can be used for photographic purposes. With this object the paper is floated on a mixture of 2 parts of albumin and 1 of water, and then dried. A strong iron dish is next taken, filled to a depth of an inch with water and covered with a layer of stretched canvas over which a piece of flannel is laid. On this latter the sheets of paper are piled up, covered with another piece of flannel, and the water heated to boiling. In a couple of minutes the albumin will be coagulated, and the paper can be taken off and dried. The surface will now be proof against water, acids, alkalis, alcohol, and ether. Finally, the paper is treated with albumin and salt, like albuminised paper, and will then be ready for use.

4. CORK PAPER.

According to Rivière's patent, a packing paper, specially adapted for glass and porcelain ware, is made from strawboard or other sized millboard or paper, woven or other fibrous materials, by coating the surface with ground cork by means of glue or other adhesive. The adhesive is sprayed over the surface of the paper or fabric, and the cork sprinkled over it by the aid of a sieve, the product being ready for use when dry. Cork paper is an effective and cheap wrapping for bottles, the sheet being cut to the size of the bottle, lapped round it, cork side inwards, and fastened with an elastic band or other suitable means.

5. METALLIC PAPER (PAPIER MÉTALLIQUE).

To make so-called metallic paper out of ordinary writing paper, all that is necessary is to coat it with powdered chalk. The pencils for writing on this paper are made of an alloy composed of 2 parts of lead and 5 of bismuth.

6. TELEGRAPHIC PAPER.

The electro-chemical paper used with the Morse telegraph instrument is made in the following manner:—

A sufficiently sized paper is treated with a solution of—

Water	100 parts.
Ammonium carbonate crystals . .	150 ,,
Potassium ferrocyanide . . .	5 ,,

When this paper is used, the lever with dry printing styles and the coil and armature are not required; and the message can be reproduced more rapidly by electricity than by the tapping of the lever. Good results have been obtained in long distance telegraphy.

7. PAPER FOR GUN CARTRIDGES.

(*a*) Düppel paper. This is a sized, nitrated paper, prepared by acting on thin paper for 2 minutes with a mixture of equal volumes of concentrated nitric and sulphuric acids, followed by careful washing with water (ammonia being added to the final water) and drying.

(*b*) This paper leaves no residue behind when the gun is fired, nor does it detonate in exploding.

Water	70 parts,
Potassium chlorate . .	9 ,,
Potassium nitrate	4½ ,,

Potassium ferrocyanide	$3\frac{1}{4}$ parts,
Powdered charcoal	$3\frac{1}{2}$,,
Starch	$\frac{1}{21}$ part,
Potassium chromate	$\frac{1}{10}$,,

are boiled and stirred together for an hour. The paper for cartridges is soaked in this solution and lapped round rollers of the proper diameter, being afterwards dried at a temperature up to 140° F. The cartridges are waterproofed in a solution of gun cotton in acetic acid.

8. TORTOISESHELL PAPER.

According to W. Ferguson's patent, tortoiseshell paper is made by rubbing a little starch paste gently, for some time, over the face of metal paper (gold paper), wiping off all the superfluous paste, and then washing the surface over with several glaze colours of different shades of brown, to imitate the markings of tortoiseshell. When dry, the metallic surface is coated with gelatine and satinised, and is then finished.

To make stiff and waterproof veneers, the gilded surface of the paper is painted in the manner described above, and is then coated twice with chrome glue and once with chrome gelatine, being then laid, face downward, on a sheet of oiled plate glass and weighted. When the gelatine layer is quite dry, the paper is stripped off the glass, and exposed to the direct rays of the sun for 2 hours, or for 10 hours to diffuse daylight, which renders the chrome-gelatine layer insoluble, without diminishing its gloss. The back of the veneer can then be primed with oil paint.

9. ARTIFICIAL SNOW PAPER.

A very popular method of increasing the effect of coloured cards is to imitate glistening, new-fallen snow by means of fine particles of mica.

In the earlier examples of this decoration, the parts to be covered with the mica were first painted over with a mixture of gum, sugar, and glycerine, to fix the mica applied by dusting. Nowadays this part of the work is done with the aid of a litho, hand, or machine press, in the same manner as in bronzing. A special printing plate is prepared and marked in bold strokes with the brush on the places where the mica is to be applied. For printing, the following special varnish is prepared: Resin is rubbed down to a pulp with thin varnish, which is heated until the resin is dissolved, a little gold size being added, together with a few drops of driers or dammar varnish, according to the character of the paper to be printed on. The impression with this varnish need only be applied once if the snow portion of the picture has already received an application of colour; but if it comes on an unprinted portion of the surface, a second impression is usually required after the first one is dry. The paper is laid, face down, in a flat box containing a layer of powdered mica, and on being lifted out is wiped over with a soft pad of cotton wool, which fixes the mica on the varnished spots and removes the remainder. After a few days, the picture is gone over again with a soft brush, and all the loose mica taken off. The floating mica dust being injurious to the lungs, all persons engaged in this work should wear respirators.

11. SOAP PAPER.

Glycerine	10 parts,
Spirit	30 ,,
Dry glycerine soap	60 ,,
Ordinary neutral soap	50 ,,

form the material with which the paper (thin satin paper) is impregnated. The mass is placed in a trough and warmed to 170°–180° F. The trough contains three rollers, all driven in the same direction by steam or other source of power, and underneath which the paper is conducted. During the treatment the paper is sprayed with a little oil of turpentine, to accelerate drying and also impart a glossy appearance.

12. WEATHER-GAUGE PAPERS.

Blue.

Cobalt chloride	1 part.
Gelatine	10 parts.
Water	100 ,,

Yellow.

Copper chloride	1 part.
Gelatine	10 parts.
Water	100 ,,

Green.

Cobalt chloride	1 part.
Nickelous nitrate	$\frac{3}{4}$,,
Copper chloride	$\frac{1}{4}$,,
Gelatine	20 parts.
Water	100 ,,

The gelatine is softened in water, and is then melted with the other ingredients over a gentle fire. The mass finds a number of practical applications, for instance, window panes coated therewith will appear colourless in dull weather, but develop colours that modify the light when the weather is bright. Wallpapers impregnated with these preparations can be obtained by passing the paper from a roll, over a couple of rollers and then over a warmed sheet metal trough containing the mass.

