CRAFTING PAPER

A JOURNEY THROUGH HISTORY AND ART

Introduction: Paper-making is an ancient craft that blends creativity and practicality. From its humble beginnings in ancient China to its widespread use in the modern world, paper-making has evolved into a sophisticated art form. This e-book explores the rich history, techniques, and artistic possibilities of paper-making, guiding you through the process of creating your own beautiful sheets of paper.

A Brief History: Paper-making began in China around, attributed to Cai Lun, a court official. Early paper was made from mulberry bark, hemp, rags, and fishnets. The technique spread to the Islamic world, then to Europe, where it became central to printing and writing. Today, paper-making is a blend of tradition and innovation, incorporating both manual and industrial processes. Paper-making is a craft with roots deeply embedded in ancient history, evolving over centuries to become a sophisticated and essential aspect of human culture.

Origins in Ancient China: The art of paper-making is believed to have begun in China around Cai Lun, a court official during the Han Dynasty, is often credited with the invention of paper. However, evidence suggests that paper-like materials were produced even earlier. The earliest Chinese papers were made from plant fibers like mulberry bark, hemp, and rags. This early paper was prized for its durability and flexibility, and it quickly became integral to Chinese culture and administration.

Spread to the Islamic World: The knowledge of paper-making spread to the Islamic world through the Silk Road. By the 8th century, paper-making was introduced to the Islamic empire. The process was refined in places like Samarkand and Baghdad, where the use of paper became widespread. The Islamic world's contributions included advancements in paper quality and the development of paper mills, which improved production efficiency.

Introduction to Europe: Paper-making reached Europe by the century, primarily through Spain and Italy, where it was initially used for administrative and scholarly purposes. European paper-makers adapted and improved the process, including innovations such as water-powered mills and the introduction of cotton rags as a primary source of fiber. By the century, paper became crucial to the spread of knowledge, particularly with the advent of the printing press.

Industrial Revolution and Modern Era: The century Industrial Revolution brought significant changes to paper-making. The invention of the Fourdrinier machine revolutionized production, allowing for continuous rolls of paper and increasing output. This period also saw the development of wood pulp as a primary raw material, replacing traditional fibers and making paper more affordable and accessible.

Contemporary Practices: Today, paper-making is a blend of traditional techniques and modern technology. While large-scale production remains dominated by industrial methods, there is a renewed interest in artisanal and sustainable paper-making. Craft paper-makers use recycled materials, eco-friendly processes, and innovative techniques to produce unique, high-quality paper.

Materials and Tools, To begin paper-making, you'll need: **Fiber Sources**: Traditional materials include cotton rags, linen, and hemp. For a modern twist, try using recycled paper or plant fibers like bamboo or banana leaves.**Papermaking Pulp**: This is the mixture of fibers and water that forms the paper. It can be prepared using a blender or a traditional Hollander beater.**Mold and Deckle**: A mold is a frame covered with fine mesh, while a deckle is a removable frame that defines the edges of the paper.**Pressing Equipment**: To remove excess water and compact the fibers, you can use a pressing board or a hand-operated press.**Drying Surface**: A flat, absorbent surface like a felt or cloth is needed for drying your paper sheets.

The Paper-Making Process

1. **Preparing the Pulp**, **Collect and Soak Fibers**: Start by collecting your chosen fiber source. Tear it into small pieces and soak them in water overnight to soften.**Blending**: Blend the soaked fibers with water to create a slurry. The consistency should be similar to a thick soup.
2. **Forming the Paper**, **Setup**: Place the mold and deckle into a container filled with water. Pour a portion of the pulp onto the mold, evenly distributing it.**Sifting**: Gently shake the mold back and forth to evenly spread the pulp and remove any air bubbles. The deckle helps shape the paper's edges.**Couching**: Carefully lift the mold and let excess water drain. Place the mold on a damp felt or cloth and remove the deckle. Transfer the wet paper to another piece of felt to continue drying.
3. **Pressing and Drying**, **Pressing**: Stack the wet sheets between felts or cloths and apply pressure to remove excess water. You can use a press or hand-roll with a rolling pin.**Drying**: Hang or lay the sheets flat on a drying surface. Allow them to dry completely, which may take several hours to a few days depending on the thickness and environment.

Techniques and Variations

- **Hand-Made vs. Machine-Made**: Hand-made paper often has a unique texture and irregularity that machine-made paper lacks. Experimenting with different fiber combinations and additives can produce interesting textures and colors.
- **Additives**: You can add natural dyes, flower petals, or metallic flakes to the pulp for decorative effects. Be creative with your additives to personalize your paper.
- **Embossing and Molding**: Use textured materials or molds to create patterns and designs on your paper. You can press objects into the wet pulp to leave impressions.

Artistic Uses of Handmade Paper: Handmade paper is more than just a medium for writing. It has artistic and practical applications:**Art Projects**: Use it for painting, drawing, or mixed media artworks. The texture of handmade paper adds a unique dimension to your creations.**Stationery**: Create custom stationery, greeting cards, or invitations. Handmade paper makes a personal and elegant touch.**Bookbinding**: Handmade paper is perfect for creating unique, one-of-a-kind journals or sketchbooks.

Care and Preservation: To keep your handmade paper in good condition: **Storage**: Store paper in a cool, dry place away from direct sunlight. Keep it flat or rolled loosely to prevent warping.**Handling**: Handle with clean hands or gloves to avoid oils and dirt. Use acid-free materials for storage and display.

Waterproof Paper.—Scoffern and Tidcombe's Process.—In this process, for which a patent was granted in, the well-known solubility of cellulose in cupro-ammonium is taken advantage of, for the purpose of producing waterproof paper by destroying its absorptive properties. After the paper is made and dried in the usual way by the paper-making machine, it is led through a bath of cuproammonium, having a roll or rollers therein, or in connection therewith, either on reels on which the paper is reeled, or from the continuous web of paper itself directly from the machine, and from this bath it is led over a table of wire-cloth, or india-rubber, or over a series of rollers forming a table, under which steampipes are placed for the purpose of "setting," or partially drying, the web; it is then led over suitable reels in a hot-air chamber to season or finish the treated paper, which is then cut as the paper runs, by the ordinary cutting machine, into the required sheets.

The chamber in which the paper is treated is ventilated as follows:—Over the bath and hot-air chamber is another chamber having openings leading into the hot-air chamber, and at these openings a steam-blast, or fan-blast, is applied, which ventilates the chamber in which the paper is heated, and drives the ammonia into contact with either sulphurous or hydrochloric acid, and by this means the ammonia is recovered in a solid form which would otherwise be wasted. The inventors also incorporate hydrated oxide of copper with paper pulp, so that after it is made into paper it has only to be subjected to the action of ammonia, as ordinarily done, or to the action of gaseous ammonia mingled with steam. Brown papers are strengthened and glazed by passing them through a bath of pulp containing cupro-ammonium, either with or without pitch, tar, or other resinous matters.

It is well known that by passing paper through a cuproammonium bath it is surface dissolved and glazed by its own material, and if it be desired to unite two or more sheets together this is the most economical way of conducting the operation; but if it be desired to strengthen and glaze a single thickness of paper or millboard, it is considered undesirable to make the glaze by dissolving a portion of the paper itself. In this case the inventors pass the web or sheet of paper through a bath, not of cupro-ammonium simply, but of cuproammonium in which ligneous material is already dissolved; and when the glazing of brown paper is to be effected, they prefer to fortify the bath with tar, pitch, marine glue, or other resinous materials. By this process, panels and tiles may be manufactured from millboard, or thick sheets of ligneous material made from pulp already incorporated with hydrated oxide of copper. The panels, etc., are passed, by means of an endless web, through a bath of ammoniacal solution, or the vapour of ammonia and steam, and the tiles or panels may be surfaceglazed by exposing them while moist to the action of fluo-silicic acid gas, by which silica is deposited in the material and on its surface.

Dr. Wright's Process for preparing Cupro-ammonium.—This process, which has been adopted at the Willesden Paper Mills, may be thus briefly described:—In the first part of the process, metallic copper, in small lumps, solid metal, or clippings, etc., is covered with a solution of ammonia in water, or with a weak solution of cupro-ammonium hydrate, containing an amount of free ammonia in solution dependent upon the strength of the copper solution ultimately required; a current of air is then caused to pass through the whole by means of an air-pump, in such a manner that the bubbles of air pass over and amongst the fragments of metallic copper, which, if in small particles, may be advantageously kept in suspension by any convenient agitator. In a few hours the liquid becomes saturated with as much copper as it can dissolve, the rate of solution varying with the form of the vessel containing the materials, the strength of the ammoniacal fluid, and the rate of the passage of the stream of air. To carry this process into effect, metallic copper in fragments of convenient size is loosely piled inside a vertical tube or tower, and water is allowed to trickle from a pipe over the copper so as to keep its surface moist.