13. TOUGHENED FILTER PAPER.

Ordinary filter paper can be toughened considerably without affecting its porosity, by immersion in nitric acid of sp. gr. 1·42, or by moistening it with this acid and then washing with water. Such paper can be washed, rubbed with a linen rag, and has ten times the tensile strength as untreated paper. On which account it is specially adapted for aspirator filters, in which case only the tip of the filtering cone is treated as described.

No nitrogen is taken up by the paper during the treatment, but it loses weight a little, through parting with ash constituents, and contracts to such an extent that the diameter of a circular filter paper is reduced from 11·5 cms. to 10·4 cms.

14. PAPER FOR MAGIC LANTERN PICTURES.

A transparent paper to replace transfer pictures for magic lantern slides must be of such amorphous structure that no fibres can be detected when exposed to the powerful light of the lantern; and should produce the same effect as photographic slides on glass. With this object, thin paper (post paper, for example) is placed in a bath of creosote oil, or brushed over with that liquid, and left in contact therewith till the fibrous structure of the paper can no longer be detected. The superfluous oil is removed by placing the paper between two sheets of blotting paper, and the paper is transferred to a solution of colophony, or similar substance, in alcohol. When dry the paper is coated with a thin film of gelatine, then printed by any of the usual methods, and finally coated with thin spirit varnish. The resulting pictures are equal to ordinary glass slides. They may also be printed on a long strip of the prepared paper, which when unwound from one roller and wound on another, enables a continuous series of views to be shown in the lantern.

15. SPLIT PAPER.

The possibility of splitting paper has latterly attracted a good deal of attention; and this faculty has been frequently utilised by Scamoni in connection with woodcuts, spoilt in appearance by print, etc., showing through from the under side. This authority, who has perfected the delicate operations relating to this process, describes it as follows: Fine, very smooth, and strong linen union is cut into two pieces of equal size, large enough to project about $3\frac{1}{2}$ inches beyond the picture all round. This material is boiled in clean water until all the dressing has been removed, then swilled in several changes of water, and strongly pressed (not wrung). The two pieces are spread on a smoothly planed board, and coated very evenly with thin, freshly prepared starch paste, the back of the picture being also treated in the same way. The picture is next laid, face up, on one of the sheets, and carefully rubbed over, to expel air bubbles. This done, the other side of the picture is coated with paste, and the second sheet of cloth is laid over it and treated as before. The next stage is to cover the whole with a smooth board and bind it firmly in a bookbinder's press for 12 hours, or weight it with a heavy stone plate until the starch paste is perfectly dry. The closely adhering pieces of linen are then pushed forward, about a hand's breadth from under the boards or weight, and a beginning is made at pulling them apart. This causes the paper fastened between them to split into two equal layers; and when a good start has been made, the operation can be carried through until the separation is complete. The woodcut, freed from the half carrying the letterpress, has now to be loosened from the linen to which it is stuck, and with this object, warm water is squeezed on to it from a sponge, until the underlying paste is thoroughly softened. At this stage a sheet of glass is laid on the back of the picture, the two being reversed, in contact, and the linen stripped off. The woodcut resting on the glass is freed from the superficial layer of paste by means of a soft badger-hair brush and warm water, and dried in a warm plate. After being carefully smoothened in a press or by ironing on a flat plate, it will be ready for reproduction.

16. CHARRED-OUTLINE PICTURES.

To prepare hidden pictures, the outlines of which are revealed by the smouldering of the treated parts on being brought into contact with a glowing object, paper is printed or drawn upon with a hot concentrated solution of lead nitrate and starch paste. In the case of battles or hunting scenes, the firing of guns can be illustrated by arranging small fulminate caps, covered with satin paper, at suitable parts of the picture.

17. FLEXIBLE MIRRORS.

Paper, or a piece of fabric coated with albumin, is treated to one or two coats of transparent lacquer varnish, and before this is perfectly dry a sheet of tinfoil is laid over it. When the latter has stuck tight, mercury is poured over it as in making glass mirrors, the cover paper is damped and stripped, and the back coated with paint and a layer of paper.

18. ICE PAPER.

A concentrated solution of lead acetate is brushed over sized paper or cardboard, and after the salt has crystallised out and the whole is dry, it is fixed with a coating of colourless varnish.

19. SULPHUR PAPER.

The strips of sulphur paper employed for fumigating wine casks measure about 1 inch by 12, and are prepared by dipping white paper in melted sulphur. At one time it was the custom among vintners to add to the sulphur small quantities of crushed spices like nutmeg, cloves, cinnamon, with the idea of improving the aroma of the wine; but this practice has fallen into desuetude.

20. ARTIFICIAL FLOWER PAPER.

According to Bianchi, Chinese rice paper (Papyrifera) is steeped for 1½–2 hours in a solution of—

Saltpetre	125 parts,
Alum	125 ,,
Potassium carbonate	125 ,,
Distilled or rain water	3750 ,,

prepared hot, cooled to about 100° F. and then mixed with 100 parts of wood spirit and 30 of glycerine.

The paper is next drained, and pressed gently to expel the superfluous solution, the sheets being afterwards spread out in a warm room for about 2 hours and then coloured, for example, with a solution containing 3750 parts of dye solution liquor, 375 parts of wood spirit and 375 of glycerine. After gently squeezing the paper, it is spread out and dried in the shade.

21. INDELIBLE PICTURES.

Pictures of this kind are obtained by coating one or both sides of the printed paper with a thin, transparent sheet of pyralin, celluloid, or other mass containing pyroxylin as the chief component. When both sides are protected in this way, only the front layer need be transparent, the one at the back being coloured in any desired way. The celluloid sheet is moistened with alcohol or other solvent of pyroxylin, and the picture is pressed on to it, either by hand or in a press. A transparent cement may also be used, or again the solvent or adhesive may be replaced by warmth and pressure. The picture may be backed with cardboard or wood, in which case the front alone is covered with celluloid. When the celluloid plate has been fastened in position it is polished.

22. BAROMETER PICTURES (WEATHER—GAUGE PICTURES).

A solution of cobaltous sulphate in water is mixed with an alcoholic solution of potassium thiocyanate (sulphocyanide), so long as a precipitate of potassium sulphate is formed. When this has settled down the liquid is filtered, the residue washed with alcohol, and the filtrate concentrated on the water bath if necessary. This solution is used for impregnating paper, which is afterwards printed with one or other of the following colours:—

Brown.

Potassium bromide	1 part.
Copper sulphate.	1 ,,
Water	20 parts.

Yellow-Green.

Cobalt chromate	0·5 part.
Nitric acid	1 ,,
Common salt (slightly warmed) .	1 ,,

Yellow.

Common salt	1 part.
Cobalt chloride	1 ,,
Water	20 parts.

Pictures printed in this way will change colour according to the humidity of the air.

23. ALBUMIN CLARIFYING PAPER.

Unsized paper is dipped in albumin that has been beaten to froth and allowed to subside, and is then hung in the sun to dry, this treatment being repeated several times. To clarify wine, liqueurs, or other liquids, a piece of the prepared paper is torn into shreds, which are then stirred round in a portion of the liquid to be treated. The clarifying action is due to the presence of the albumin.

24. INSULATING PAPER.

Paper for lapping round steam and water pipes, to prevent loss of heat by radiation, is prepared by fastening a layer of cottonwool, wool, hair, etc., between two sheets of paper, by the aid of an adhesive. The resulting material is wound spirally, one or more times, round the pipes to be protected, and is fastened on by string.

25. ELECTRIC PAPER.

Satin or filter paper is soaked in a mixture of equal parts of nitric and sulphuric acid, and afterwards dried, in which state it forms pyroxylin—a substance analogous to gun cotton. This paper is highly electric when subjected to rapid friction—far more so than ordinary paper. The property in question is retained for a long time and can be restored by gentle heating when it shows signs of diminishing.

26. PAPER FLOOR COVERING.

Paper floor carpeting is prepared on the floor itself in the following manner: The floor is first carefully cleaned, and all holes and cracks are stopped with a filling obtained by soaking newspaper with a paste made from—

Wheaten flour	50 parts.
Water	300 „
Alum	2 „

The floor is next coated with this paste and covered with a layer of manila or other strong hemp paper. To obtain a very durable covering, this layer in turn is coated with the paste and covered with a second layer of paper. After this has dried thoroughly, a layer of wallpaper of any desired kind is pasted over it; and the latter may be protected against wear by two or more coats of a solution of 250 parts of pale glue in 2000 of hot water, topped with pale boiled linseed oil when dry.

27. PAPER MATCHES.

Sheets of paper or thin millboard are impregnated with saltpetre solution containing some substance that gives out an agreeable aroma when burned. When thoroughly dry two of these sheets are placed together with an intermediate thin layer of gum, phosphorus (or phosphorus compounds) and some incombustible material—like powdered glass, pumice, or calcined alum—to prevent the phosphorus composition burning too freely. That portion of the sheets, however, that will be held between the fingers when using the match, is not coated with the said composition. The dried double sheet is cut into thin strips of the proper shape. The strips, or matches, may be coated with varnish at the phosphorus end, to protect them from moisture, and also to prevent ignition by friction during transport.

A coloured varnish may be used to distinguish the phosphorus end from the other; and if necessary the former may be dipped in a more inflammable phosphorus composition than the rest.

28. CROCODILE TEARS—PHYSICAL TOY.

Thin, white cardboard is steeped in a saturated solution of fluoresceine, and then dried and perforated to form a number of small squares—40–60 on a sheet. If one of these squares be placed in a glass of water—which must be perfectly steady, or the experiment will fail—the fluoresceine will quickly dissolve with the formation of curious mushroom or nail-shaped tufts, as seen in Fig. 36. These have a beautiful emerald or malachite green colour, and disseminate a phosphorescent sheen in sinking to the bottom of the glass; and at the end of a few minutes the entire liquid will be coloured a bright green.

29. MAGIC PICTURES.

These pictures consist of two sheets of paper, fastened together, one of which is translucent, and is coloured on the

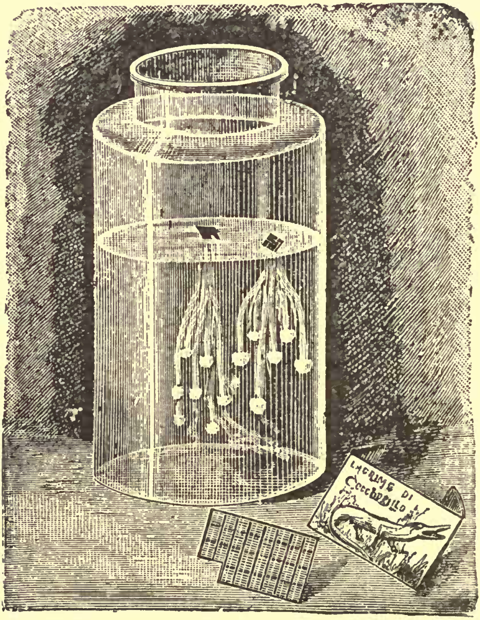


FIG. 36.—Crocodile tears.

under side, so that little colour shows through on the face, on which are drawn the outlines of the picture or the lettering. The backing paper serves to mask the colouring and to stiffen the pictures if the latter be cut out of the sheet.

The pictures are prepared by drawing the outlines of the picture on one side of a slightly sized (pervious) paper (satin paper, for instance), whilst the other side is coated or printed with suitable colours in such a manner that when water is brushed over the face of the picture, the underlying colours dissolve and show through, thus causing great surprise. To hide the colour beforehand and stiffen the paper, a second sheet of paper is pasted over them, or else they are coated over with a covering paint. To prevent the colours from overrunning the edges of the design when the brush used is too damp, the colour side of the paper is painted over with a glacé colour mixed up with a minimum of vehicle. The outlines and colours are preferably produced by lithography. By using a sappy black colour, the dissolved colours can be advantageously restricted. The stones for the colour printings are outlined by taking an impression from the outline stone so as to ensure perfect register. Any non-poisonous colours that are soluble in water are suitable. They are prepared by grinding with boiled linseed oil (two-thirds to one-third) and printed thinly from a not too damp stone, in order to prevent the colours striking through. If the outlines are printed on the front and the colours on the back of the same sheet of paper, that side of the backing sheet that is next the colours is preferably coated with ultramarine or indigo, to prevent the colours shining through. The two sheets are stuck together with strong glue or a strong varnish containing driers, and possibly some pigment added in the boiling. Of course the outlines and colours may both be printed on the under side of the top sheet so that when the paper is worked on with a damp brush the whole picture shows up at once.

LAUNDRY BLUE PAPERS.