At the base of the tower a current of air, mixed with ammonia gas, is caused to pass into the tower, so as to ascend upwards, meeting the descending water as it trickles over the copper. Under these conditions the copper becomes oxidised, and the water dissolves firstly the ammonia gas, and, secondly, the oxide of copper formed, so that the liquor which passes out at the base of the tower is a solution of cuproammonium hydrate, the strength of which depends on the proportions subsisting between the bulk of the mass of copper, the quantity of water trickling over it, and the amount of air and ammonia gas supplied in a given time. As an example of the method of carrying out the above process, the inventor proceeds as follows:—He constructs a vertical iron tower which may be ten inches in internal diameter and ten feet in height, and this is filled with scraps of sheet copper.

On this water is allowed to trickle, whilst at the base of the tower a mixture of air and gaseous ammonia is allowed to pass upwards through the tower, by which a solution of cupro-ammonium is formed, which is allowed to trickle out at the base of the tower into a tank. It has been found advantageous to use a series of towers, allowing the air and ammonia gas that pass out at the top of the first tower to enter at the bottom of the second tower, and so on successively throughout the series. The weaker solutions produced in the later towers of the series are used instead of water in the earlier towers, so that practically all the ammonia gas originally used is obtained in the form of cuproammonium hydrate solution, issuing from the first tower of the series. The cupro-ammonium process, as carried on at the Willesden Mills, is applied to ropes, netting, etc., by immersing them in a solution of cupro-ammonium, which, when they are subsequently dried, gives them a varnished appearance, while at the same time, the fibres having become cemented together by the action of the cupro-ammonium, their strength is increased.

By the same process paper, canvas, and other manufactured articles are rendered waterproof. A concentrated solution of cupro-ammonium may also be used for securing envelopes, whereby the adhesion of the surfaces of the paper is rendered perfect, and the only means of opening the envelope is by cutting or tearing the paper. **Jouglet's Process.—**This process, which with modifications has been adopted by others, is based on the solvent action on cellulose of a solution of oxide of copper in ammonia. A quantity of this solution is placed in a tank, and the paper rapidly passed over and in contact with the surface of the liquid, by means of suitable rollers in motion. The paper is afterwards pressed between a pair of rolls and dried by the ordinary drying cylinders. The brief contact of the paper with the liquid occasions just sufficient action on the cellulose to have the effect of an impermeable varnish. **Waterproof Composition for Paper.—**The following composition for rendering paper waterproof for roofing and flooring purposes has been patented in America.

By preference good, hard manilla paper is selected, and a composition of the following ingredients is applied with a brush, or by means of rollers:— is dissolved in gallons of crude petroleum, of about the density of gallons of resin oil, and about half a pint of oil of eucalyptus, which will have the effect of destroying the objectionable odour of the resin oil. To this mixture is further added about 4 gallons of any ordinary drier. The above ingredients are to be thoroughly mixed by agitation, and the composition brushed over the paper in a room heated to about ., and allowed to dry. It is said that paper thus coated will exclude wind, cold, dampness, and dust. **Toughening Paper**.—Morfit's Process.—The object of the following process is to produce a paper "toughened in a degree and quality distinctively from any other in the market," and is applicable to all kinds of paper, but more particularly to those made with inferior grades of pulp for printing newspapers, and for wrapping papers.

The means employed are the seaweeds which form glutinous liquors with water, such as Carrageen, or Irish moss, Agar-agar, and the like. Any of such seaweeds may be employed, either separately or mixed with another of its kind, according to the judgment of the operator and the sort of paper to be manufactured, but some seaweeds are superior to others for this purpose. The raw seaweed is first washed, and then boiled with water until all the soluble matter has been extracted, and the resulting liquor is then strained. The hot strained liquor forms the bath in which sheets of paper or pulp are to be treated. If desired, resin soap and aluminous cake may be added to the glutinous liquor, but these "serve rather to size and make the paper rustle than increase its toughness." If the paper is to be treated in the form of sheets or web, it is to be passed, as it leaves the wire-cloth in which it is formed, through a hot solution of the seaweed alone, or mixed with resinous soap and aluminous cake, and dried by means of suitable machinery.