These papers are made of very absorbent blotting paper impregnated with various pigments: indigo, indigo-carmine, Paris blue, or also with blue coal tar dyes, which they give up on immersion in water. They have the advantage over laundry blues in the solid or paste form of actually staining the water with dissolved colour, and not—as in the case of ultramarine blocks—merely charging the liquid with insoluble matter in suspension, which matter unless very finely divided is liable to ball and produce deep blue stains on the linen. The above sole advantage is, however, great enough to make bluing papers popular with housewives who have once tried them, in comparison with other preparations.

Naturally, the indigo-carmine, aniline blue, or Paris blue used in making these papers must be readily soluble in water and of strong tinctorial properties, since the goodness of the paper is dependent thereon.

1.	Indigo	200 parts.
	Sulphuric acid	750 ,,
	Sodium bicarbonate	65 ,,
	Water	900 ,,

The sulphuric acid is warmed to 122° F. in a porcelain dish, and the indigo, previously powdered and thoroughly dried on the water bath, is stirred in, a little at a time, until dissolved.

The dish is covered and left for 12 hours, the water being then added and left for 4 days with frequent stirring. At the end of this time the sodium bicarbonate is dissolved in a little water and added by degrees until the main solution is perfectly neutral. After standing another day the mixture is stirred up and strained through a clean, undyed woollen cloth. When thoroughly drained, the residue in the cloth is washed with a little water, which is added to the rest of the filtrate, and the entire runnings are evaporated to dryness on the water bath. The product is the so-called carmine blue or soluble indigo. Ten parts of this are dissolved in 1500 of warm water, left to settle in a cool place (cellar) for several days, and then decanted into a flat dish, taking care not to disturb the sediment.

Fairly thick absorbent paper is dipped repeatedly in this solution until thoroughly impregnated, and is then hung on cords in a warm room to dry.

To avoid the trouble involved in the foregoing operation of making the indigo-carmine, the same may be purchased ready made, and merely has to be dissolved in warm water as above.

2. A cheaper and simpler method is to employ a coal tar dye, such as fast blue, the best kind to use being ascertained by trying a few samples from the different makers. The colour imparted to the paper in this way is, however, less permanent than indigo.

BLUE PAPER FOR BLEACHERS' USE.

One part of best indigo is finely ground and bolted, and mixed by stirring with 3 parts of sulphuric acid, the temperature being kept down by placing the indigo pan in cold water. After 3 days, 60 parts of water are added, followed by 5 parts of cow hair, the whole being boiled for 3 hours with constant stirring, till the hair is dyed a deep blue-green colour. After cooling, the hair is left for another 24 hours in the bath, and is next transferred to cold water and gently washed, the blue colouring matter being then extracted by boiling the hair in a bath containing 10 parts of water and 10 of soda to each part of indigo. The filtered solution is concentrated to half its original volume, cooled and left for 24 hours, during which time the colouring matter will settle down as a thick pulp. This is placed in a wide, shallow vessel and mixed with a solution of glycerine. Unsized paper is steeped in this strong liquor for 5 minutes, and acquired a deep blue colour, whereupon it is taken out, pressed, and dried.

CHAPTER XIX.

Waterproof Papers.

WASHABLE DRAWING PAPER.

ANY convenient make of paper is taken, and primed with glue or other suitable medium containing a powdered inorganic substance like zinc-white, chalk, heavy spar, etc., and any desired colouring matter. The paper is next coated with or dipped in water glass containing a little magnesia, and left to dry for 10 days at 77° F.

Writings or drawings made on this paper with lead pencil, chalk, crayon, charcoal, Indian ink, or litho chalk can be washed off again, twenty times or more, without appreciably affecting the paper—a great advantage for schools, drawing classes, etc. In drafting designs, plates, etc., the paper affords the advantage that any errors can be quickly removed with a wet sponge and corrected, since the washed surface is ready for immediate use. This paper can also replace the heavy slates used in schools, etc., and is recommended because it can be stained any colour that is not fatiguing to the eye.

WATERPROOF SATIN PAPER.

A waterproof paper, resembling parchment paper, that can be moistened without injury, and is also suitable for tracing paper, is obtained by floating satin paper on a solution of shellac in borax water. This treatment makes the paper transparent and impervious to both fats and water. After drying in the open air it is smoothed with a hot iron.

Brown satin paper treated in this way and made into sausage skins has the appearance of having been smoke cured. By staining the shellac solution with different aniline dyes, a paper can be prepared suitable for making artificial flowers, etc.

IMPERVIOUS PAPER.

According to Miran, unsized paper can be rendered impervious by immersing it in a bath of—

Gas tar	1000 parts,
Mineral oil	100 ,,
Sodium carbonate	100 ,,

followed by drying, either in the air or by passing it over heated rollers.

IMPERVIOUS PACKING PAPER FOR HYGROSCOPIC SUBSTANCES.

A packing paper for bleaching powder, alkalis, and hygroscopic substances generally can be waterproofed by dipping in boiled linseed oil and drying in the air. The joins and corners of the packages are made airtight by pasting them down with shellac or the like.

WATERPROOFING COMPOSITION FOR CELLULOSE CASKS.

Petroleum	1250 parts,
Resin	260 ,,
Linseed oil	350 ,,
Vaseline oil	25 ,,

are melted together and applied in a hot state to the cellulose casks.

WATERPROOFING COMPOSITION FOR CARTRIDGES.

Paraffin wax	100 parts,
Colophony.	15 ,,

are melted together and the cardboard shells are steeped in the hot liquid until no more bubbles appear—a sign that all the air has been expelled from the material of the shells—after which they are allowed to drain.

WASHABLE CARD FOR PHOTOGRAPHIC AND LITHOGRAPHIC PURPOSES.

Many unsuccessful attempts have been made to make glacé paper washable by means of aqueous solutions of shellac or dissolved paraffin wax, the surfacing composition of *blanc-fixe* chalk, etc., being rendered curdy and lumpy by these adjuncts, and spoiled for the purposes in view.

This defect can, however, be overcome in the following manner:—

A shellac solution is made with borax or sal ammoniac, and 2000 parts of this are mixed with a solution prepared by extracting 100 parts of marshmallow root with 500 parts of water. The mixture is stirred in with a thin pulp obtained by stirring 1000 parts of slightly alkaline aluminium hydrate, 10 parts of potassium chromate (in 150 of water) 500 parts of liquid glue (sp. gr. 1·05) and 200 parts of water.

Another pulp is made by mixing 8000–1000 parts of *blanc-fixe* with 10,000–20,000 of liquid glue (as above) and about 500 parts of dissolved shellac.