To apply it to the pulp, the latter is to be diffused in the hot liquor, and the sheets or web made therefrom in the usual manner. The proper proportions of seaweed, resinous soap, and aluminous cake will vary with the kind of pulp and sheets under treatment, and must be adjusted as the judgment of the operator determines best for each operation.

Tracing Paper.—Sheets of smooth unsized paper are laid flat on a table, and then carefully coated on one side only with a varnish composed of Canada balsam and oil of turpentine. The brush used for this purpose must be a clean sash tool, and when the first sheet has been varnished in this way it is to be hung across a line to dry. The operation is then to be applied to fresh sheets in succession until the required quantity of paper has been treated. In the event of one coating of the varnish not rendering the paper sufficiently transparent, a second coating may be applied when the first coating has become quite dry.

Varnished Paper.—When it is desired to varnish the surface of paper, cardwork, pasteboard, etc., it must first be rendered non-absorbent with two or three coatings of size, which will also prevent the varnish from acting upon any colour or design which may be impressed upon the paper. The size may be made by dissolving isinglass in boiling water, or by boiling clean parchment cuttings in water until a clear solution is formed, which, after straining, is ready for use. If necessary, for very delicate purposes, the size thus prepared may be clarified with a little white of egg. The size should be applied, as in the former case, with a clean sash tool, but the touch should be light, especially for the first coating, lest the inks or colours should run or become bleared. When dry, the varnish may be applied in the usual way.

Oiled Paper.—Sheets of paper are brushed over with boiled linseed oil, and then hung up to dry. Paper thus prepared is waterproof, and has been used as a substitute for bladder and gut skins for covering jam pots, etc., but the introduction of parchment paper has almost entirely superseded it.

Lithographic Paper.—This paper, which is written upon with lithographic ink, may be prepared by either of the following formulæ:—1. Take starch, 6 ozs.; gum arabic, 2 ozs.; alum, 1 oz. Make a strong solution of each separately in hot water, then mix the whole and strain the liquor through gauze. It must be applied to one side of the paper while still warm by means of a soft brush or sponge; a second or third coating may be given as the preceding one becomes dry. The paper is finally pressed to render it smooth. 2. The paper must first receive three coats of thin size, one coat of good white starch, and one coat of a weak solution of gamboge in water. The ingredients are to be applied cold with a sponge, and each coat allowed to dry before the next is applied. Cork Paper.—A paper under this title was patented in America by Messrs. H. Felt and Co.; it is prepared by coating one side of a thick, soft, and flexible paper with a mixture composed of glue, 20; gelatine, 1; and molasses, 3 parts, and covering with finely-powdered cork, which is afterwards lightly rolled in. The paper thus prepared is said to be used for packing bottles. New Japanese Paper.—According to the Bulletin du Musée Commercial, a native of Japan has recently invented a new process by which paper may be made from seaweed. The paper thus made is said to be very strong, almost untearable, and is sufficiently transparent to admit of its being used as a substitute for window glass; it takes all colours well, and in many respects resembles old window glass.—Board of Trade Journal.

Blotting Paper.—This paper, requiring to be very absorbent, is not sized, but is prepared with starch alone, which, while holding the fibres together, does not affect the absorbent property of the paper. Dunbar gives a recipe for making blotting paper which has been found successful, and from which we make a few extracts. In selecting materials for blotting, of high-class, cotton rags of the weakest and tenderest description procurable should be chosen. Boil them with 4 lbs. of caustic soda to the cwt.—that is, if you have no facilities for boiling them in lime alone. When furnished to the breaking-engine, wash the rags thoroughly before letting down the roll; when this is done, reduce them to half-stuff, and as soon as possible convey them to the potcher. When up to the desired colour, drain immediately. The breaker-plate should be sharp for blottings, and the beater-roll and plate also in good order, and the stuff beaten smartly for not more than an hour and a half in the engine. For pink blottings furnish two-thirds white cottons and one-third of Turkey reds if they can be got, or dye with cochineal to desired shade; empty down to the machine before starting, and see that the vacuum pumps are in good condition.

Remove weights from couch-roll, and if there are lifting screws raise the top couch-roll a little. Take shake-belt off, as the shake will not be required. Press light with first press, and have the top roll of the second press covered with an ordinary jacket similar to couch-roll jacket. Dry hard, and pass through one calender with weights off, and roll as light as possible, just enough to smooth slightly.

Parchment Paper.—This paper, which is extensively used for covering jars and pots for pickles and jams, is prepared, according to the process of Poumarède and Figuier, as follows:—White unsized paper is dipped for half a minute in strong sulphuric acid, specific gravity 1·842, and afterwards in water containing a little ammonia. By Gaine's process (1857) unsized paper is plunged for a few seconds into sulphuric acid diluted with half to a quarter of its bulk of water (the acid being added to the water), and the solution allowed to cool until of the same temperature as the air. The paper is afterwards washed with weak ammonia. This process, which has been extensively worked by Messrs. De la Rue and Co., produces a far better material than the foregoing.

Mill and Card-board.—In the manufacture of boards refuse materials of all kinds that occur in the paper-mill may be used, and these are sorted according to the quality of boards for which they are best suited. After being well beaten the resulting mass is mixed with suitable proportions of rag pulp, kaolin, chalk, white clays, &c. There are four principal processes by which boards are manufactured, namely, 1. By superposing several sheets of paper and causing them to unite by a sizing material. 2. By superposing several wet leaves at the time of couching. 3. By moulds provided with thick deckles. 4. By special machines similar to those used for making continuous webs of paper, but without a drying cylinder, the sheets being dried in the open air or in a heated room. The third method is only adopted for boards of moderate thickness, as an excess of pulp would render the draining difficult.

Making Paper or Cardboard with two Faces by Ordinary Machine.—By this process, recently patented by Mr. A. Diana, all kinds of thin or thick paper or cardboard are manufactured with two different faces by means of the ordinary paper-machine, having a single flat table with a single wire-gauze web, without requiring a second metallic web. For this purpose the two pulps are prepared separately, and one is caused to pass on to the web in an almost liquid condition; this is allowed to drain off sufficiently, and the second pulp (also in a liquid condition) is then passed uniformly upon the whole surface of the previous layer. The water drains off from this layer through the first layer, and the paper or cardboard is thus directly formed with two different faces, the subsequent operations being as ordinarily employed in paper-making. The space between two of the suction cases employed for drawing off the water in the pulp is a suitable point for the distribution of the diluted second pulp, which is almost liquid.

Test Papers.—These papers, which are extensively used both in the laboratory and the factory, for determining the presence of acids or alkalies in various liquids, may be prepared as follows:—Litmus paper, for detecting the presence of acids, is prepared by first making an infusion of litmus. Reduce to a paste with a pestle and mortar 1 oz. of litmus, adding a little boiling water; then add more boiling water—from 3 to 4 ozs. in all—and put the mixture into a flask and boil for a few minutes; finally, add more boiling water to make up half a pint, and when cold filter the liquor. To prepare the test paper, a sufficient quantity of the liquid being poured into a flat dish, pieces of unsized paper are steeped in the blue liquid, so that all surfaces may be thoroughly wetted; the paper is then to be hung up by one corner to drain, and afterwards dried. As many sheets of paper as may be required should be treated in this way, and the sheets afterwards cut up into convenient strips for use. Red litmus paper, for detecting slight traces of alkali in liquids, may be prepared by dipping a glass rod, previously dipped into a very dilute solution of sulphuric acid, into one-half of the above infusion, repeating the operation cautiously until the liquid turns from blue to a slightly red tint. Unsized paper when dipped in this will acquire a reddish colour which is very sensitive to the action of weak alkaline liquors, and the vapour of ammonia restores the blue colour instantly. Turmeric paper is prepared by dipping unsized paper in a decoction of turmeric—about 2 ozs. to the pint. Paper steeped in this solution and dried acquires a yellow colour, which turns brown in alkaline solutions.

Bentley and Jackson's Drum-Washer.—This drum-washer, for use in the rag-engine, is shown in. It has cast-iron ends, strong copper buckets, shaft, stands, lifting-gear, and driving-wheel, but instead of the drum being covered with the ordinary strong brass backing-wire, it is covered with their improved "honey-comb" backing-plates, over which the fine wire is wrapped as usual. The honey-comb backing consists of tough rolled brass or copper plates, curved to suit the diameter of the drum, and secured to its ends by cross-bars. It is practicably indestructible, strengthens the drum, and by maintaining its cylindrical form, adds considerably to the durability of the fine covering-wire.