These two preparations are strained together through a fine sieve and treated with about 250 parts of glycerine. The resulting product is soft and workable, can be shaded any colour by lakes, and when used for coating card or glacé paper, and satinised after drying and polishing, furnishes a printing and embossing surface that has a high gloss and will stand washing.

ANTI-PERSPIRATION SOCKS.

Boot socks that are proof against perspiration are made of three thicknesses of paper, the bottom one being impregnated with chrome-glue, the middle one coated with starch paste, and the top layer faced with stearine. The three thicknesses are stuck together by passing them through rollers, then exposed to light on the chrome-glue side, passed through warm rollers and cut into sheets, which are subjected to a pressure of 500–600 tons in a hydraulic press and dried at 95° F.

WASHABLE COLOURED PAPER.

In the preparation of these papers the use of paraffin wax is advisable, and when properly applied will give satisfactory results. Of course it cannot be used to advantage on paper that is to be hot calendered, but only for glossy or glacé paper, a very fine gloss being obtained by smoothing on a stone and by friction. The wax is incorporated with the staining colour in marking the paper, either by adding the dissolved paraffin to the liquid colour, or by melting the solid wax along with the latter. The following modifications may be adopted :—

1. The paraffin is melted in a large brass pan by gentle fire heat or steam, with continued stirring, which is kept up after removing the pan from the source of heat, till the contents begin to set at the edges. At this stage about 6 parts of petroleum ether or carbon disulphide are stirred in until the wax is dissolved. The solution is either stored in tightly closed vessels, or may be used at once. In this and the following method precautions must be taken against fire.

2. The paraffin wax is shredded very fine and placed in a tightly closed vessel where it is suffused with 5 times its weight of carbon disulphide, and left for 2–3 days to dissolve completely to a thick, milky mass.

The paraffin solution from 1 or 2 is mixed with the staining colour as follows: 100 parts of *blanc-fixe*, with the necessary shading colour are mixed with 11–15 parts of glue jelly, followed by 12–17 parts of the dissolved paraffin, and 12 parts of softened wax as generally used in the production of coloured papers. If the colour be too thick it is reduced with luke-warm water and strained through a fine hair sieve for use.

3. The ready mixed colour can be mixed with the undissolved paraffin wax by finely shredding the latter and adding it by degrees to the warmed colour (105° F.), the whole being stirred until the paraffin has disappeared. The solution is, however, less complete than by the other methods.

These washable coloured papers have a much higher gloss than ordinary glacé paper, when stone-surfaced and friction-polished. The paraffin wax has no effect on the colours; neither has the carbon disulphide, unless the prepared colour be allowed to stand for some time, in which event sulphuretted hydrogen is liberated by the glue and carbon disulphide. The colour should, therefore, be used whilst quite fresh, since once dry there is no reaction of the kind.

Other recipes for the same purpose are—

One part of paraffin wax is dissolved by immersion in 5 parts of carbon disulphide for 2–3 days, the milky solution being then mixed with the colour as follows: 100 parts of *blanc-fixe* are mixed with the necessary colour and 12 parts of glue, followed by 16 parts of the dissolved paraffin, and 11 parts of melted wax. The resulting coloured paper acquires a high gloss when stone-surfaced, and the colour resists moisture well. Since carbon disulphide is highly inflammable, it must not be brought near a fire or open light.

The best way to waterproof satinised papers is with a mixture of turpentine and shellac solution, as follows: 550 parts of turpentine are boiled in a copper pan with 600 of water, and stirred until all lumps have disappeared. This turpentine pulp is mixed with 4000–6000 parts of an aqueous solution of shellac, and the whole kneaded with 1000 parts of *blanc-fixe*. No glue or starch is required.

According to another report, paraffined coloured paper is prepared in the following manner:—

1. Formula for waterproof coloured paper to be stone-surfaced or friction-polished—

Colour	50 parts.	
Water	10 ,,	
Glue	4 ,,	dissolved in
Water	4 ,,	
Paraffin wax . . .	5 ,,	
Wax soap	5 ,,	

2. Formula for waterproof photographic cards—

Colour	20 parts.	
Glue	3 ,,	dissolved in
Water	6 ,,	
Paraffin wax . . .	2 ,,	

The paraffin is added after the colour and size have been thoroughly mixed. The finished preparation can be applied by hand or machine, is supple, and does not crack if laid on too thickly. The matt-coloured surface takes a finer polish when rubbed with a cloth than other coloured papers. This gloss reappears after the paper has been immersed in water—an important feature for photographic papers; and the gloss also reappears after the removal of spots of starch paste, etc., by washing. The paraffin can be mixed with any colouring matter, and the longer the paper is stored the faster is the colour.

WATERPROOF PAPERS.

Water glass is mixed with oil and stirred up with melted wax until homogeneous, the soda of the water glass facilitating the combination of the other ingredients. Vegetable oils (*e.g.* cottonseed oil) are best, but mineral oil will do. Any bad smell can be masked by scent. The mass is applied in a melted condition to one or both sides of the paper, which it renders waterproof and mothproof, besides making it sufficiently transparent for use as tracing paper. To reduce the consumption of the expensive wax, the paper may be dipped in oil first.

Blackburn's Recipe.

Two gallons of soft water are heated to boiling, and to them is added $\frac{3}{4}$ lb. of glue followed by $\frac{1}{2}$ lb. of good soft soap, 1 lb. of flour, and $\frac{1}{4}$ lb. of salt; the whole being boiled till an intimate mixture of the ingredients is obtained. This mass is applied warm to both sides of the paper with a brush. The paper is preferably washed with a solution of alum beforehand.

Mitschele's Recipe.

Oleomargaric or margaric acid is saponified with an alkali and sufficient water, until no more free acid is left. Aluminium sulphate or some other salt of alumina is added to the mass, and the mixture is heated until the alumina-soap separates from the water, which is then poured off. After the soap has been repeatedly washed it is saponified again with water and alkali until sufficiently soluble to impregnate paper. When dry the paper is passed through a bath of alum or other mineral salt to again make the compound insoluble. In this way the paper is waterproofed right through, without losing its flexibility or becoming hard or brittle.

Carmichael's Recipe.

This is an improved method of impregnating paper with oil, instead of allowing the oil to dry on the surface and make the paper leathery. According to the Patent Specification, linseed oil is boiled to the thickness of syrup, and after cooling is heated again to 285° F. When paper is passed through this oil bath and then through rollers, etc., which remove the oil again, only the interior fibres remain impregnated with oil. On passing this paper through rollers heated to about 212° F., the oil only oxidises and hardens (according to the inventor's idea) in the interior of the paper, the latter retaining its external appearance and flexibility. The impregnated paper will stand hot and cold water and atmospheric influences.