Drying Cylinders.—These cylinders, by the same firm, for which patents were obtained in, are made with concave and convex ends, the latter type being shown in. The cylinder body is made of hard cast-iron, turned and polished on outside surface. The ends and trunnions are of tough cast iron, turned to fit into their places, and there secured by bolts and nuts by a patented method, whereby no bolts (excepting for the manhole) are put through the metal, an unbroken surface is preserved, and the annoyance of leakage through the bolt-holes is avoided. A manhole and cover is fitted to all cylinders 3 feet in diameter and upwards, and a water-lifter and pipe to remove the condensed steam. The trunnions are bored to receive nozzles or junctions for admitting steam, and the whole, when completed, is carefully balanced and tested by steam pressure to per square inch. The firm state that they have made cylinders from in diameter by this system..

Self-acting Dry Felt Regulator.—This contrivance, which is manufactured by Messrs. Bentley and Jackson, is represented in front and side elevation in . A is the framing of the paper-machine, B the felt-rollers, C the dry felt; D is a slide carrying one end of the felt guide-roller B; C is a shaft across the machine, with a pulley F, two-keyed on one end, and a bevel pinion two-keyed on the other end. The pulley F and pinion H are keyed together, and run loose upon the shaft G; I is a bevel-wheel, gearing into the pinions H and 2. The wheel I is connected by a spindle and a pair of bevel-wheels to a screw E, which works through a threaded bush. When the machine is at work, if the felt C should run on one side, it will pass between the pulley F and the guide-roller B, causing the pulley to revolve, and turning the screw E in the threaded bush, thereby moving the slide fixing D and the guide-roller B, which causes the felt to run back. Should the felt run to the other side, it will run in contact with the pulley , and thus reverse the motion of the guide-roller B.

Paper-cutting Machine.—This machine, which is manufactured by the same firm, is constructed to cut from one to eight webs simultaneously, in sheets of any required length, from 8 to 60 inches. It is built on the "Verny" principle, and its operation is as follows:—The webs of paper from the reel-rolls are carried by an endless felt, and the paper is drawn off the rolls by travelling cast-iron gripper beams, which firmly grasp the felt and the webs of paper to be cut, the travel of the beams being equal to the length of the sheet of paper to be cut. When the required length of the sheet is drawn from the rolls, a cast-iron clamp, placed close to the dead cross-cut knife, descends and firmly holds the paper until the movable cross-cut knife has cut off the sheets, which fall on a second endless felt, and are placed by the catchers in the usual manner. As soon as the sheets are cut, the clamp is released, and the travelling-grippers are again ready to seize the paper and repeat the operation.

Single Web Winding Machine.—This machine is constructed for preparing webs of paper for continuous printing-presses. The roll of paper to be prepared is carried by brass bearings having vertical and horizontal screw adjustments attached to standards mounted on a slide, and movable by a screw transversely on the machine to accommodate the deckle edges. The paper web is taken through a pair of iron draw-rolls, carried by brass bearings, fitted in castiron stands; there are two pairs of ripping-knives with bosses, springs, and collars, mounted on turned wrought-iron shafts running in brass bearings carried by cast-iron stands; a wrought-iron leading-roll and carrying brackets fitted with brass bushes; a copper measuring roll counter, geared to indicate up to yards, with disengaging apparatus to cease measuring when the paper breaks; a friction-drum 2 feet in diameter, made of wood, mounted on cast-iron rings, and a wrought-iron shaft, all carefully turned and balanced; two cast-iron swivelling arms, with brass sliding bearings to carry the mandrel on which the prepared web is to be wound, with screws, struts, wheels and shaft to regulate the angular pressure of the roll of paper against the wood drum, according to its weight and the quantity of paper**.**

Cooling and Damping Rolls.—The illustration represents an. apparatus, constructed by Messrs. Bentley and Jackson, for cooling and damping paper after leaving the drying cylinders and before passing through the calenders. It consists of two brass rolls bored and fitted with cast-iron ends, brass nozzles, and regulating taps, through which the rolls are supplied with a constant flow of water. The rolls are carried by cast-iron standards, fitted with brass steps and cast-iron caps. Jets of steam are blown on each of the rolls from a perforated copper pipe running parallel with, and at a little distance from, the body of the roll.

The steam is condensed on the cold surfaces of the brass rolls, and absorbed by the web of paper, which passes around and in contact with their surfaces, and is consequently damped on both sides. The perforated steam-pipes are enclosed by copper hoods, to prevent the steam from spreading, and the supply of steam is regulated by ordinary brass valves or cocks. The rolls are geared together by a pair of spur-wheels, and driven by a pulley of suitable diameter.