Dorlan's Recipe.

Waterproof paper, specially adapted for wallpapers is made by mixing the paper-stock with bleaching powder solution in the pulp mill, and omitting to wash it out again, the paper being afterwards sized as usual. The mutual reaction of the bleach and size renders the paper waterproof by the formation of calcium resinate.

Bird's Recipe.

Colophony	50 parts,
Paraffin	45 ,,
Water glass	5 ,,

are melted together in a pan and poured into a heated trough through which a band of paper or millboard is passed. The proportions of colophony and paraffin are varied according to the uses for which the product is intended, but the water glass is always 5 per cent. of the whole. The impregnated paper, etc., is dried and smoothed between rollers, and is suitable for wall or ceiling paper.

WATERPROOF MILLBOARD.

According to E. Nolan's patent, wood is boiled for 10–15 hours, under a pressure of 5–6 atmospheres, in association with petroleum, common salt, and saltpetre. This treatment is said to give a tougher pulp than when water alone is used; and the petroleum loosens the resins from the fibre. The wood is then pulped in the usual way and made up into millboard, the dried sheets of which are steeped in a mixture of resin dissolved in: turpentine 20 per cent., asphaltum 30 per cent., glue dissolved in linseed oil 50 per cent.

This mixture is prepared by dissolving the resin in turpentine and the glue in linseed oil by the aid of heat. The impregnated board is squeezed between rollers before drying, this pressure filling up all the internal pores and making the board perfectly waterproof. Any desired colour can be incorporated, together with white lead or lead oxide, in the above mixture.

SUGAR PAPER.

The paper is cut into sheets and coated by hand with a colour prepared from logwood extract, green vitriol, and potato starch. It is then hung up in a room warmed to 77° F., the coated surface acquiring a dull dark grey shade. The dried sheets are brushed over with size and again dried, the surface now being a glossy black.

This dual treatment, however, makes the paper dearer than it should be, and the following method is much simpler, enabling the colour to be laid on by a device interposed between the paper machine and the drying cylinder, so that hand work is reduced to a minimum.

With this object—

Ordinary glue	8 parts,
Water	16 ,,

Potato starch	1 part,
Water	$5\frac{1}{2}$ parts,
Campeachy logwood extract (6° B.) .	$5\frac{1}{4}$,,
Green vitriol	$1\frac{1}{4}$,,
Water	4 ,,
Dark glycerine	8 ,,

are boiled together, and one application of this preparation will give the paper a better black and brighter gloss than the old method in two coatings, the paper also being softer to handle. The colour must be used fresh or it gets hard like all preparations containing glue, though it can be resoftened by warming. The glycerine does not retard drying nor does it make the paper moist when stored in a damp room. To alter the consistency the proportion of glue and starch must be changed accordingly, both in the same ratio, in order not to affect the gloss. The omission of glycerine leaves the black lifeless, this substance counteracting the tendency of the insoluble compound of glue and logwood to give a matt surface. This property of glycerine is shown by the fact that in its presence the usual flocculent precipitate formed on treating dilute glue with dilute tannin fails to appear.

CHAPTER XX.

The Characteristics of Paper—Paper Testing.

OWING to the enormous demand existing for paper at the present time, the supply of rags—from which paper was exclusively made in former days—is far too small to meet requirements, and numerous substitutes have therefore been proposed—most of them, however, being too dear to have more that a limited application. By far the most important of these substitutes are wood pulp, straw, and esparto grass. The introduction of chlorine bleaching and paper machines soon led the public to look for very white smooth paper, so that the makers, to improve these properties, began to load the paper with fine white pulverulent mineral substances, such as kaolin, china clay, gypsum, heavy spar, alumina, etc., to such an extent, indeed, that the quality of the paper very soon began to deteriorate. The blame for this has been laid on the use of machinery in papermaking, but unjustly, since machine-made paper of the same materials as hand-made is quite equal to the latter. The deterioration of the paper must be sought in the selection and preparation of the raw materials—the pulping mill, for instance, being often run in such a way (to obtain an increased output) that the fibres are injured and ground too fine. In bleaching again, insufficient care is used in protecting the fibres from the chemicals in the treatment and washing, and so forth. It must also be remembered that any earthy substance added to the fibres reduces their felting power and tensile strength. Finally, it is true that the old method of sizing with glue and drying the paper in the open air increased its strength.

In this respect the paper machine must take some blame, since it is not yet the custom to size with glue in the machine,

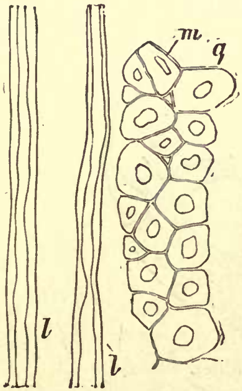


FIG. 37.—Jute fibres.
l. Bast cell fragment.
q. Section through jute fibre.
m. Lumen.

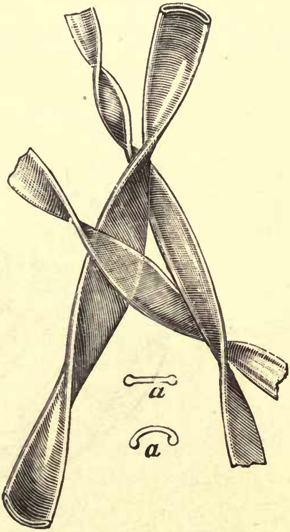


FIG. 38.—Cotton fibre.
Magnified 300 times.
a. Cross section in water.

and finish the drying of the paper under slight tension. On the other hand, with good machines, the relative difference in strength caused by the drying process is far less than generally supposed, though there is a great difference in the elasticity, air-dried paper stretching four times as much before tearing as that dried on the machine.

The quality of paper and its value for certain purposes depend on certain properties which must be determined, both quantitatively and qualitatively, before a decision can be formed. Chief among these properties are tensile strength, elongation, and durability, next in order coming smoothness, evenness of structure, colour, thickness, sizing, etc. Tensile strength is the resistance offered to breaking (tearing) strain, or to pressure applied to the surface; *e.g.* by the impact of a finger tip to a

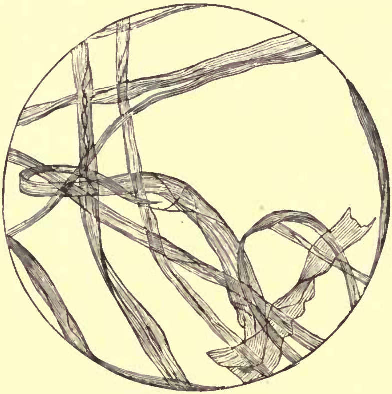


FIG. 39.—Cotton fibres.

stretched sheet, by the cutting effect of string on the edges in packing, or, finally, by folding or pulling. Durability is the property of paper to keep its tensile strength for a considerable time without much or any alteration.

Since, when paper is torn, the interrupted continuity may result from either the breakage or slipping of the fibres, the durability of the paper depends on both the material and twisting of the fibres, and the latter in turn on their length and flexibility; long, powerful fibres, for instance, will twist better than short and stiffer ones. Moreover, the sizing also influences the cohesion of the fibres. A decrease in tensile strength results in lessened durability, but this is due to chemical action, causing a gradual decomposition of the paper, and will be less apparent the smaller the amount of decomposable matter present. Hence the most durable paper is one made of very long, strong, and flexible fibres of pure cellulose. Sizing with glue has a better effect than any other adhesive on the tensile strength of the paper.

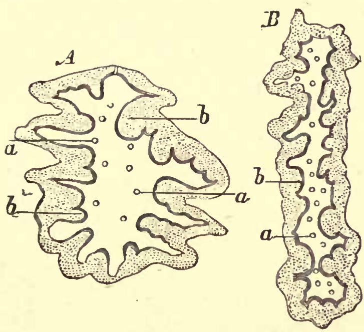


FIG. 40.—*A* and *B*, epidermis cells of maize fibre ; *a*, pores ; *b*, layers of the cell wall.

Hoyer, from whom these data are borrowed, classifies papers as follows :

1. Papers made from flax or hemp ;
2. " " cotton, esparto, jute, nettle fibre ;
3. " " wood cellulose and straw ;
4. " " wood, wool ;
5. " " wool, hair, silk.

Each class is subdivided according to the method of sizing, and a number of intermediate varieties arise from the mixing of the various fibres among themselves and with other substances, especially loading ingredients. The quality of paper is lower in proportion as its composition gets farther and farther away from that of linen paper sized with glue.

Owing to the great increase in the number of sub-varieties of paper, the differences in their composition have decreased, and the difficulties of examination grown in proportion, so that mistakes in judgment are more than ever liable to be committed. On this account it is desirable to establish certain standards, for better sorts at least, according to which papers can be

FIG. 41.—Epidermis cells of rye straw.

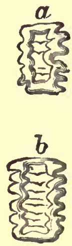


FIG. 42.—Epidermis cells of esparto.

selected and used for the purposes in view. The first of these standards is naturally that of tensile strength and elongation. The standard adopted is that of the breaking length: *i.e.* the length at which a body of uniform section will break under its own weight.

Thus if a strip of paper 15 mm. wide will break under a weight of 5000 grms., and the paper weighs 75 grms. per square metre, the breaking length will be—

$$\frac{500\ 0}{75 \times 15} \times 1000 = 4444 \text{ metres (5500 yds.)}.$$

Now it may be stated that paper with a breaking length of less than 2200 yds. is bad.

Between 2,200 and 2,750	. . .	moderate.
,, 2,750 ,, 3,300	. . .	fairly good.
,, 3,300 ,, 4,400	. . .	good.
,, 4,400 ,, 5,500	. . .	very good.
,, 5,500 ,, 6,600	. . .	excellent.

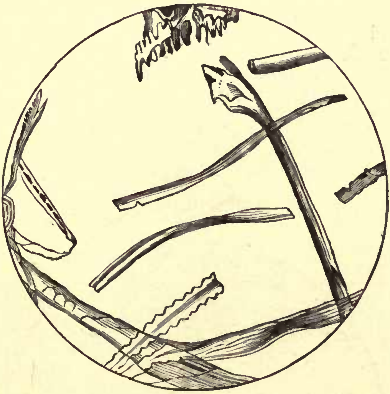


FIG. 43.—Straw.

Bearing also in mind that the best grades of paper should have a certain weight, without any loading ingredients other than size and blue (*i.e.* a low ash content), together with a certain elongation before breaking, we can lay down certain requirements that paper should fulfil for certain purposes, as is done in the following table:—

TABLE OF STANDARDS FOR PAPERS.

Kind of Paper.	Ash.	Elongation.	Weight per sq. yard.	Breaking length.
	Per cent.	Per cent.	oz.	yards.
1. Document and book paper (sized with glue) . .	1·0	4·0	4	5,500
2. Document and book paper (sized with resin) . .	2·0	3·5	4	4,400
3. Official and letter paper .	2·0	3·0	3·6	4,400
4. Draft paper . . .	2·0	2·5	2·8	3,300
5. Sized printing paper .	2·0	2·5	2·8	3,300
6. Blotting paper . . .	0·4	1·5	2·4	1,100

It should also be noted that the best paper ought to be free from wood, straw, and similar fibres, since these do not

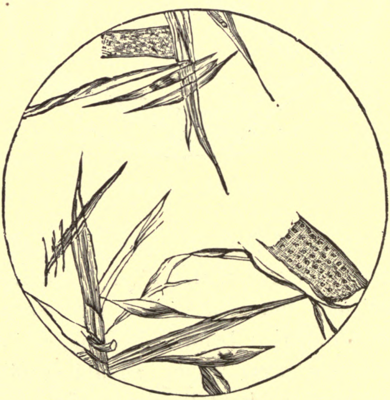


FIG. 44.—Aspen wood (section).

felt, and are of doubtful durability on account of their chemical behaviour.

The testing of paper to see whether it comes up to the prescribed standard is a task that cannot very well be undertaken by the general consumer, but must be relegated to a properly equipped laboratory under skilled management.