Reversing or Plate-glazing Calender.—This machine, which is shown in, is also made by the firm referred to, and consists of two hammered iron rolls, each about twelve inches in diameter, of any suitable length, carefully turned and carried by strong cast-iron standards, fitted with bell-metal steps. The top roll is provided with setting-down blocks and brasses, compound levers and weights to regulate the pressure required. The two rolls are geared together by strong shrouded wheels, and driven by a strong cast-iron spur-wheel and pinion, a driving-shaft, fast and loose pulleys, carried by castiron stands and pedestals fitted with brass steps. The machine is fitted with two metal feed-tables, and a self-acting apparatus for returning the sheets to the rolls, and a handle-lever, slide-bar, and strap-forks for starting and reversing.

Plate-planing Machine.—This machine, which is manufactured by Messrs. Bryan Donkin and Co., of Bermondsey, is shown in. By its aid the plates of rag-engines can be sharpened without being taken to pieces. The slide of the machine is made exactly like the roll-bar planing machine (see below), and is so arranged that it can easily be taken off and used for sharpening roll-bars.

Roll-Ear Planing Machine.—In the accompanying engraving is shown an apparatus fitted to a rag-engine for sharpening rag-engine rollbars, and it will be seen that by means of it the operation can be performed. without removing the roll from its usual position. The edges of the bars are first planed by a tool supplied by the manufacturers to render the whole cylindrical before sharpening them; the bevelled sides are then planed by suitable tools, two of which accompany the apparatus. This method of sharpening renders the bars uniform in shape, the roll is kept in better working order, and it can be dressed in considerably less time, and at less expense, than can be done by chipping by hand.

Washing-Cylinder for Rag-Engine.—The illustration at represents the machine as manufactured by Messrs. Bryan Donkin and Co. It is so made that the water is delivered on the driving side of the rag-engine, thus avoiding any trough across the engine, and admitting of the midfeather being thin, as is usual in cast-iron engines. It is all self-contained, and the driving apparatus is wholly on the outside of the engine. The raising and lowering are effected by a worm and worm-wheel, so that the cylinder will stop at any point required.

Bleach Pump.—In the accompanying engraving is shown a pump, manufactured by Bryan Donkin and Co., which is arranged expressly for the purpose of pumping up bleach-liquor. Each pump is all self-contained, and merely requires a drum and strap to drive it. The live and dead riggers upon the pump allow it to be started and stopped at pleasure. "In all paper-mills," say the manufacturers, "the bleach-liquor should be used over and over again, not only to save bleach, which amounts to a considerable sum in the course of a year, but also to keep the paper clean."

Three-Roll Smoothing-Presses.—The engraving shows a damp smoothing-press, with rolls for smoothing the paper between the two sections of drying cylinders of a paper-machine. The makers are Messrs. Bryan Donkin and Co. A three-roll smoothing press, for smoothing the paper at the end of a paper-machine, also by the same makers, is shown in.

Back-water Pump.—The engraving shows a pair of back or sizewater pumps, manufactured by Bertrams, Limited. The barrels are of cast-iron, lined with copper. The suction and discharge valves are each contained in a chamber with covers, so that every valve could be easily got at by simply releasing the cover. The valve-seats are of brass, with brass guards and rubber clacks. The plungers are of brass, with cup-leathers. All is fitted up on a castiron sole-plate, with tall standards, disc-cranks, and driving-pulley between frames.

Web-glazing Calender.— represents Bertrams' web-glazing calender, with steam-engine attached. The illustration shows the machine in front elevation. The steam-engine is specially designed for this class of work, having two cylinders in diameter by stroke, fitted on a doublehooded sole-plate, with double-throw crank-shaft, fly-wheel, two eccentrics, wrought-iron piston-rods, connecting-rods and valve-rods, steam and exhaust branch pipes with one inlet valve, lubricators, and the cylinders cased with teak legging and brass hoops.

Reeling Machine.—One form of reeling machine manufactured by Bertrams, Limited, is shown in, and is used for slitting and re-reeling webs of paper, especially where large webs are requisite for web-calendering, webprinting, and suchlike. The reel of paper from the paper-machine is placed on a sliding-carriage arrangement, the brackets of which are planed and fitted to a planed sole, with wedge or dove-tail corners, and controlled by screws, handwheel, etc., so that the reel can quickly and easily be moved forward or backward to suit any unequal reeling that may have taken place on the paper or the machine.