The only reliable way to identify the fibrous constituents of paper is with the microscope, under which instrument they appear in the forms shown in Figs. 37–42. The remarkable difference between the fibres of linen (Fig. 47) and jute (Fig. 43) and those from fabrics (Figs. 47 and 38) will be understood when it is remembered that the fibres

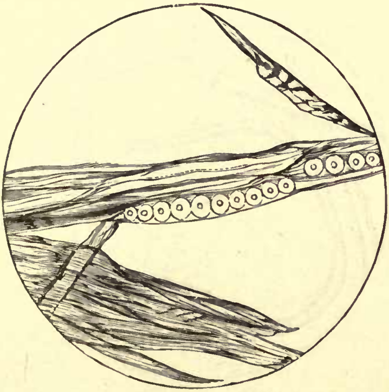


FIG. 45.—Fir wood (section).

are greatly broken down in papermaking. Oftentimes they are recognisable only by certain peculiarities, such as vascular fragments, epidermal cells, etc., in the case of wood, straw, maize, esparto, and others. Maize when present is detected by the action of chromic acid which shows up the epidermis cells with pores *a*, and stratified cell walls *b* (Fig. 40, *A* and *B*). Esparto under the same treatment looks as shown in Fig. 42, *a* and *b*. Rye straw as in Figs. 41 and 42; coniferous wood (Fig. 45), deciduous timber (Fig. 44). The paper is prepared for the test by soaking it all night in ether, then boiling it for a few minutes in a 5 per cent. solution of hydrochloric acid and finally in water. A fragment about $\frac{1}{2}$ an inch square is moistened with glycerine and dissected with a pair of fine needles, the fragments being placed under a cover glass and examined. When staining or other reagents are used the glycerine is omitted.

Owing to the skill required in microscope work, attempts have been made to fine chemical reagents affording reliable tests for the lignified cells of wood, jute, etc. Of these,

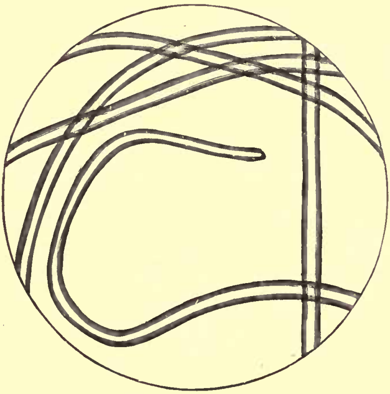


FIG. 46.—Jute.

phloroglucine as a $\frac{1}{2}$ per cent. aqueous solution imparts a purple red stain to paper containing wood wool, when applied to the paper moistened with hydrochloric acid. *Aniline sulphate* (1 per cent. solution) gives a yellow stain to the same paper; *naphthylamine chloride* an orange; and a mixture of 1 part of sulphuric acid and 3 of nitric acid, a brown-yellow. Phloroglucine, however, is the most sensitive and only reliable test; and none of the foregoing reagents is applicable to wood cellulose prepared by chemical processes.

To test paper for size, the presence of starch, and therefore resin sizing, is shown by the blue coloration given with a single drop of iodine tincture. Glue can be detected by boiling 5–10 grms. of the paper in small fragments with 120 c.c. of water until only about 25 grms. of liquid remain. On pouring this into a flask with 5 c.c. of 5 per cent. caustic soda and 5 c.c. of a 1 per cent. solution of mercuric chloride (sublimate) and boiling up for 3–5 minutes, the reddish-yellow precipitate of mercuric oxide will turn dark grey, if glue be present, owing to partial reduction, whereas in presence

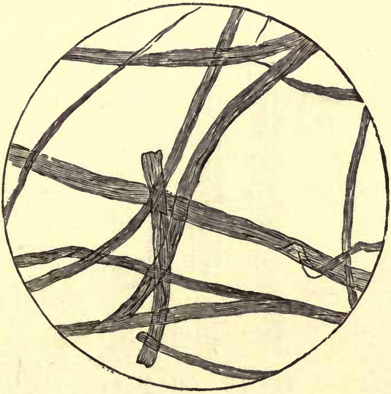


FIG. 47.—Linen.

of resin size it will only acquire a faintly greenish tinge. The quantitative determination of resin-starch size is effected by soaking paper all night in sulphuric ether, drying 2–5 grms. of cut fragments at 100° C., and boiling them in alcohol containing a few drops of hydrochloric acid. After pouring off this solution, the paper is boiled 2 or 3 times with pure alcohol, dried at 100° C., and weighed. Any loss observed is resin. After again boiling the paper with equal volumes of alcohol and acidified water, till the liquid gives no blue stain with iodine, it is dried at 100° C. and reweighed, any further loss being starch. To allow for the dissolved mineral matters in paper free from loading ingredients, $\frac{1}{10}$ of the weight of the resin may be deducted.

Some papers are acid or contain free chlorine, and in either case turn brittle and perish. Since litmus is not a reliable test, being also reddened by the acid aluminium sulphate used in sizing, the test for free acid must be applied by means of methyl orange (0·25 per cent. aqueous or alcoholic solution),

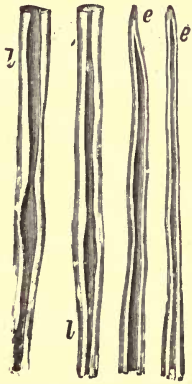


FIG. 48.—Jute fibre ;
l with contracted lumen ; *e* ends of fibres.

which will give a deep rose-red in presence of 0·01 grm. of free acid per litre. Chlorine is detected in the extract by the cloudy precipitate given by silver nitrate (1 per cent. solution). Free chlorine is revealed by the blue to violet coloration imparted to the extract by a paste consisting of 1 part of starch, 3 of water, and 1 of potassium iodide.

The capacity of paper to retard the passage of ink, is determined by Leonhardi as follows: A line about $\frac{1}{25}$ inch wide is drawn on one side of the paper with a horn pen charged with a neutral solution of ferric chloride containing 1·531 per cent. of iron. When dry, the other side of the paper is suffused at the corresponding part with a little sulphuric ether (sp. gr. 0·726) saturated with pure tannin. Porous paper exhibits a more or less greenish-black stain due to the reaction of the tannin and iron.

In testing the tensile strength and elasticity of paper in the dynamometer, at least 5 sheets 13×8 ins. are required, and these should be perfectly clean, and free from defects, tears, or folds. When sent through the post to the testing laboratory, they should be packed in millboard to prevent injury from the cancelling stamps, etc., *en route*. Only paper that is used in smaller sheets (letter paper, etc.) should be sent in smaller sizes than that specified. For the other tests—ash content, mineral adjuncts, sizing, kind of fibre, etc.—5 grms. of paper will be needed, or enough to furnish 5 sheets of 4 sq. cms. area. For complete analyses, enough paper should be sent to give at least 2 grms. of ash in the combustion test.

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