A hot cast-iron is provided for mending breaks in the web, and a measuring-roll and counter is also applied. The machine has an important application of drawing-in or regulating rolls of cast iron, with arrangement of expanding pulley for regulating the tension on the paper. Slitting-knives, regulating, dancing, or leading-rolls, of cast iron, etc., are applied for separating the edges and guiding the webs after they are slit. The reeling is performed by a diameter drum, cross-shafts, and arms, to which regulating heads are fitted, so that several webs can be run up at one operation.

Web-Ripping Machine.—This machine, which is manufactured by Messrs. Bentley and Jackson, is shown in, and is constructed to divide webs of paper into two or more widths. It consists of two brass bearings on cast-iron standards, with screw adjustments, a break-pulley and friction-regulator, all mounted on cast-iron slides, movable transversely by means of a screw, gearedwheels, shaft and hand-wheel; a wood guide-roll, about 7 inches diameter, with wrought-iron centres, carried by brass bearings with screw adjustment; three skeleton drums, each in diameter, on wrought-iron shafts, carried by brass bearings, and driven by spur-wheels and pinions; two wrought-iron leading-rolls, with brass bearings and cast-iron stands; a pair of strong wrought-iron ripper shafts with circular steel knives, bosses, springs, and collars; cast-iron stands and brass bearings, spur-wheels and driving-pulley; two (or more) changeable wood drums in diameter, each with wrought-iron shaft and catch-box, carried by brackets fitted with brass steps for easily changing, driven by wrought-iron shafts with pedestals and friction-pulleys, in diameter, with regulating screws and lock-nuts, all carried by strong cast-iron framing and standards, and driven by a wrought-iron driving-shaft, with fast and loose driving-pulleys, strap-fork and levers for starting and stopping.

Roeckner's Clarifier.—In this apparatus, of which an illustration is given in Mr. Roeckner has taken advantage of the fact that if a column of liquid is ascending very slowly and quietly within a vessel, it will not be able to carry up with it the solid particles which it contains, which will gradually fall back and sink to the bottom under the action of gravity, without ever reaching the top of the vessel, provided this be of sufficient height. The illustration shows the arrangement of the apparatus on a small scale; the liquor to be clarified is run into a well or reservoir b; into this dip a wrought-iron cylinder c, which is open at the lower end, but hermetically closed at the top by means of the casing d. From this casing air can be withdrawn through a pipe, h, by means of an airpump i. As soon as this is done the liquid will begin to ascend the cylinder c, and if the height of this is below that to which the water will rise at the atmospheric pressure the liquid will ascend until it fills the cylinder and the casing. Into the pocket at the side of the casing there dips a pipe g, which passes out through the opposite side of the casing, descends below the level of the water in the tank, and ends in a discharge-cock.

When this cock is opened, the cylinder c and the pipe g form between them a syphon, of which, however, the descending leg is of very small diameter compared with the ascending leg. In consequence, the liquid will rise in the cylinder c very slowly. The sediment it contains will sink back and collect in the bottom of the tank b, and clear water will flow out at the outlet. A sludge-cock at the bottom of the tank allows the solid matter to be drawn off at intervals and conveyed to any convenient place for drying, etc. For drawing clear water from a river, the clarifier would simply be placed in the river, dipping inches into it below the lowest water-level. The clear water will then be drawn through the clarifier, while the heavier matters will fall down and be carried away by the river current. It is stated that this has proved a great advantage to a paper-mill which used a river, and had, prior to its use, been much troubled through the dirt being pumped with the water. The clarifier to receive the waste from paper-machinery, or from washings in the engines, can be placed in any convenient corner, and by its action the water can be re-used, and the otherwise lost fibres collected, without its action ever being stopped.

Marshall's Perfecting Engine.—This engine, a longitudinal section of which is shown in , has been introduced into this country by Messrs. Bentley and Jackson, and is described in Industries as follows:—"The machine, which is the invention of of Turner's Falls, Mass., U.S.A., is used in one of the processes of paper manufacture, and has for its purpose the more effectual drawing of the pulp fibre, the clearance of knots from the pulp previous to its delivery on to the paper-making machine, and the saving of time in the treatment of the material. As will be seen in the illustration , the machine consists essentially of a cast-iron conical casing, bored, and fitted with about two hundred elbowed steel knives, G, placed in sections.